Psychiatry Research 190 (2011) 275–281

Contents lists available at SciVerse ScienceDirect

Psychiatry Research

journal homepage: www.elsevier.com/locate/psychres

Preliminary study of Internet addiction and cognitive function in adolescents based on IQ tests

Min-Hyeon Park [a], E-Jin Park [b], Jeewook Choi [c], Sukhi Chai [d], Ji-Han Lee [e], Chul Lee [a], Dai-Jin Kim [a,*]

[a] Department of Psychiatry, Seoul St. Mary's Hospital, The Catholic University of Korea College of Medicine, Seoul, South Korea
[b] Department of Psychiatry, Incheon St. Mary's Hospital, The Catholic University of Korea, College of Medicine, Incheon, South Korea
[c] Department of Psychiatry, Daejeon St. Mary's Hospital, The Catholic University of Korea College of Medicine, Daejeon, South Korea
[d] Department of Addiction Rehabilitation and Social Welfares, Eulji University, Seoung-nam, Gyeonggi-do, South Korea
[e] Asia Pacific International School, Seoul, South Korea

ARTICLE INFO

Article history:
Received 26 October 2010
Received in revised form 1 August 2011
Accepted 10 August 2011

Keywords:
Problematic internet use
Brain development
Adolescent
Students

ABSTRACT

The potential relationship between Internet addiction and certain cognitive function problems has been suggested by several studies. However, few or no studies have examined the differences in cognitive functioning between persons addicted to the Internet and persons not addicted using a standard neuropsychological test. This study screened 253 middle school students and 389 high school students for Internet addiction and compared 59 Internet-addicted students with 43 non-addicted students using an IQ test. The Internet-addicted group had comprehension sub-item scores that were significantly lower than those of the non-addicted group. As the comprehension item reflects ethical judgement and reality testing, there may be a relationship between Internet addiction and weak social intelligence. Earlier onset of Internet addiction and longer addiction duration were associated with lower participant performance in areas related to attention. As this study is a cross-sectional study, it is not clear whether the persons who display weak cognitive functioning are susceptible to Internet addiction or if Internet addiction causes cognitive problems. However, as brain development remains active during adolescence, the possibility that Internet addiction adversely affects the cognitive functioning of adolescents cannot be ruled out.

1. Introduction

With the continuing widespread use of the Internet, Internet addiction has drawn considerable attention. Goldberg (1996) initially defined Internet addiction as the pathological and obsessive use of the Internet. Later, Young (1998a) introduced diagnostic criteria for Internet addiction that were similar to those for pathological gambling in the Diagnostic and Statistical Manual of Mental Disorders, Fourth Edition (DSM-IV) (American Psychiatric Association, 1994).

Interest in the characteristics related to possible Internet addiction continues, and research is ongoing. Ko et al. (2010) reported that persons addicted to the Internet had personality traits including higher novelty seeking and lower reward dependence. Moreover, many studies have reported that Internet addiction correlates with psychiatric diagnoses, such as depression (Kraut et al., 1998; Young, 1998a), anxiety disorder (Shapira et al., 2000), substance-related disorders (Shapira et al., 2000), attention deficit hyperactivity disorder (ADHD) (Yoo et al., 2004) and impulse control disorder (Shapira et al., 2000).

In addition, researchers have suggested that Internet addiction might be related to cognitive function. On the one hand, people with deficits in certain aspects of cognitive functioning are more likely to be addicted to the Internet than those who have intact cognitive functioning. Pallanti et al. (2006) suggested that adolescents, whose frontal cortex and subcortical monoamine system are immature, are impulsive and have disturbance in reward motivation. Therefore, adolescents are susceptible to Internet addiction. Yoo et al. (2004) reported that persons with an attention deficit disorder, such as ADHD, or with frontal lobe control dysfunction easily become addicted to the Internet. On the other hand, there is the possibility that Internet addiction causes deficits in some cognitive functions. In a fluoro-deoxyglucose-positron emission tomography (FDG-PET) study of Internet-addicted adolescents, Koo and Paeng (2008) suggested that a neuronal adaptation to excessive visual stimulation and synaptic plasticity due to Internet addiction causes hypometabolic changes in the visual information processing circuits and hypermetabolic changes in the prefrontal areas of adolescents with Internet addiction, as compared with normal controls.

