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Study Protocol of the Internet user Cohort for Unbiased Recognition of gaming disorder in Early Adolescence (iCURE), Korea, 2015–2019

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Abstract

Introduction:

In 2013, the Diagnostic and Statistical Manual of Mental Disorders, Fifth Edition (DSM-5) proposed nine internet gaming disorder (IGD) diagnostic criteria as a condition warranting further empirical and clinical research. The aim of this study is to clarify the natural and clinical courses of IGD proposed DSM-5 in adolescents and to evaluate its risk and protective factors.

Method and analysis:

The Internet user Cohort for Unbiased Recognition of gaming disorder in Early Adolescence (iCURE) study is an ongoing multidisciplinary, prospective, longitudinal cohort study conducted in 21 schools in Korea. Participant recruitment commenced in March 2015 with the goal of registering 3,000 adolescents. The baseline assessment included surveys on emotional, social, and environmental characteristics. A parent or guardian completed questionnaires and a structured psychiatric comorbidity diagnostic interview regarding their children. Adolescents with the Internet Game Use-Elicited Symptom Screen (IGUESS) total scores of 6 or higher were asked to participate in the clinical diagnostic interview. Two sub-cohorts of adolescents were constructed: a representative sub-cohort and a high-risk IGD sub-cohort. The representative sub-cohort comprises a randomly selected 10% of the iCURE to investigate the clinical course of IGD based on clinical diagnosis and to estimate the false negative rate. The high-risk IGD sub-cohort comprised participants meeting 3 or more of the nine IGD criteria, determined by clinical diagnostic interview, to show the clinical course of IGD. Follow-up data will be collected annually for the three years following the baseline assessments. The primary endpoint is 2-year incidence, remission, and recurrence rates of IGD. Cross-sectional and longitudinal associations between exposures and outcomes as well as mediation factors will be evaluated.

Ethics and dissemination: This study is approved by the Institutional Review Board of The Catholic University of Korea. Results will be published in peer-reviewed journals. This study's protocol is registered at clinicaltrials.gov (identifier: NCT02415322).

Article summary

Strengths and limitations of this study

- Internet gaming disorder (IGD) was assessed by using both polychotomous and dichotomous tools based on the nine DSM-5 IGD criteria. In addition, we are conducting structured interviews using DISC-IV of the parents or guardians to assess participant psychiatric comorbidities.
- This study is that the clinical diagnosis of IGD based on the DSM-5 is performed by qualified mental health specialists.
- It is not a representative sample because the registration was conducted among the schools in the specific area.
- The participants were included only 3rd-, 4th-, and 7th-grade students.

Introduction

Internet games are popular entertainment in modern society, with a variety of people of different ages participating in gaming. Internet game play rates and sales are increasing [1]. Players choose to play games for many reasons, including fun, recreation, coping with stress, sociability, and escaping real life [2-4]. The gaming research literature has reported both positive and negative effects on players. Playing games promotes problem solving and visual, motor, and spatial skills, and it fosters interaction with friends [5]. Although there are several positive effects of playing games for adolescents, there can also be negative effects, such as the possibility of problematic or addictive gaming [6]. Gaming has been associated with inattention and hyperactivity, aggressive behaviors, negative emotions including depression [7 8], low self-esteem, social anxiety, loneliness [9], and low psychological well-being [10].

South Korea is one of the most highly digitalized societies in the world. The Internet penetration rate in South Korea exceeded 75% in 2011 [11]. More than half of people in their 50s and almost 100% of teenagers use the Internet in their daily lives [12]. Korea has developed a computer industry with Internet use reaching over 50% of the population. Currently, in Korea, 25 million among 45 million citizens use the Internet, and 14.4 million homes are equipped with Internet access. In addition to home assess, many people visit “PC rooms”, a type of gaming center with a broad-band Internet network that is equipped with the best performance computers in Korea. PC rooms became popular following the release of the PC game StarCraft in 1998, with an estimated 25,000 PC rooms nationwide in 2014. ‘PC rooms’ have no any age restrictions on accessibility, and many adolescents often play online games [13]. A 2010 nation-wide survey regarding Internet addiction showed that 8.0% of the Korean population and 12.4% of adolescents were addicted to Internet use, as assessed via the self-administered K-scale [12]. This prevalence is a little higher than has been found in other countries, such as Singapore (8.7%) [14], the Netherlands (6.8%) [15], the US (8.5%) [16], and

China (10.8%) [17]. The higher prevalence in Korea could be expected, given that it is a country with such broad and easy access. Although the number of Internet game users has increased dramatically over the last decade, the phenomenon of Internet gaming addiction is not yet well understood, and research on its etiology and natural history is still in its infancy [2]. Studies have used various tools to estimate the prevalence of -Internet gaming disorder (IGD), but the lack of common diagnostic criteria for IGD has created difficulties in comparing studies.

In May 2013, IGD was included in Section III of the DSM-5 as a condition warranting further study [18]. This marked the first occasion of IGD being formally recognized as a mental health disorder. Even though the classification and rationale for including this condition as a mental health disorder have been controversial, the suggested IGD classification criteria have paved the way for measuring IGD in a consistent manner. These suggestions enable more direct comparisons of findings and may be used to eventually reach a consensus on the status of the disorder [19]. The DSM-5 proposes nine criteria for IGD, and it states explicitly that the specific criteria and the threshold for diagnosis require systematic investigation and empirical validation before their wide-scale adoption. The proposed criteria apply only to Internet gaming, and not general Internet use, which can differ in terms of presenting symptoms, etiology, comorbidities, course, and treatment. Empirical data are required to ascertain the extent to which these criteria apply to various populations and to aid diagnosis. To this end, we registered and began a prospective school-based cohort study of adolescents to provide evidence regarding the IGD diagnostic criteria by clarifying the characteristics of IGD's natural history. Given the broad discussion of a replicability "crisis" in many sciences, it is valuable to document *a priori* our research methods, goals, and planned approach.

Aims

The aim of the study is to clarify the natural and clinical courses of IGD based on the DSM-5 diagnostic criteria, to provide evidence for empirical validation of the suggested IGD diagnostic criteria, and to further evaluate the etiological risk and predictive factors in adolescents.

Methods

Study design and setting

The Internet user Cohort for Unbiased Recognition of gaming disorder in Early Adolescence (iCURE) study is a multidisciplinary, prospective, longitudinal cohort study of 3,000 adolescents, conducted in Korea, with 4 waves of annual data collection currently planned. The study is being conducted in Seoul and Uijeongbu, Gyeonggi Province, with 3rd-, 4th-, and 7th-grade students in 6 primary schools and 19 secondary schools participating. Participation requires consent from the participants as well as written parental consent following explanation of the nature of the principles of research, including confidentiality and the freedom of choice to participate. The study was fully reviewed and approved by the Institutional Review Board of The Catholic University of Korea (MC140NM10085) and was conducted in accordance with the Declaration of Helsinki.

Pretest and pilot test of methods

We validated the feasibility of the study before beginning data collection by performing a pretest and a pilot test. For the pretest, we recruited a convenience sample of 25 3rd- and 4th-grade students to test the understandability of the questionnaires for this age group of students. We performed a pilot test to verify that the overall survey system worked well, with participants composed of one school class of 35 students. They completed all baseline measures which were recruited outside of the sampling frame.

Recruitment

Participant recruitment commenced in March 2015. Recruitment took place at the school level. We sent official letters to all primary and secondary schools in three educational districts to invite their participation. After school principles provided consent for their schools to participate, the parents or guardians were contacted to obtain consent for their children to participate in the study. A total of 21 schools (6 elementary and 19 secondary) participated in the study, out of 258 schools (163 elementary and 95 secondary) in the three districts. In order to encourage participation in this research, the research team members visited the 21 participating schools to provide a seminar that presented the aims of the study and provided additional information about the research project to teachers and parents. The finial enrollment is expected to be 3,000 adolescents. Three regional hospitals were designated in the three areas where the participating schools are located to provide treatment options for adolescents experiencing IGD.

Inclusion and exclusion criteria

The inclusion criteria were that the participants were 3rd-, 4th-, or 7th-grade students at baseline. We required that each student participant had a parent or guardian who also participated in the study. The exclusion criteria included lack of competence in the Korean language by the parent or guardian and intellectual disability of the adolescent.

Data collection

The participants completed questionnaires at baseline and will again annually for the following three years. The baseline assessments started in May 2015. We are collecting data from multiple informants, including students' self-report questionnaires, clinical diagnostic

interviews of the students, parents' or guardians' self-report questionnaires, and structured clinical interviews of the parents or guardians regarding any psychiatric comorbidity in their children.

Follow-up and retention strategy

In an effort to maintain contact with iCURE study participants, we will send individual reports annually via registered mail, and we will periodically send text messages about general contents via cell phone to the participants. Once a year, we will send each participant's survey results to their parents via registered mail, which will be called a "mental health signal." This will include the mental health status regarding symptoms of Internet game addiction, depression, anxiety, and ADHD, marked as red, yellow, and green traffic signals, indicating symptom severity as assessed by both the self-report survey and the clinical diagnosis. We will also provide referrals for treatment availability.

During this study, we are operating a 24-hour counseling helpline for the parents and guardians. A clinical psychologist with more than 10 years of clinical experience specializing in children and adolescents is conducting telephone consultations. This telephone counseling is free and anonymous, providing parents with general counseling about their children, as well as specific counseling regarding gaming addiction.

Student self-report questionnaires

Student data collection is conducted at the schools during school hours. The7th-grade students complete questionnaires using a web-based self-administration method. The 3rd- and 4th-grade students complete the questionnaires in a class setting; a research assistant reads the questions aloud, following a standard script, to aid comprehension and diminish time demands. In later waves, all students will complete the questionnaires on their own, with a supervising research

assistant available to answer questions. During the baseline assessment, the questionnaires took approximately 90–120 minutes to complete; later waves will take approximately 45–80 minutes.

The student data collection at later waves will also be conducted at the schools during school hours. For students who transfer to other schools, arrangements will be made to complete the follow-up questionnaires, either by visiting their homes or via website access.