Despite these reports, few or no studies to date have used neuropsychological testing to examine the cognitive functioning of

* Corresponding author at: Department of Psychiatry, Seoul St. Mary's Hospital, The Catholic University of Korea College of Medicine, 505 Banpo-Dong, Seocho-gu, Seoul 137–701, South Korea. Tel.: +82 2 2258 6086; fax: +82 2 594 3870.
E-mail address: kdj922@catholic.ac.kr (D.-J. Kim).

0165-1781/$ – see front matter © 2011 Elsevier Ireland Ltd. All rights reserved.
doi:10.1016/j.psychres.2011.08.006

students addicted to the Internet. To our knowledge, this is the first study to test whether standard neuropsychological tests reveal cognitive differences between Internet-addicted students and non-addicted students.

2. Methods

2.1. Instruments

2.1.1. Korean Educational Developmental Institute-Wechsler Intelligence Scale for Children (KEDI-WISC)

The KEDI-WISC is a Korean version of the Wechsler Intelligence Scale for Children-Revised (WISC-R; Wechsler, 1974). This test was designed for children between 5 and 15 years of age. The KEDI-WISC consists of 10 basic tests (verbal tests comprise information, vocabulary, arithmetic, comprehension and similarities; performance tests comprise picture completion, picture arrangement, block design, object assembly and digit symbol) and two supplementary tests (verbal test, digit span; performance test and maze). In the current study, only the digit span test of the supplementary tests was used (Korea Educational Development Institute, 1987).

2.1.2. Korean-Wechsler Adult Intelligence Scale (K-WAIS)

The K-WAIS is a standardised adaptation of the revised Wechsler Adult Intelligence Scale (WAIS-R) for the Korean population (Wechsler, 1981). The K-WAIS can be used for adolescents and adults between the ages of 16 and 64. It consists of 11 subtests (verbal tests comprise information, digit span, vocabulary, arithmetic, comprehension and similarities; performance tests comprise picture completion, picture arrangement, block design, object assembly and digit symbol) (Korean Clinical Psychology Association, 1992).

2.1.3. Korean Internet Addiction Scale (K-scale)

The K-scale is a self-rating scale that measures adolescents' addictive tendencies with regard to Internet use. This scale was developed by the National Information Society Agency of Korea (2002) under the auspices of the Ministry of Information and Communication. It consists of 40 questions on a four-point Likert scale. It has seven subscales, which measure the following: (a) disturbance of adaptive function, (b) disturbance of reality testing, (c) addictive automatic thoughts, (d) withdrawal, (e) virtual interpersonal relationships, (f) deviant behaviour and (g) tolerance (National Information Society Agency of Korea, 2002). A total scale score over 89, a subscale (a) score over 19, a subscale (d) score over 14 or a subscale (g) score over 13 indicates Internet addiction. In a study conducted by the National Information Society Agency of Korea (2005), the K-scale had a Cronbach's alpha of 0.96.

2.1.4. Young's Diagnostic Questionnaire (YDQ)

Young (1998a) modified the pathological gambling model in the DSM-IV and developed a diagnostic questionnaire that consists of eight questions. An answer of 'yes' to more than five of these questions identifies a person as an addicted Internet user (Internet-addicted group), while a 'yes' to fewer than five questions indicates a normal Internet user (non-addicted group) (Young, 1998a). In a previous study of the YDQ, the instrument's split-half reliability was 0.729 and its Cronbach's alpha was 0.713 (Johansson and Gotestam, 2004).

2.1.5. Children's Depression Inventory (CDI)

The CDI is a self-report scale that evaluates the cognitive, emotional and behavioural symptoms of depression during childhood. This scale is a children's adaptation of Beck's adult depression scale (Beck et al., 1961). It is composed of 27 questions and is standardised for use with the Korean population (Cho and Lee, 1990). A score between 22 and 25 indicates mild depression, between 26 and 28 indicates substantial depression and over 29 indicates severe depression (Smucker et al., 1986).

2.1.6. State-Trait Anxiety Inventory (STAI)

The STAI comprises 40 questions: 20 questions about the patient's present anxiety state (the State Anxiety Inventory or SAI) and 20 questions about trait anxiety (the Trait Anxiety Inventory or TAI (Spielberger et al., 1970). A score greater than 41 on the SAI or a score greater than 39 on the TAI is considered high. This test has been translated and standardised for use with Korean children (Lee et al., 2008).