Interviewing parents

At baseline, each parent or guardian completed a questionnaire and the Diagnostic Interview Schedule for Children, Version 4 (DISC-IV). The DISC-IV is a highly structured diagnostic interview used to assess psychiatric disorders in children and adolescents. We are including 7 of the 34 diagnostic assessments: generalized anxiety disorder, separation anxiety, obsessive-compulsive disorder, major depression disorder, attention deficit disorder and attention deficit hyperactive disorder (ADD/ADHD), oppositional defiant disorder, and conduct disorder.

The DISC-IV was administered by trained interviewers at the participants' homes or at a private space at the school, based on the participant's preference. The parent questionnaire contained demographic questions and took 20 to 30 minutes to complete, and the DISC-IV took 40 to 90 minutes. Parent or guardian survey is conducting only at baseline.

Second-stage clinical diagnosis by mental health professionals

The clinical diagnostic interviews for IGD were conducted face-to-face by five psychiatrists and four Master's degree–level clinical psychologists with at least five years of training and clinical experience. The interviews assessed participants based on the nine DSM-5 IGD criteria, in accordance with the international consensus for IGD represented in the DSM-5 [19]. Diagnoses were based on clinically significant functional impairments that substantially

derived from gaming and not from any other psychiatric illnesses. Any psychiatric comorbidities were also thoroughly evaluated by the psychiatrists using the semi-structured tool of the Kiddie-Schedule for Affective Disorders and Schizophrenia-Present and Lifetime Version-Korean version (K-SADS-PL), which has been previously validated in Korean [20]. Global functioning was assessed using the Children's Global Assessment Scale (GAS), based on the child's worst level of emotional and behavioral functioning in the past three months. The criterion for a second-stage clinical diagnosis is an Internet Game Use-Elicited Symptom Screen (IGUESS) total score of 6 or higher, either at baseline or at the follow-up waves. Additionally, random selection of 10% of the full cohort, stratified by the school, completed the clinical diagnostic interviews at baseline and the further follow-up waves. Anyone who responds insincerely with marking all of the same numbers to the IGUESS at every wave will be excluded to rule out false negatives. Anyone who reports a suicidal experience during the past year at any wave will be given diagnostic interviews. The clinical diagnostic interviews are being conducted one week after completion of the baseline study. The interviews are being conducted confidentially in private spaces at the participants' schools.

Sub-cohorts

Two sub-cohorts have been constructed. A representative sub-cohort consists of a randomly selected 10% of adolescents in the cohort. They will participate in the clinical diagnostic interview every year to estimate the false negative rate and to evaluate the clinical course of DSM-5–defined IGD based on clinical diagnosis. Additionally, a high-risk IGD sub-cohort is comprised of those meeting 3 or more of the 9 IGD criteria, as determined by the clinical diagnostic interview at baseline and at each follow-up wave. The interviews will be conducted annually for 3 years to observe the clinical history, remission, and recurrence rates.

Measurement

The measurements using i-CURE are presented in Table 1.

Demographic information

Demographic characteristics were assessed at baseline. Sex, date of birth, family composition, and number of siblings were obtained from the student assessment, and parental education level, socio-economic status, parental marital status, parental education level, and parental job were obtained from the parent or guardian assessments.

Internet, gaming, and smartphone use

Comprehensive assessments of participants' Internet, gaming, and smartphone usage were performed, including questions regarding the first time of exposure, the average daily time spent online, and gaming-related questions, such as online gaming type preference and weekly playing time. We classified online games as role-playing games, shooter games, simulation games, arcade games, and unknown.

Regulated usage of smartphones or games

We assess school policies on possession and usage of smartphones and domestic regulations of smartphone or game time.

Internet Addiction Test (IAT)

Young's IAT consists of 20 items rated on a 5-point Likert scale from *rarely* (1) to *always* (5), with higher scores indicating more severe Internet addiction [21].

Korean Scale for Internet Addiction (K-Scale)

To assess Internet addiction, we use the K-Scale-short form for adolescents, which were developed in Korea. It is comprised of 20 items rated on a 4-point Likert scale, from 1 (*not at all*) to 4 (*always)*[22].

Internet Game Use-Elicited Symptom Screen (IGUESS)

This instrument was created based on the nine DSM-5 IGD criteria. Students are instructed to

respond based on their gaming behavior within the last 12 months, with each item rated on a 4-point scale: 1=*strongly disagree*, 2=*somewhat disagree*, 3=*somewhat agree*, 4=*strongly agree*).

Self-reported version of structured clinical interview for Internet Gaming Disorder (SR-IGD)

We use the SR-IGD to assess IGD with respect to occurrences over the past 6 months. The assessment uses yes-or-no questions [23].

Smartphone Addiction Scale (SAS-SV)

We assessed smartphone addiction using the short version of the Smartphone Addiction Scale (SAS-SV). The SAS-SV addresses the following 5 content areas with respect to the previous year: (1) daily-life disturbance, (2) withdrawal, (3) cyberspace-oriented relationship, (4) overuse, and (5) tolerance. It contains 10 items rated on a dimensional scale (1=*strongly disagree* to 6=*strongly agree*). The total scores range from 10 to 60, with the higher scores indicating greater degrees of smartphone addiction [24].

Children's Depression Inventory (CDI)

The Children's Depression Inventory (CDI) is a 27-item, self-rated, symptom-oriented scale suitable for youths aged 7 to 17 years. It assesses cognitive, affective, somatic, and behavioral symptoms, with items scored from 0 to 2, where 0 means *the symptom is not present*, 1 means *the symptom is present and mild*, and 2 means *the symptom is present and marked* [25].

Trait Anxiety Inventory for Children (TAIC)

To examine trait anxiety, we used the Korean translation [26] of the Trait Anxiety Inventory for Children (TAIC), which is part of the State-Trait Anxiety Inventory for Children (STAIC) developed by Spielberger and colleagues (1973). The Korean TAIC is a 20-item inventory that asks respondents to indicate how frequently, on a 3-point scale (1=*almost never* to 3=*almost always*), they feel worried, bothered, or nervous [27]..

Korean version of the ADHD Rating Scale (K-ARS)

The Korean version of the ADHD Rating Scale (K-ARS) was used to assess ADHD which was originally developed by DuPaul [28]. The K-ARS is a scale for ADHD symptom severity composed of 18 items (9 items for inattention and 9 items for hyperactivity) scored from as 0 (*never or rarely*) to 3 (*very often*) [29].

Diagnostic Interview Schedule for Children, Version IV (DISC-IV)

In the current study, the DISC-IV was administered by a trained interviewer. The DISC-IV is comprised of six domains of possible impairment present during a "time in the last year when symptoms caused the most problems." These domains are (1) getting along with parent caretakers, (2) participating in family activities, (3) participating in peer activities, (4) academic/occupational functioning, (5) relationships with teachers, and (6) distress attributable to symptoms. Each set of questions has a 2-part structure, the first determining whether impairment is present, and the second measuring severity or frequency. We selected an introductory module that includes demographic information (age, grade, names and ages of siblings, and identification of caretakers and attachment figures). The remainder of the interview is organized into 3 modules, each containing related diagnoses (anxiety, mood, and disruptive disorders)[30].

Presence of suicidal ideation, suicide plans, and suicide attempts

The presence of suicidal ideation, suicide plans, and suicide attempts is determined using the following direct questions derived from the Structured Clinical Interview for DSM-IV Axis I Disorders (SCID-I). Participants are asked whether they had seriously considered committing suicide, made a plan to commit suicide, or attempted suicide during the past year. The presence or absence of suicide ideation, plans, and attempts is based on the subject response (yes or no) [31]

Pati*ent Health Questionnaire (PHQ-9)*

The PHQ-9 is a multipurpose instrument that assists in screening, diagnosing, and monitoring

depression severity. It incorporates the DSM-IV depression diagnostic criteria with other leading major depressive symptoms into a brief nine-item, self-report tool. Respondents rate the frequency of the symptoms over the last 2 weeks on a 4-point rating scale (*not at all* = 0; *several days* = 1; *more than half of the days* = 2; *nearly every day* = 3) [32].

Rosenberg's Self-Esteem Scale

Rosenberg's Self-Esteem Scale has 10 items, each rated on a 5-point Likert scale, ranging from 1 (*strongly disagree*) to 5 (*strongly agree*). The total score ranges from 10 to 50 [33].

Self-Control Scale

Self-Control Scale is defined by Gottfredson and Hirschi (1990) [34]. The 20-item scale is divided into two self-control constructs: immediate and delayed satisfaction. Each item is rated on a 4-point scale: (4) *strongly agree*, (3) *agree somewhat*, (2) *disagree somewhat*, and (1) *strongly disagree*. Higher scores indicate lower self-control.

Aggression Questionnaire (AQ)

The Buss-Perry Aggression Questionnaire is a 29-item scale that measure four aspects of human aggression and hostile personality. Participants rate each item using a 5-point Likert scale from 1 (*uncharacteristic of me*) to 5 (*very characteristic of me)*[35].

Social Support Appraisals Scale: Child's Subjective Appraisal of Family, Peer, and Teacher Support (SSAS)

We use the Social Support Appraisals Scale: Child's Subjective Appraisal of Family, Peer, and Teacher Support (SSAS) to address the adolescent participants' perceived support. It is a 41-item self-report instrument developed by Dubow et al. (1989) [36]. Items are rated on a 5-point Likert scale, from 1 (*never*) to 5 (*always*).

Parent-Adolescent Communication Inventory (PACI)

The Parent-Adolescent Communication Inventory (PACI) is a 40-item inventory used to assess communication in the parent–adolescent relationship. There are two forms of the

inventory, one for parents and the other for adolescents. Scores range from 0 to 120, with higher scores reflecting a greater degree of parent-adolescent communication [37].

The Children's Perception of Interparental Conflict Scale (CPIC)

The CPIC uses a multiple-choice format with three possible responses: *true*, *sort of true*, and *false*. Items are scored from 1 to 3, with 3 reflecting more negative forms of conflict and their appraisal [38].

Revised Inventory of Parent and Peer Attachment (IPPA_R)

The original IPPA was developed by Armsden and Greenberg (1987) to assess adolescents' perceptions of the positive and negative affective and cognitive dimensions of relationships with their parents and close friends. In particular, the inventory examines how well these figures serve as sources of psychological security. Three broad dimensions are assessed: degree of mutual trust, quality of communication, and alienation. Participants are asked to rate each of the items on a 5-point Likert-scale from 1 (*never true*) to 5 (*always true)* [39].

Physical and mental health status

We assess physical pain experiences, such as in the hand, wrist, shoulder, or neck; dry eyes; drinking and smoking habits during the past year; histories of physical illness, including rheumatoid arthritis, lupus, diabetes mellitus; and psychiatric illness, including depression, anxiety disorders, and ADHD. We also ask about sleep hours during the week and during weekends.

Sample size estimation

We calculated the study sample size required to investigate whether overuse of Internet gaming is a risk factor of IGD presence at the 2-year follow up. For a 15% prevalence of exposure to 3 or more hours per day of Internet gaming, a 5% incidence of IGD at the 2-year follow-up period, a relative risk of this risk factor for IGD of 2 (RR=2.0), and setting α at

0.05 and β at 0.20 (power of 0.80), a sample size of 2,559 is required. Considering a dropout rate of 14%, the required sample size is estimated to be almost 3,000. We expect there will be 150 adolescents at high-risk for IGD (meeting 3 or more of the 9 DSM-5 IGD criteria) among the 3,000 participants at baseline, and we estimate that 75 new IGD cases will be found at the 2-year follow-up [40].

Strategies to minimize error and bias

Online assessment system

The participants log onto the study's website with unique authentication codes provided, where they complete the online questionnaires. We use a branched algorithmic structure to enhance the confidentiality and accuracy of responses and to reduce the risk of exposing sensitive information.

Training of the interviewers

To administer the parent–guardian surveys, we recruited psychologists and nurses with Bachelor's or Master's degrees, and the research team provided them with training that included information on Internet gaming addiction and communication skills, through a 2-day (16-hour) training workshop. In addition to administering the surveys, the interviewers reported on the status of the data collection and any problems and issues arising during the interviews, at mandatory weekly meetings.

Prior to the diagnostic interviews and twice each year, all psychiatrists and clinical psychologists attend a seminar about IGD diagnosis to increase inter-rater reliability and diagnostic agreement. In the seminar, we review recent papers on IGD diagnosis and provide mock cases in a video to enhance diagnostic concordance. Also, at the end of each day of diagnostic interviews, all psychiatrists and clinical psychologists who participate in the clinical diagnosis attend a case conference to discuss any ambiguous diagnoses and make

final determinations.

Statistical analyses plan

We will calculate the 2-year incidence, remission, and recurrence rates of IGD, with 95% confidence intervals. We will investigate the cross-sectional and longitudinal associations between exposures and outcomes using a logistic or linear regression model or a generalized linear model, as appropriate. Models will include exposures to games, such as time spent playing games, types of Internet games, and gaming-related activities, with IGD as the outcome variable and covariates including socio-demographic, personal, social, and environmental factors. Moderation tests will examine for differences in associations and mediation tests will assess indirect effects based on socio-demographic, personal, social, and environmental factors.

Ethics and dissemination

All procedures performed in studies involving human participants were in accordance with the ethical standards of the Institutional Review Board of The Catholic University of Korea (approval number: MC140NM10085) and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards. Written consent was received from all participants and from one of the participants' parents or caregivers following an explanation of the study, including confidentiality and freedom of choice to participate. All results will be published in relevant peer-reviewed international scientific journals and presented at conferences, nationally and internationally.

Discussion

A major strength of this study is that it is conducted in a county with a particularly high

burden of IGD in adolescents. Korea has a high likelihood of exposure to games because Korea plays a leading role in the development of the game industry and is one of the most highly digitalized societies in the world. It provides a high-access environment for Internet gaming, including PC rooms, which have broad-band Internet networks and are equipped with the best performance computers in Korea. This makes Korea an optimal place to perform a cohort study to characterize IGD.

We are screening 3rd-, 4th-, and 7th-grade students for IGD using both polychotomous and dichotomous tools based on the nine DSM-5 IGD criteria. In addition, we are conducting structured interviews using DISC-IV of the parents or guardians to assess participant psychiatric comorbidities. Because the participants are early adolescents, we obtained their mental health status through their parents or guardians. Self-reports can include false or insincere reports, making evaluation of the IGD risk factors less accurate. To reduce this effect, we have added a reverse scale to each self-report questionnaire.

Another strength of this study is that the clinical diagnosis of IGD based on the DSM-5 is performed by qualified mental health specialists. Most prior studies have not been able to also get a true clinical diagnosis along with the screening tool scores, so this study will provide needed validity data. Participants included those considered positive for IGD, defined as scores of 6 or higher on IGUESS, as well as a reference group of a random selection of 10% of the participants. We have constructed two sub-cohorts from those who have participated in the clinical diagnosis: a representative and a high-risk cohort. The representative sub-cohort consists of 10% randomly selected adolescents from the full cohort. They participate in the clinical diagnostic interview every year in order to estimate the false negative rate and to evaluate the clinical course of IGD, observed via the diagnostic interviews. The high-risk sub-cohort is comprised of participants meeting 3 or more of the 9 IGD criteria, based on the clinical diagnostic interviews at baseline and each follow-up wave. The high-risk sub-cohort

is similar to a dynamic cohort. The suggested diagnostic criteria of IGD in DSM-5 is to meet 5 or more of the 9 IGD criteria; however, we plan to follow those adolescent participants meeting 3 or more clinical diagnostic interview in any year in order to investigate the course of IGD at syndromal and subsyndromal levels.

This study aims to clarify the natural and clinical courses of IGD based on the DSM-5 suggested diagnostic criteria in order to empirical validate the criteria and to evaluate the risk and predictive factors in adolescents based on the IGD diagnostic criteria. This study will contribute to establishing standardized IGD diagnostic criteria and to providing scientific evidence regarding the proposed DSM-5 IGD diagnostic criteria.

Keywords:
Internet gaming disorder, adolescents, cohort, protocol

Lists of Abbreviations
Aggression Questionnaire (AQ)
Attention Deficit Hyperactivity Disorder (ADHD)
Children's Depression Inventory (CDI)
Children's Perception of Inter-parental Conflict Scale (CPIC)
Diagnostic and Statistical Manual of Mental Disorders 5th version (DSM-5)
Diagnostic Interview Schedule for Children, Version IV (DISC-IV)
Global assessment scale (GAS)
International Classification of Diseases 10th version (ICD-10)
International Classification of Diseases 11th version (ICD-11)
Internet Game Use-Elicited Symptom Screen (IGUESS)
Internet gaming disorder (IGD)
Internet user Cohort for Unbiased Recognition of gaming disorder in Early adolescents (iCURE)
Kiddie-Schedule for Affective Disorders and Schizophrenia-Present and Lifetime Version-Korean version (K-SADS-PL)
Korean version of the ADHD Rating Scale (K-ARS)
Parent-Adolescent Communication Inventory (PACI)
Parent-Adolescent Communication Inventory (PACI)
Parenting attitude test (PAT)
Patient Health Questionnaire (PHQ-9)
Post-traumatic stress disorder (PTSD)
Revised Inventory of Parent and Peer Attachment (IPPA-R)
Smartphone Addiction Scale (SAS-SV)

Social Support Appraisal Scale (SSAS)
Standard Patients Evaluation of Eye Dryness Questionnaire (SPEED)
Structured Clinical Interview for DSM-IV Axis I Disorders (SCID-I)
Self-reported version of structured clinical interveiw for Internet Gaming Disorder (SR-IGD)

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Availability of data and materials
Not applicable. This protocol was not included any participants data.

Authors' contribution:
HJ conducted the analyses and led the writing of the manuscript. HWY guided and supervised the writing of the manuscript. HWY, HJ, and SJ developed and proposed the basic idea of the study. HWY, HJ, SJ, EK, HS and HH contributed to conducting the study. SL, HL, YK, SB, and JC conducted diagnostic interviews. BK guided to performance DISC assessment. DAG advised to construct study design. DAG and MNP reviewed scientific and proof reading of the manuscript. All authors contributed editorial comments on the manuscript.

Conflict of interest:
The authors declare no conflicts of interest with respect to the content of the manuscript..

Consent for publication
Not applicable.

References

1. Entertainment_software_association. 2012 Essential facts about the computer and video game industry. *Retrieved from http://wwwtheesacom/facts/pdfs/ESA_EF_2012pdf* 2012
2. Wan CS, Chiou WB. Why are adolescents addicted to online gaming? An interview study in Taiwan. *Cyberpsychology & behavior : the impact of the Internet, multimedia and virtual reality on behavior and society* 2006;9(6):762-6. doi: 10.1089/cpb.2006.9.762 [published Online First: 2007/01/05]
3. Wood RT, Griffiths MD. A qualitative investigation of problem gambling as an escape-based coping strategy. *Psychology and psychotherapy* 2007;80(Pt 1):107-25. doi: 10.1348/147608306x107881 [published Online First: 2007/03/10]
4. Kuss DJ, Griffiths MD, Karila L, et al. Internet addiction: a systematic review of epidemiological research for the last decade. *Current pharmaceutical design* 2014;20(25):4026-52. [published Online First: 2013/09/05]
5. Boot WR, Kramer AF, Simons DJ, et al. The effects of video game playing on attention, memory, and executive control. *Acta psychologica* 2008;129(3):387-98. doi: 10.1016/j.actpsy.2008.09.005 [published Online First: 2008/10/22]
6. Witt E. MA, , & Jackson L. Trends in youth's videogame playing, overall computer use, and communication technology use: The impact of self-esteem and the Big Five personality factors. *Computers in Human Behavior archive* 2011;27(2):763-69
7. Chan PA, Rabinowitz T. A cross-sectional analysis of video games and attention deficit hyperactivity disorder symptoms in adolescents. *Annals of general psychiatry* 2006;5:16. doi: 10.1186/1744-859x-5-16 [published Online First: 2006/10/25]
8. Desai RA, Krishnan-Sarin S, Cavallo D, et al. Video-gaming among high school students: health correlates, gender differences, and problematic gaming. *Pediatrics* 2010;126(6):e1414-24. doi: 10.1542/peds.2009-2706 [published Online First: 2010/11/17]
9. Van Rooij AJ, Schoenmakers TM, Vermulst AA, et al. Online video game addiction: identification of addicted adolescent gamers. *Addiction (Abingdon, England)* 2011;106(1):205-12. doi: 10.1111/j.1360-0443.2010.03104.x [published Online First: 2010/09/16]
10. Barnett JaC, Mark Virtually real: a psychological perspective on massively multiplayer online games. . *Review of General Psychology* 2010;14(2):167-79.
11. Union IT. World Telecommunication/ ICT Indicators Database *17th edition* 2013
12. Service KSI. Statistics on Internet use. National Information Society Agency (2011) Internet Addiction Survey. *Agency NIS, Seoul, South Korea* 2013
13. Ministry of Culture S, and Tourism. Introduction of regulations of internet game in Korea. 2014
14. Choo H, Gentile DA, Sim T, et al. Pathological video-gaming among Singaporean youth. *Annals of the Academy of Medicine, Singapore* 2010;39(11):822-9. [published Online First: 2010/12/18]
15. Lemmens JS, Valkenburg PM, Gentile DA. The Internet Gaming Disorder Scale. *Psychological assessment* 2015;27(2):567-82. doi: 10.1037/pas0000062 [published Online First:

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16. Gentile D. Pathological video-game use among youth ages 8 to 18: a national study. *Psychological science* 2009;20(5):594-602. doi: 10.1111/j.1467-9280.2009.02340.x [published Online First: 2009/05/30]
17. Lam LT, Peng ZW, Mai JC, et al. Factors associated with Internet addiction among adolescents. *Cyberpsychology & behavior : the impact of the Internet, multimedia and virtual reality on behavior and society* 2009;12(5):551-5. doi: 10.1089/cpb.2009.0036 [published Online First: 2009/07/22]
18. AmericanPsychiatricAssociation. Diagnostic and Statistical Manual of Mental Disorders (DSM-5). 2013
19. Petry NM RF, Gentile DA, Lemmens JS, Rumpf H, Mößle T, et al. An international consensus for assessing Internet gaming disorder using the new DSM-5 approach. *Addiction* 2014;109(9):1399-406.
20. Kim Y, Cheon, K., Kim,B., Chang, S., Yoo, H., & Kim, J. . The reliability and validity of Kiddie Schedule for Affective Disorders and Schizophrenia Present and Lifetime Version-Korean version (K-SADSPL-K). *Yonsei Medical Journal* 2004;45:81-89.
21. Young KS. The research and controversy surrounding internet addiction. *Cyberpsychology & behavior : the impact of the Internet, multimedia and virtual reality on behavior and society* 1999;2(5):381-3. doi: 10.1089/cpb.1999.2.381 [published Online First: 1999/01/01]
22. Kim DI JY, Lee EA, Kim DM, Joe YM. Development of Internet Addiction Proneness Scale - Short Form (KS-Scale). *Korean J Counseling* 2008;9:1703-22.
23. Koo HJ, Han DH, Park SY, et al. The Structured Clinical Interview for DSM-5 Internet Gaming Disorder: Development and Validation for Diagnosing IGD in Adolescents. *Psychiatry investigation* 2017;14(1):21-29. doi: 10.4306/pi.2017.14.1.21 [published Online First: 2017/01/18]
24. Kwon M, Kim DJ, Cho H, et al. The smartphone addiction scale: development and validation of a short version for adolescents. *PloS one* 2013;8(12):e83558. doi: 10.1371/journal.pone.0083558 [published Online First: 2014/01/07]
25. Kovacs M, Feinberg TL, Crouse-Novak MA, et al. Depressive disorders in childhood. I. A longitudinal prospective study of characteristics and recovery. *Archives of general psychiatry* 1984;41(3):229-37. [published Online First: 1984/03/01]
26. Cho S. CJ. Development of State - Trait Anxiety Scale for Korean Children. *Medicine Journal of Seoul Natinal University* 1989;14(3):150-57.
27. Spielberger CD. Manual for the State: Trait Anxiety Inventory for Children. *Palo Alto, Consulting Psychologist Press* 1972
28. GJ. D. Parent and teacher ratings of ADHD symptoms: psychometric properties in a community-based sample. . *J Clin Child Psychol* 1990;20:245-53.
29. Kim JW, Park KH, Cheon KA, et al. The child behavior checklist together with the ADHD rating scale can diagnose ADHD in Korean community-based samples. *Canadian journal of*

psychiatry Revue canadienne de psychiatrie 2005;50(12):802-5. doi: 10.1177/070674370505001210 [published Online First: 2006/01/18]

30. Shaffer D, Fisher P, Lucas CP, et al. NIMH Diagnostic Interview Schedule for Children Version IV (NIMH DISC-IV): description, differences from previous versions, and reliability of some common diagnoses. *Journal of the American Academy of Child and Adolescent Psychiatry* 2000;39(1):28-38. doi: 10.1097/00004583-200001000-00014 [published Online First: 2000/01/19]
31. First MB, Spitzer, R. L, Gibbon M, and Williams, J.B.W.. Structured Clinical Interview for DSM-IV-TR Axis I Disorders, Research Version, Research Edition. (SCID-I). *New York: Biometrics Research, New York State Psychiatric Institute* 2002
32. Kroenke K, Spitzer RL, Williams JB. The PHQ-9: validity of a brief depression severity measure. *Journal of general internal medicine* 2001;16(9):606-13. [published Online First: 2001/09/15]
33. Rosenberg M. Society and the adolescent self-image. *Princeton, NJ: Princeton University Press* 1965
34. Gottfredson MR, & Hirschi,T. A generaltheory ofcrime. *Stanford, CA:StanfordUniversityPress* 1990
35. Buss AH, Perry M. The aggression questionnaire. *Journal of personality and social psychology* 1992;63(3):452-9. [published Online First: 1992/09/01]
36. Dubow EF, Tisak J. The relation between stressful life events and adjustment in elementary school children: the role of social support and social problem-solving skills. *Child development* 1989;60(6):1412-23. [published Online First: 1989/12/01]
37. Bienvenu MJ. A parent-adolescent communicaiton inventory. *Saluda, NC: Family Life publictions* 1969
38. Grych JH, Seid M, Fincham FD. Assessing marital conflict from the child's perspective: the children's perception of interparental conflict scale. *Child development* 1992;63(3):558-72. [published Online First: 1992/06/01]
39. Armsden GC, Greenberg MT. The inventory of parent and peer attachment: Individual differences and their relationship to psychological well-being in adolescence. *Journal of youth and adolescence* 1987;16(5):427-54. doi: 10.1007/bf02202939 [published Online First: 1987/10/01]
40. Gentile DA, Choo H, Liau A, et al. Pathological video game use among youths: a two-year longitudinal study. *Pediatrics* 2011;127(2):e319-29. doi: 10.1542/peds.2010-1353 [published Online First: 2011/01/19]

Table 1. Measurement tools in each wave

Categories	Measures	Source	Wave T1	T2	T3	T4
Exposure	Exposure time to internet, smart phone, and online game	student/parents	√	√	√	√
	Internet, smart phone, and online game using behaviors	Student	√	√	√	√
Diagnosis	Young scale	Student	√			
	K-scale	Student	√			
	IGUESS	Student	√	√	√	√
	IGDS	Student	√		√	√
	SAS-SV	Student	√	√	√	√
Psychiatric commorbidity	Depression (CDI)	Student	√	√	√	√
	Anxiety (TAIC)	Student	√	√	√	√
	K-ARS	Parents	√			
	DISC-IV	Parents	√			
	Sociality	Student	√	√	√	√
	PHQ-9	Parents	√			
Personal	Self-esteem scale	student	√			
	Gottfredson' self-control	student	√			
	Aggression Questionnaire	student	√	√	√	√
	Demographic information	student/parents	√			
	Academic achievement	Parents	√			
Environmental	School policy on having smart phone use in school	student	√	√	√	√
	PACI	student	√			
	Marriage satisfaction	Parents	√			
	PAT	student/parents	√			
	CPIC	student	√			
	IPPA-R	student	√			
	Perceived Parenting Competence	Parents	√			
	Online gaming rule in home	Parents	√	√	√	√
Social	Social network	Student	√			
	Bullying scale	student	√			
	SSAS	student	√			
Health consequence	Physical health	student/parents	√			
	Mental health	students	√			

PACI: Parent-Adolescent Communication Inventory; SPEED: Standard Patients Evaluation of Eye Dryness Questionnaire; IPPA-R: Revised Inventory of Parent and Peer Attachment PACI: Parent-Adolescent Communication Inventory; AQ: Aggression Questionnaire; PAT: Parenting attitude test; CPIC: The Children's Perception of Inter-parental Conflict Scale; SSAS: Social Support Appraisal Scale

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Study Protocol of the Internet user Cohort for Unbiased Recognition of gaming disorder in Early Adolescence (iCURE), Korea, 2015–2019

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Abstract

Introduction:

In 2013, the Diagnostic and Statistical Manual of Mental Disorders, Fifth Edition (DSM-5) proposed nine internet gaming disorder (IGD) diagnostic criteria as a condition warranting further empirical and clinical research. The aim of this study is to clarify the natural and clinical courses of IGD proposed DSM-5 in adolescents and to evaluate its risk and protective factors.

Method and analysis:

The Internet user Cohort for Unbiased Recognition of gaming disorder in Early Adolescence (iCURE) study is an ongoing multidisciplinary, prospective, longitudinal cohort study conducted in 21 schools in Korea. Participant recruitment commenced in March 2015 with the goal of registering 3,000 adolescents. The baseline assessment included surveys on emotional, social, and environmental characteristics. A parent or guardian completed questionnaires and a structured psychiatric comorbidity diagnostic interview regarding their children. Adolescents with the Internet Game Use-Elicited Symptom Screen (IGUESS) total scores of 6 or higher were asked to participate in the clinical diagnostic interview. Two sub-cohorts of adolescents were constructed: a representative sub-cohort and a clinical evaluation sub-cohort. The representative sub-cohort comprises a randomly selected 10% of the iCURE to investigate the clinical course of IGD based on clinical diagnosis and to estimate the false negative rate. The clinical evaluation sub-cohort comprised participants meeting three or more of the nine IGD criteria, determined by clinical diagnostic interview, to show the clinical course of IGD. Follow-up data will be collected annually for the three years following the baseline assessments. The primary endpoint is two-year incidence, remission, and recurrence rates of IGD. Cross-sectional and longitudinal associations between exposures and outcomes as well as mediation factors will be evaluated.