2.2. Participants and procedures

This study was conducted as part of the 'Clean Internet Project', carried out by Seoul Saint Mary's hospital in association with Seocho-gu Community Mental Health Center. Fifteen middle schools and 11 high schools, located in Seocho-gu, Seoul, were asked to participate in this study. Of these, one girls' middle school and one technical high school agreed to participate. Fig. 1 presents a flow chart of the participants and procedures in this study.

Between September and October 2009, the K-scale was administered to 253 seventh graders at a girls' middle school and 389 tenth and eleventh graders (of whom 40 were female) at a technical high school to identify the Internet-addicted students. Of the middle school participants, 13 students (5.14% of the seventh grade students) met the Internet addiction criteria; all of these students agreed to participate in the study. Among the high school participants, 48 students (12.34% of the high school students), including one female student, met the Internet addiction criteria. Of these students, two (one female, one male) refused to participate in the study. Ultimately, 13 female middle school students and 46 male technical high school students participated in this study as the Internet addiction group (IAG).

Of the female middle school students who, according to the K-scale, did not have Internet addiction, 21 voluntarily participated in the research. We randomly selected 13 of these students for the non-addiction group (NAG). At the technical high school, 32 students who, according to the K-scale, did not have Internet addiction voluntarily participated in the research. All of these students were selected for the NAG because this sample size was even smaller than the preferred minimum number of targeted students (46). Thus, the NAG included 13 randomly selected female middle school students and 32 male technical high school students who were not addicted to the Internet and who volunteered to participate in the study.

In the next step, a psychiatrist interviewed the participants using the YDQ to identify false-positive (inaccurate diagnosis of Internet addiction) and false-negative (inaccurate diagnosis of non-addiction to the Internet) results on the K-scale and to learn each participant's history of psychiatric treatment.

Among those in the IAG, seven had previously received psychiatric treatment, but none received treatment at the time of the study. The diagnoses of the students who had previously received medication or other treatment (counselling or cognitive behavioural therapy) were as follows: depression (4), social anxiety disorder (1) and oppositional defiant disorder (1); one student's diagnosis was unknown. None of the NAG had a history of psychiatric treatment, and none received such treatment at the time of this study.

For intelligence testing, the middle school students completed the KEDI-WISC, and the high school students completed the K-WAIS. Because depression and anxiety might affect intelligence testing and cognitive functioning (Sweeney et al., 1989; Toren et al., 2000; Porter et al., 2003; Gunther et al., 2004), we administered the CDI and STAI to the participants in both groups in order to adjust for the effects of these factors.

The following students were excluded from the study: those who withdrew consent, those who screened positive for Internet addiction according to the K-scale but did not satisfy the YDQ diagnostic criteria for Internet addiction, those who screened positive for Internet addiction on the YDQ but not on the K-scale or those who had an IQ below 70 (i.e., intellectual disability). Based on these criteria, two students were excluded from the analysis. These students were from the technical high school and in the NAG. Both were excluded because they had an IQ below 70.

Finally, we analysed data from 59 students in the IAG and 43 in the NAG. Written informed consent was obtained from each student and his or her parent, and this protocol was approved by the Ethics Committee of the Catholic University of Korea.

2.3. Statistical analysis

To compare the differences in cognitive function between the IAG and NAG, with adjustments for gender, age and CDI and SAI results, we used an analysis of covariance (ANCOVA). To determine a correlation between the duration of Internet addiction and cognitive function, Pearson's correlation test was used. The statistical significance for all tests was set at $P<0.05$. All statistical analyses were conducted using the Statistical Analysis System (SAS, version 9.1; SAS Institute Inc., Cary, NC, USA).

3. Results

3.1. Demographic characteristics of participants

There were no significant age- or gender-related differences between the IAG and NAG. Table 1 shows the demographic data and the clinical scales of the IAG and the NAG.

Both the IAG and NAG's average CDI scores were consistent with mild depression, and both groups' STAI scores were in the normal range.

3.2. Differences in intelligence test performance between the IAG and NAG

The average age for Internet-addicted users to display problematic Internet use was 9.72 (S.D. 2.31), and the duration of addiction among the female middle school students and the technical high school students was 2.91 years (S.D. 2.09) and 9.76 years (S.D. 2.43), respectively. The IAG's main addiction content was games, with 61% of the total IAG, 38.5% of the middle school IAG and 67.4% of the technical high school IAG addicted to games.

Table 2 shows a summary of the characteristics of the IAG's Internet use.