Ethics and dissemination: This study is approved by the Institutional Review Board of The Catholic University of Korea. Results will be published in peer-reviewed journals. This study's protocol is registered at clinicaltrials.gov (identifier: NCT02415322).

Article summary

Strengths and limitations of this study

- Internet gaming disorder (IGD) was assessed by using both polychotomous and dichotomous tools based on the nine DSM-5 IGD criteria. In addition, we are conducting structured interviews using DISC-IV of the parents or guardians to assess participant psychiatric comorbidities.
- This study is that the clinical diagnosis of IGD based on the DSM-5 is performed by qualified mental health specialists.
- It is not a representative sample because the registration was conducted among the schools in the specific area.
- The participants were included only 3rd-, 4th-, and 7th-grade students.

Introduction

Internet games are popular entertainment in modern society, with a variety of people of different ages participating in gaming. Internet game play rates and sales are increasing [1]. Players choose to play games for many reasons, including fun, recreation, coping with stress, sociability, and escaping real life [2-4]. The gaming research literature has reported both positive and negative effects on players. Playing games promotes problem solving and visual, motor, and spatial skills, and it fosters interaction with friends [5]. Although there are several positive effects of playing games for adolescents, there can also be negative effects, such as the possibility of problematic or addictive gaming [6]. Gaming has been associated with inattention and hyperactivity, aggressive behaviors, negative emotions including depression [7 8], low self-esteem, social anxiety, loneliness [9], and low psychological well-being [10].

South Korea is one of the most highly digitalized societies in the world. The Internet penetration rate in South Korea exceeded 75% in 2011 [11]. More than half of people in their 50s and almost 100% of teenagers use the Internet in their daily lives [12]. Korea has developed a computer industry with Internet use reaching over 50% of the population. Currently, in Korea, 25 million among 45 million citizens use the Internet, and 14.4 million homes are equipped with Internet access. In addition to home assess, many people visit “PC rooms”, a type of gaming center with a broad-band Internet network that is equipped with the best performance computers in Korea. PC rooms became popular following the release of the PC game StarCraft in 1998, with an estimated 25,000 PC rooms nationwide in 2014. ‘PC rooms’ have no any age restrictions on accessibility, and many adolescents often play online games [13]. A 2010 nation-wide survey regarding Internet addiction showed that 8.0% of the Korean population and 12.4% of adolescents were addicted to Internet use, as assessed via the self-administered K-scale [12]. This prevalence is a little higher than has been found in other countries, such as Singapore (8.7%) [14], the Netherlands (6.8%) [15], the US (8.5%) [16], and

China (10.8%) [17]. The higher prevalence in Korea could be expected, given that it is a country with such broad and easy access. Although the number of Internet game users has increased dramatically over the last decade, the phenomenon of Internet gaming addiction is not yet well understood, and research on its etiology and natural history is still in its infancy. Studies have used various tools to estimate the prevalence of Internet gaming disorder (IGD), but the lack of common diagnostic criteria for IGD has created difficulties in comparing studies.

In May 2013, IGD was included in Section III of the DSM-5 as a condition warranting further study [18]. This marked the first occasion of IGD being formally recognized as a mental health disorder and suggested IGD classification criteria have paved the way for measuring IGD in a consistent manner. These suggestions enable more direct comparisons of findings and may be used to eventually reach a consensus on the status of the disorder [19]. The DSM-5 proposes nine criteria for IGD, and it states explicitly that the specific criteria and the threshold for diagnosis require systematic investigation and empirical validation before their wide-scale adoption. The proposed criteria apply only to Internet gaming, and not general Internet use, which can differ in terms of presenting symptoms, etiology, comorbidities, course, and treatment. Empirical data are required to ascertain the extent to which these criteria apply to various populations and to aid diagnosis.

However, the classification and rationale for DSM-5 IGD as a mental health disorder have been controversial[20]. A previous study ~~was~~ proposed the possibilities that gaming behavior can be common behavior or leisure activity. Excessive involvement on gaming per se, ~~that~~ might reflect engagement, passion, or coping[21]. Excessive behaviors on gaming can be transient for many adolescents and we will look into whether excessive behavior on gaming is episodic or steady through the longitudinal observation. It is also argued that several IGD criteria such as withdrawal and tolerance are often inappropriate to be put into the conceptualization of behavioral addiction and difficult to apply convincingly and measure in

relation to behaviors[22]. In addition, a previous study did not support the hypothesis that the nine DSM-5 IGD criteria had the same validity for the diagnosis [23]. To this end, we registered and began a prospective school-based cohort study of adolescents to provide evidence regarding the IGD diagnostic criteria by clarifying the characteristics of IGD's natural history. Given the broad discussion of a replicability "crisis" in many sciences, it is valuable to document *a priori* our research methods, goals, and planned approach.

Aims

The aim of the study is to clarify the natural and clinical courses of IGD based on the DSM-5 diagnostic criteria, to provide evidence for empirical validation of the suggested IGD diagnostic criteria, and to further evaluate the etiological risk and predictive factors in adolescents.

Methods

Study design and setting

The Internet user Cohort for Unbiased Recognition of gaming disorder in Early Adolescence (iCURE) study is a multidisciplinary, prospective, longitudinal cohort study of 3,000 adolescents, conducted in Korea, with 4 waves of annual data collection currently planned. The study is being conducted in Seoul and Uijeongbu, Gyeonggi Province, with 3rd-, 4th-, and 7th-grade students in 6 primary schools and 19 secondary schools participating. Participation requires consent from the participants as well as written parental consent following explanation of the nature of the principles of research, including confidentiality and the freedom of choice to participate. The study was fully reviewed and approved by the Institutional Review Board of The Catholic University of Korea (MC140NM10085) and was conducted in accordance with the Declaration of Helsinki.

Pretest and pilot test of methods

We validated the feasibility of the study before beginning data collection by performing a pretest and a pilot test. For the pretest, we recruited a convenience sample of 25 3rd- and 4th-grade students to test the understandability of the questionnaires for this age group of students. We performed a pilot test to verify that the overall survey system worked well, with participants composed of one school class of 35 students. They completed all baseline measures which were recruited outside of the sampling frame.

Recruitment

Participant recruitment commenced in March 2015. Recruitment took place at the school level. We sent official letters to all primary and secondary schools in three educational districts to invite their participation. After school principles provided consent for their schools to participate, the parents or guardians were contacted to obtain consent for their children to participate in the study. A total of 21 schools (6 elementary and 19 secondary) participated in the study, out of 258 schools (163 elementary and 95 secondary) in the three districts. In order to encourage participation in this research, the research team members visited the 21 participating schools to provide a seminar that presented the aims of the study and provided additional information about the research project to teachers and parents. The finial enrollment is expected to be 3,000 adolescents. Three regional hospitals were designated in the three areas where the participating schools are located to provide treatment options for adolescents experiencing IGD.

Inclusion and exclusion criteria

The inclusion criteria were that the participants were 3rd-, 4th-, or 7th-grade students at

baseline. We required that each student participant had a parent or guardian who also participated in the study. The exclusion criteria included lack of competence in the Korean language by the parent or guardian and intellectual disability of the adolescent.

Data collection

The participants completed questionnaires at baseline and will again annually for the following three years. The baseline assessments started in May 2015. We are collecting data from multiple informants, including students' self-report questionnaires, clinical diagnostic interviews of the students, parents' or guardians' self-report questionnaires, and structured clinical interviews of the parents or guardians regarding any psychiatric comorbidity in their children.

Follow-up and retention strategy

In an effort to maintain contact with iCURE study participants, we will send individual reports annually via registered mail, and we will periodically send text messages about general contents via cell phone to the participants. Once a year, we will send each participant's survey results to their parents via registered mail, which will be called a "mental health signal." This will include the mental health status regarding symptoms of Internet game addiction, depression, anxiety, and ADHD, marked as red, yellow, and green traffic signals, indicating symptom severity as assessed by both the self-report survey and the clinical diagnosis. We will also provide referrals for treatment availability.

During this study, we are operating a 24-hour counseling helpline for the parents and guardians. A clinical psychologist with more than 10 years of clinical experience specializing in children and adolescents is conducting telephone consultations. This telephone counseling is free and anonymous, providing parents with general counseling about their children, as

well as specific counseling regarding gaming addiction.

Student self-report questionnaires

Student data collection is conducted at the schools during school hours. The7th-grade students complete questionnaires using a web-based self-administration method. The 3rd- and 4th-grade students complete the questionnaires in a class setting; a research assistant reads the questions aloud, following a standard script, to aid comprehension and diminish time demands. In later waves, all students will complete the questionnaires on their own, with a supervising research assistant available to answer questions. During the baseline assessment, the questionnaires took approximately 90–120 minutes to complete; later waves will take approximately 45–80 minutes. The student data collection at later waves will also be conducted at the schools during school hours. For students who transfer to other schools, arrangements will be made to complete the follow-up questionnaires, either by visiting their homes or via website access.

Interviewing parents

At baseline, each parent or guardian completed a questionnaire and the Diagnostic Interview Schedule for Children, Version 4 (DISC-IV). The DISC-IV is a highly structured diagnostic interview used to assess psychiatric disorders in children and adolescents. We are including 7 of the 34 diagnostic assessments: generalized anxiety disorder, separation anxiety, obsessive-compulsive disorder, major depression disorder, attention deficit disorder and attention deficit hyperactive disorder (ADD/ADHD), oppositional defiant disorder, and conduct disorder. The DISC-IV was administered by trained interviewers at the participants' homes or at a private space at the school, based on the participant's preference. The parent questionnaire contained demographic questions and took 20 to 30 minutes to complete, and the DISC-IV took 40 to 90 minutes. Parent or guardian survey is conducting only at baseline.

Second-stage clinical diagnosis by mental health professionals

The clinical diagnostic interviews for IGD were conducted face-to-face by five psychiatrists and four Master's degree–level clinical psychologists with at least five years of training and clinical experience. The interviews assessed participants based on the nine DSM-5 IGD criteria, in accordance with the international consensus for IGD represented in the DSM-5 [19]. Diagnoses were based on clinically significant functional impairments that substantially derived from gaming and not from any other psychiatric illnesses. Any psychiatric comorbidities were also thoroughly evaluated by the psychiatrists using the semi-structured tool of the Kiddie-Schedule for Affective Disorders and Schizophrenia-Present and Lifetime Version-Korean version (K-SADS-PL), which has been previously validated in Korean [24]. Global functioning was assessed using the Children's Global Assessment Scale (GAS), based on the child's worst level of emotional and behavioral functioning in the past three months. The criterion for a second-stage clinical diagnosis is an Internet Game Use-Elicited Symptom Screen (IGUESS) total score of 6 or higher, either at baseline or at the follow-up waves. Additionally, random selection of 10% of the full cohort, stratified by the school, completed the clinical diagnostic interviews at baseline and the further follow-up waves. Anyone who responds insincerely with marking all of the same numbers to the IGUESS at every wave will be excluded to rule out false negatives. Anyone who reports a suicidal experience during the past year at any wave will be given diagnostic interviews. The clinical diagnostic interviews are being conducted one week after completion of the baseline study. The interviews are being conducted confidentially in private spaces at the participants' schools.

Sub-cohorts

Two sub-cohorts have been constructed. A representative sub-cohort consists of a randomly

selected 10% of adolescents in the cohort. They will participate in the clinical diagnostic interview every year to estimate the false negative rate and to evaluate the clinical course of DSM-5–defined IGD based on clinical diagnosis. Additionally, a clinical evaluation sub-cohort is comprised of those meeting three or more of the nine IGD criteria, as determined by the clinical diagnostic interview at baseline and at each follow-up wave. The reason why they were selected as a clinical evaluation sub-cohort was to observe the natural history or clinical course of them even though they did not reach the DSM-5 IGD diagnostic criteria. Following up this sub-cohort may reveal whether they actually turned out to be IGD or normal behavior. The interviews will be conducted annually for 3 years to observe the clinical history, remission, and recurrence rates.

Measurement

The measurements using i-CURE are presented in Table 1.

Demographic information

Demographic characteristics were assessed at baseline. Sex, date of birth, family composition, and number of siblings were obtained from the student assessment, and parental education level, socio-economic status, parental marital status, parental education level, and parental job were obtained from the parent or guardian assessments.

Internet, gaming, and smartphone use

Comprehensive assessments of participants' Internet, gaming, and smartphone usage were performed, including questions regarding the first time of exposure, the average daily time spent online, and gaming-related questions, such as online gaming type preference and weekly playing time. We classified online games as role-playing games, shooter games, simulation games, arcade games, and unknown.

Regulated usage of smartphones or games

We assess school policies on possession and usage of smartphones and domestic regulations of smartphone or game time.

Internet Addiction Test (IAT)

Young's IAT consists of 20 items rated on a 5-point Likert scale from *rarely* (1) to *always* (5), with higher scores indicating more severe Internet addiction [25].

Korean Scale for Internet Addiction (K-Scale)

To assess Internet addiction, we use the K-Scale-short form for adolescents, which were developed in Korea. It is comprised of 20 items rated on a 4-point Likert scale, from 1 (*not at all*) to 4 (*always)*[26].

Internet Game Use-Elicited Symptom Screen (IGUESS)

This instrument was created based on the nine DSM-5 IGD criteria. Students are instructed to respond based on their gaming behavior within the last 12 months, with each item rated on a 4-point scale: 1=*strongly disagree*, 2=*somewhat disagree*, 3=*somewhat agree*, 4=*strongly agree*).

Self-reported version of structured clinical interview for Internet Gaming Disorder (SR-IGD)

We use the SR-IGD to assess IGD with respect to occurrences over the past 6 months. The assessment uses yes-or-no questions [27].

Short version of the Smartphone Addiction Scale (SAS-SV)

We assessed smartphone addiction using the short version of the Smartphone Addiction Scale (SAS-SV). The SAS-SV addresses the following 5 content areas with respect to the previous year: (1) daily-life disturbance, (2) withdrawal, (3) cyberspace-oriented relationship, (4) overuse, and (5) tolerance. It contains 10 items rated on a dimensional scale (1=*strongly disagree* to 6=*strongly agree*). The total scores range from 10 to 60, with the higher scores indicating greater degrees of smartphone addiction [28].

Children's Depression Inventory (CDI)

The Children's Depression Inventory (CDI) is a 27-item, self-rated, symptom-oriented scale suitable for youths aged 7 to 17 years. It assesses cognitive, affective, somatic, and behavioral symptoms, with items scored from 0 to 2, where 0 means *the symptom is not present*, 1 means *the symptom is present and mild*, and 2 means *the symptom is present and marked* [29].

Trait Anxiety Inventory for Children (TAIC)

To examine trait anxiety, we used the Korean translation [30] of the Trait Anxiety Inventory for Children (TAIC), which is part of the State-Trait Anxiety Inventory for Children (STAIC) developed by Spielberger and colleagues (1973). The Korean TAIC is a 20-item inventory that asks respondents to indicate how frequently, on a 3-point scale (1=*almost never* to 3=*almost always*), they feel worried, bothered, or nervous [31]..

Korean version of the ADHD Rating Scale (K-ARS)

The Korean version of the ADHD Rating Scale (K-ARS) was used to assess ADHD which was originally developed by DuPaul [32]. The K-ARS is a scale for ADHD symptom severity composed of 18 items (9 items for inattention and 9 items for hyperactivity) scored from as 0 (*never or rarely*) to 3 (*very often*) [33].

Diagnostic Interview Schedule for Children, Version IV (DISC-IV)

In the current study, the DISC-IV was administered by a trained interviewer. The DISC-IV is comprised of six domains of possible impairment present during a "time in the last year when symptoms caused the most problems." These domains are (1) getting along with parent caretakers, (2) participating in family activities, (3) participating in peer activities, (4) academic/occupational functioning, (5) relationships with teachers, and (6) distress attributable to symptoms. Each set of questions has a 2-part structure, the first determining whether impairment is present, and the second measuring severity or frequency. We selected an introductory module that includes demographic information (age, grade, names and ages of siblings, and identification of caretakers and attachment figures). The remainder of the

interview is organized into 3 modules, each containing related diagnoses (anxiety, mood, and disruptive disorders)[34].

Presence of suicidal ideation, suicide plans, and suicide attempts

The presence of suicidal ideation, suicide plans, and suicide attempts is determined using the following direct questions derived from the Structured Clinical Interview for DSM-IV Axis I Disorders (SCID-I). Participants are asked whether they had seriously considered committing suicide, made a plan to commit suicide, or attempted suicide during the past year. The presence or absence of suicide ideation, plans, and attempts is based on the subject response (yes or no) [35].

Pati*ent Health Questionnaire (PHQ-9)*

The PHQ-9 is a multipurpose instrument that assists in screening, diagnosing, and monitoring depression severity. It incorporates the DSM-IV depression diagnostic criteria with other leading major depressive symptoms into a brief nine-item, self-report tool. Respondents rate the frequency of the symptoms over the last 2 weeks on a 4-point rating scale (*not at all* = 0; *several days* = 1; *more than half of the days* = 2; *nearly every day* = 3) [36].

Rosenberg's Self-Esteem Scale

Rosenberg's Self-Esteem Scale has 10 items, each rated on a 5-point Likert scale, ranging from 1 (*strongly disagree*) to 5 (*strongly agree*). The total score ranges from 10 to 50 [37].

Self-Control Scale

Self-Control Scale is defined by Gottfredson and Hirschi (1990) [38]. The 20-item scale is divided into two self-control constructs: immediate and delayed satisfaction. Each item is rated on a 4-point scale: (4) *strongly agree*, (3) *agree somewhat*, (2) *disagree somewhat*, and (1) *strongly disagree*. Higher scores indicate lower self-control.

Aggression Questionnaire (AQ)

The Buss-Perry Aggression Questionnaire is a 29-item scale that measure four aspects of

human aggression and hostile personality. Participants rate each item using a 5-point Likert scale from 1 (*uncharacteristic of me*) to 5 (*very characteristic of me)*[39].

Social Support Appraisals Scale: Child's Subjective Appraisal of Family, Peer, and Teacher Support (SSAS)

We use the Social Support Appraisals Scale: Child's Subjective Appraisal of Family, Peer, and Teacher Support (SSAS) to address the adolescent participants' perceived support. It is a 41-item self-report instrument developed by Dubow et al. (1989) [40]. Items are rated on a 5-point Likert scale, from 1 (*never*) to 5 (*always*).

Parent-Adolescent Communication Inventory (PACI)

The Parent-Adolescent Communication Inventory (PACI) is a 40-item inventory used to assess communication in the parent–adolescent relationship. There are two forms of the inventory, one for parents and the other for adolescents. Scores range from 0 to 120, with higher scores reflecting a greater degree of parent-adolescent communication [41].

The Children's Perception of Interparental Conflict Scale (CPIC)

The CPIC uses a multiple-choice format with three possible responses: *true*, *sort of true*, and *false*. Items are scored from 1 to 3, with 3 reflecting more negative forms of conflict and their appraisal [42].

Revised Inventory of Parent and Peer Attachment (IPPA-R)

The original IPPA was developed by Armsden and Greenberg (1987) to assess adolescents' perceptions of the positive and negative affective and cognitive dimensions of relationships with their parents and close friends. In particular, the inventory examines how well these figures serve as sources of psychological security. Three broad dimensions are assessed: degree of mutual trust, quality of communication, and alienation. Participants are asked to rate each of the items on a 5-point Likert-scale from 1 (*never true*) to 5 (*always true)* [43].

Physical and mental health status

We assess physical pain experiences, such as in the hand, wrist, shoulder, or neck; dry eyes; drinking and smoking habits during the past year; histories of physical illness, including rheumatoid arthritis, lupus, diabetes mellitus; and psychiatric illness, including depression, anxiety disorders, and ADHD. We also ask about sleep hours during the week and during weekends.

Sample size estimation

We calculated the study sample size required to investigate whether overuse of Internet gaming is a risk factor of IGD presence at the 2-year follow up. For a 15% prevalence of exposure to 3 or more hours per day of Internet gaming, a 5% incidence of IGD at the 2-year follow-up period, a relative risk of this risk factor for IGD of 2 (RR=2.0), and setting α at 0.05 and β at 0.20 (power of 0.80), a sample size of 2,559 is required. Considering a dropout rate of 14%, the required sample size is estimated to be almost 3,000. We expect there will be 150 adolescents at high-risk for IGD (meeting 3 or more of the 9 DSM-5 IGD criteria) among the 3,000 participants at baseline, and we estimate that 75 new IGD cases will be found at the 2-year follow-up [44].

Strategies to minimize error and bias

Online assessment system

The participants log onto the study's website with unique authentication codes provided, where they complete the online questionnaires. We use a branched algorithmic structure to enhance the confidentiality and accuracy of responses and to reduce the risk of exposing sensitive information.

Training of the interviewers

To administer the parent–guardian surveys, we recruited psychologists and nurses with

Bachelor's or Master's degrees, and the research team provided them with training that included information on Internet gaming addiction and communication skills, through a 2-day (16-hour) training workshop. In addition to administering the surveys, the interviewers reported on the status of the data collection and any problems and issues arising during the interviews, at mandatory weekly meetings.

Prior to the diagnostic interviews and twice each year, all psychiatrists and clinical psychologists attend a seminar about IGD diagnosis to increase inter-rater reliability and diagnostic agreement. In the seminar, we review recent papers on IGD diagnosis and provide mock cases in a video to enhance diagnostic concordance. Also, at the end of each day of diagnostic interviews, all psychiatrists and clinical psychologists who participate in the clinical diagnosis attend a case conference to discuss any ambiguous diagnoses and make final determinations.

Statistical analyses plan

We will calculate the 2-year incidence, remission, and recurrence rates of IGD, with 95% confidence intervals. We will investigate the cross-sectional and longitudinal associations between exposures and outcomes using a logistic or linear regression model or a generalized linear model, as appropriate. Models will include exposures to games, such as time spent playing games, types of Internet games, and gaming-related activities, with IGD as the outcome variable and covariates including socio-demographic, personal, social, and environmental factors. Moderation tests will examine for differences in associations and mediation tests will assess indirect effects based on socio-demographic, personal, social, and environmental factors.

Ethics and dissemination

All procedures performed in studies involving human participants were in accordance with the ethical standards of the Institutional Review Board of The Catholic University of Korea (approval number: MC140NM10085) and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards. Written consent was received from all participants and from one of the participants' parents or caregivers following an explanation of the study, including confidentiality and freedom of choice to participate. All results will be published in relevant peer-reviewed international scientific journals and presented at conferences, nationally and internationally.

Discussion

A major strength of this study is that it is conducted in a county with a particularly high burden of IGD in adolescents. Korea has a high likelihood of exposure to games because Korea plays a leading role in the development of the game industry and is one of the most highly digitalized societies in the world. It provides a high-access environment for Internet gaming, including PC rooms, which have broad-band Internet networks and are equipped with the best performance computers in Korea. This makes Korea an optimal place to perform a cohort study to characterize IGD.

We are screening 3rd-, 4th-, and 7th-grade students for IGD using both polychotomous and dichotomous tools based on the nine DSM-5 IGD criteria. In addition, we are conducting structured interviews using DISC-IV of the parents or guardians to assess participant psychiatric comorbidities. Because the participants are early adolescents, we obtained their mental health status through their parents or guardians. Self-reports can include false or insincere reports, making evaluation of the IGD risk factors less accurate. To reduce this effect, we have added a reverse scale to each self-report questionnaire.

Another strength of this study is that the clinical diagnosis of IGD based on the DSM-5 is

performed by qualified mental health specialists. Most prior studies have not been able to also get a true clinical diagnosis along with the screening tool scores, so this study will provide needed validity data. Participants included those considered positive for IGD, defined as scores of 6 or higher on IGUESS, as well as a reference group of a random selection of 10% of the participants. We have constructed two sub-cohorts from those who have participated in the clinical diagnosis: a representative and a high-risk cohort. The representative sub-cohort consists of 10% randomly selected adolescents from the full cohort. They participate in the clinical diagnostic interview every year in order to estimate the false negative rate and to evaluate the clinical course of IGD, observed via the diagnostic interviews. The high-risk sub-cohort is comprised of participants meeting 3 or more of the 9 IGD criteria, based on the clinical diagnostic interviews at baseline and each follow-up wave. The high-risk sub-cohort is similar to a dynamic cohort. The suggested diagnostic criteria of IGD in DSM-5 is to meet 5 or more of the 9 IGD criteria; however, we plan to follow those adolescent participants meeting 3 or more clinical diagnostic interview in any year in order to investigate the course of IGD at syndromal and subsyndromal levels.

This study aims to clarify the natural and clinical courses of IGD based on the DSM-5 suggested diagnostic criteria in order to empirical validate the criteria and to evaluate the risk and predictive factors in adolescents based on the IGD diagnostic criteria. This study will contribute to establishing standardized IGD diagnostic criteria and to providing scientific evidence regarding the proposed DSM-5 IGD diagnostic criteria.

Keywords:
Internet gaming disorder, adolescents, cohort, protocol

Lists of Abbreviations
Aggression Questionnaire (AQ)

Attention Deficit Hyperactivity Disorder (ADHD)
Children's Depression Inventory (CDI)
Children's Perception of Inter-parental Conflict Scale (CPIC)
Diagnostic and Statistical Manual of Mental Disorders 5th version (DSM-5)
Diagnostic Interview Schedule for Children, Version IV (DISC-IV)
Global assessment scale (GAS)
International Classification of Diseases 10th version (ICD-10)
International Classification of Diseases 11th version (ICD-11)
Internet Game Use-Elicited Symptom Screen (IGUESS)
Internet gaming disorder (IGD)
Internet user Cohort for Unbiased Recognition of gaming disorder in Early adolescents (iCURE)
Kiddie-Schedule for Affective Disorders and Schizophrenia-Present and Lifetime Version-Korean version (K-SADS-PL)
Korean version of the ADHD Rating Scale (K-ARS)
Parent-Adolescent Communication Inventory (PACI)
Parent-Adolescent Communication Inventory (PACI)
Parenting attitude test (PAT)
Patient Health Questionnaire (PHQ-9)
Post-traumatic stress disorder (PTSD)
Revised Inventory of Parent and Peer Attachment (IPPA-R)
Smartphone Addiction Scale (SAS-SV)
Social Support Appraisal Scale (SSAS)
Standard Patients Evaluation of Eye Dryness Questionnaire (SPEED)
Structured Clinical Interview for DSM-IV Axis I Disorders (SCID-I)
Self-reported version of structured clinical interview for Internet Gaming Disorder (SR-IGD)

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Availability of data and materials
Not applicable. This protocol was not included any participants data.

Authors' contribution:
HJ conducted the analyses and led the writing of the manuscript. HWY guided and supervised the writing of the manuscript. HWY, HJ, and SJ developed and proposed the basic idea of the study. HWY, HJ, SJ, EK, HS and HH contributed to conducting the study. SL, HL, YK, SB, and JC conducted diagnostic interviews. BK guided to performance DISC assessment. DAG advised to construct study design. DAG and MNP reviewed scientific and proof reading of the manuscript. All authors contributed editorial comments on the manuscript.

Conflict of interest:
The authors declare no conflicts of interest with respect to the content of the manuscript..

Consent for publication

Not applicable.

References

1. Entertainment_software_association. 2012 Essential facts about the computer and video game industry. *Retrieved from http://wwwtheesacom/facts/pdfs/ESA_EF_2012pdf* 2012
2. Wan CS, Chiou WB. Why are adolescents addicted to online gaming? An interview study in Taiwan. *Cyberpsychology & behavior : the impact of the Internet, multimedia and virtual reality on behavior and society* 2006;9(6):762-6. doi: 10.1089/cpb.2006.9.762 [published Online First: 2007/01/05]
3. Wood RT, Griffiths MD. A qualitative investigation of problem gambling as an escape-based coping strategy. *Psychology and psychotherapy* 2007;80(Pt 1):107-25. doi: 10.1348/147608306x107881 [published Online First: 2007/03/10]
4. Kuss DJ, Griffiths MD, Karila L, et al. Internet addiction: a systematic review of epidemiological research for the last decade. *Current pharmaceutical design* 2014;20(25):4026-52. [published Online First: 2013/09/05]
5. Boot WR, Kramer AF, Simons DJ, et al. The effects of video game playing on attention, memory, and executive control. *Acta psychologica* 2008;129(3):387-98. doi: 10.1016/j.actpsy.2008.09.005 [published Online First: 2008/10/22]
6. Witt E. MA, , & Jackson L. Trends in youth's videogame playing, overall computer use, and communication technology use: The impact of self-esteem and the Big Five personality factors. *Computers in Human Behavior archive* 2011;27(2):763-69
7. Chan PA, Rabinowitz T. A cross-sectional analysis of video games and attention deficit hyperactivity disorder symptoms in adolescents. *Annals of general psychiatry* 2006;5:16. doi: 10.1186/1744-859x-5-16 [published Online First: 2006/10/25]
8. Desai RA, Krishnan-Sarin S, Cavallo D, et al. Video-gaming among high school students: health correlates, gender differences, and problematic gaming. *Pediatrics* 2010;126(6):e1414-24. doi: 10.1542/peds.2009-2706 [published Online First: 2010/11/17]
9. Van Rooij AJ, Schoenmakers TM, Vermulst AA, et al. Online video game addiction: identification of addicted adolescent gamers. *Addiction (Abingdon, England)* 2011;106(1):205-12. doi: 10.1111/j.1360-0443.2010.03104.x [published Online First: 2010/09/16]
10. Barnett JaC, Mark Virtually real: a psychological perspective on massively multiplayer online games. . *Review of General Psychology* 2010;14(2):167-79.
11. Union IT. World Telecommunication/ ICT Indicators Database *17th edition* 2013
12. Service KSI. Statistics on Internet use. National Information Society Agency (2011) Internet Addiction Survey. *Agency NIS, Seoul, South Korea* 2013
13. Ministry of Culture S, and Tourism. Introduction of regulations of internet game in Korea. 2014
14. Choo H, Gentile DA, Sim T, et al. Pathological video-gaming among Singaporean youth. *Annals*

of the Academy of Medicine, Singapore 2010;39(11):822-9. [published Online First: 2010/12/18]

15. Lemmens JS, Valkenburg PM, Gentile DA. The Internet Gaming Disorder Scale. *Psychological assessment* 2015;27(2):567-82. doi: 10.1037/pas0000062 [published Online First: 2015/01/07]
16. Gentile D. Pathological video-game use among youth ages 8 to 18: a national study. *Psychological science* 2009;20(5):594-602. doi: 10.1111/j.1467-9280.2009.02340.x [published Online First: 2009/05/30]
17. Lam LT, Peng ZW, Mai JC, et al. Factors associated with Internet addiction among adolescents. *Cyberpsychology & behavior : the impact of the Internet, multimedia and virtual reality on behavior and society* 2009;12(5):551-5. doi: 10.1089/cpb.2009.0036 [published Online First: 2009/07/22]
18. AmericanPsychiatricAssociation. Diagnostic and Statistical Manual of Mental Disorders (DSM-5). 2013
19. Petry NM RF, Gentile DA, Lemmens JS, Rumpf H, Mößle T, et al. An international consensus for assessing Internet gaming disorder using the new DSM-5 approach. *Addiction* 2014;109(9):1399-406.
20. Griffiths MD, van Rooij AJ, Kardefelt-Winther D, et al. Working towards an international consensus on criteria for assessing internet gaming disorder: a critical commentary on Petry et al. (2014). *Addiction (Abingdon, England)* 2016;111(1):167-75. doi: 10.1111/add.13057 [published Online First: 2015/12/17]
21. Kardefelt-Winther D, Heeren A, Schimmenti A, et al. How can we conceptualize behavioural addiction without pathologizing common behaviours? *Addiction (Abingdon, England)* 2017 doi: 10.1111/add.13763 [published Online First: 2017/02/16]
22. Starcevic V. Tolerance and withdrawal symptoms may not be helpful to enhance understanding of behavioural addictions. *Addiction (Abingdon, England)* 2016;111(7):1307-8. doi: 10.1111/add.13381 [published Online First: 2016/04/21]
23. Ko CH, Yen JY, Chen SH, et al. Evaluation of the diagnostic criteria of Internet gaming disorder in the DSM-5 among young adults in Taiwan. *Journal of psychiatric research* 2014;53:103-10. doi: 10.1016/j.jpsychires.2014.02.008 [published Online First: 2014/03/04]
24. Kim Y, Cheon, K., Kim,B., Chang, S., Yoo, H., & Kim, J. . The reliability and validity of Kiddie Schedule for Affective Disorders and Schizophrenia Present and Lifetime Version-Korean version (K-SADSPL-K). *Yonsei Medical Journal* 2004;45:81-89.
25. Young KS. The research and controversy surrounding internet addiction. *Cyberpsychology & behavior : the impact of the Internet, multimedia and virtual reality on behavior and society* 1999;2(5):381-3. doi: 10.1089/cpb.1999.2.381 [published Online First: 1999/01/01]
26. Kim DI JY, Lee EA, Kim DM, Joe YM. Development of Internet Addiction Proneness Scale - Short Form (KS-Scale). *Korean J Counseling* 2008;9:1703-22.
27. Koo HJ, Han DH, Park SY, et al. The Structured Clinical Interview for DSM-5 Internet Gaming

Disorder: Development and Validation for Diagnosing IGD in Adolescents. *Psychiatry investigation* 2017;14(1):21-29. doi: 10.4306/pi.2017.14.1.21 [published Online First: 2017/01/18]

28. Kwon M, Kim DJ, Cho H, et al. The smartphone addiction scale: development and validation of a short version for adolescents. *PloS one* 2013;8(12):e83558. doi: 10.1371/journal.pone.0083558 [published Online First: 2014/01/07]
29. Kovacs M, Feinberg TL, Crouse-Novak MA, et al. Depressive disorders in childhood. I. A longitudinal prospective study of characteristics and recovery. *Archives of general psychiatry* 1984;41(3):229-37. [published Online First: 1984/03/01]
30. Cho S. CJ. Development of State - Trait Anxiety Scale for Korean Children. *Medicine Journal of Seoul Natinal University* 1989;14(3):150-57.
31. Spielberger CD. Manual for the State: Trait Anxiety Inventory for Children. *Palo Alto, Consulting Psychologist Press* 1972
32. GJ. D. Parent and teacher ratings of ADHD symptoms: psychometric properties in a community-based sample. . *J Clin Child Psychol* 1990;20:245-53.
33. Kim JW, Park KH, Cheon KA, et al. The child behavior checklist together with the ADHD rating scale can diagnose ADHD in Korean community-based samples. *Canadian journal of psychiatry Revue canadienne de psychiatrie* 2005;50(12):802-5. doi: 10.1177/070674370505001210 [published Online First: 2006/01/18]
34. Shaffer D, Fisher P, Lucas CP, et al. NIMH Diagnostic Interview Schedule for Children Version IV (NIMH DISC-IV): description, differences from previous versions, and reliability of some common diagnoses. *Journal of the American Academy of Child and Adolescent Psychiatry* 2000;39(1):28-38. doi: 10.1097/00004583-200001000-00014 [published Online First: 2000/01/19]
35. First MB, Spitzer, R. L, Gibbon M, and Williams, J.B.W.. Structured Clinical Interview for DSM-IV-TR Axis I Disorders, Research Version, Research Edition. (SCID-I). *New York: Biometrics Research, New York State Psychiatric Institute* 2002
36. Kroenke K, Spitzer RL, Williams JB. The PHQ-9: validity of a brief depression severity measure. *Journal of general internal medicine* 2001;16(9):606-13. [published Online First: 2001/09/15]
37. Rosenberg M. Society and the adolescent self-image. *Princeton, NJ: Princeton University Press* 1965
38. Gottfredson MR, & Hirschi,T. A generaltheory ofcrime. *Stanford, CA:StanfordUniversityPress* 1990
39. Buss AH, Perry M. The aggression questionnaire. *Journal of personality and social psychology* 1992;63(3):452-9. [published Online First: 1992/09/01]
40. Dubow EF, Tisak J. The relation between stressful life events and adjustment in elementary school children: the role of social support and social problem-solving skills. *Child development* 1989;60(6):1412-23. [published Online First: 1989/12/01]
41. Bienvenu MJ. A parent-adolescent communicaiton inventory. *Saluda, NC: Family Life publictions*

1969

42. Grych JH, Seid M, Fincham FD. Assessing marital conflict from the child's perspective: the children's perception of interparental conflict scale. *Child development* 1992;63(3):558-72. [published Online First: 1992/06/01]
43. Armsden GC, Greenberg MT. The inventory of parent and peer attachment: Individual differences and their relationship to psychological well-being in adolescence. *Journal of youth and adolescence* 1987;16(5):427-54. doi: 10.1007/bf02202939 [published Online First: 1987/10/01]
44. Gentile DA, Choo H, Liau A, et al. Pathological video game use among youths: a two-year longitudinal study. *Pediatrics* 2011;127(2):e319-29. doi: 10.1542/peds.2010-1353 [published Online First: 2011/01/19]

Table 1. Measurement tools in each wave

Categories	Measures	Source	Wave			
			T1	T2	T3	T4
Exposure variables	Exposure time to internet, smart phone, and online game	student/parent	√	√	√	√
	Internet, smart phone, and online game using behaviors	Student	√	√	√	√
Diagnosis	IAT	Student	√			
	K-scale	Student	√			
	IGUESS	Student	√	√	√	√
	SR-IGD	Student	√		√	√
	SAS-SV	Student	√	√	√	√
Psychiatric comorbidities	CDI	Student	√	√	√	√
	TAIC	Student	√	√	√	√
	K-ARS	Parent	√			
	DISC-IV	Parent	√			
	Suicidality	Student	√	√	√	√
	PHQ-9	Parent	√			
Personal factors	Rosenberg's Self-Esteem Scale	Student	√			
	Self-control scale	Student	√			
	AQ	Student	√	√	√	√
	Demographic information	Student/parent	√			
	Academic achievement	Student/parent	√	√	√	√
Environmental factors	School policy on having smart phone use in school	Student	√	√	√	√
	PACI	Student	√			
	Marriage satisfaction	Parent	√			
	IPPA-R	Student	√			
	Perceived Parenting Competence	Parent	√			
	Online gaming rule in home	Parent	√	√	√	√
Social factors	Social network	Student	√			
	Bullying scale	Student	√			
	SSAS	Student	√			
Health consequences	Physical health	Student/parent	√			
	Mental health	Student	√			

Internet Addiction Test (IAT); Korean Scale for Internet Addiction (K-Scale); Internet Game Use-Elicited Symptom Screen (IGUESS); Self-reported version of structured clinical interview for Internet Gaming Disorder (SR-IGD); Short version of the Smartphone Addiction Scale (SAS-SV); Children's Depression Inventory (CDI); Trait Anxiety Inventory for Children (TAIC); Korean version of the ADHD Rating Scale (K-ARS); Diagnostic Interview Schedule for Children, Version IV (DISC-IV); Patient Health Questionnaire (PHQ-9); Aggression Questionnaire (AQ); Parent-Adolescent Communication Inventory (PACI); Revised Inventory of Parent and Peer Attachment (IPPA-R); Social Support Appraisals Scale: Child's Subjective Appraisal of Family, Peer, and Teacher Support (SSAS)