Cross-sectional and longitudinal epidemiological studies of internet gaming disorder:
A systematic review of the literature

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Abstract

Aim:

The diagnostic criteria of Internet Gaming Disorder (IGD) have been included in section III of DSM-5. This study aims to systematically review both cross-sectional and longitudinal epidemiological studies of IGD.

Methods:

All publications included in PubMed and PsychINFO up to May 2016 were systematically searched to identify cross-sectional studies on prevalence and longitudinal studies of IGD. In the process of identification, articles in non-English languages, and studies focusing solely on the use of gaming were excluded, and those meeting the methodological requirements set by this review were included.

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As a result, 37 cross-sectional and 13 longitudinal studies were selected for review.

Results:

The prevalence of IGD in the total samples ranged from 0.7% to 27.5%. The prevalence was higher among males than females in the vast majority of studies and tended to be higher among younger rather than older people in some studies. Geographical region made little difference to prevalence. Factors associated with IGD were reported in 28 of 37 cross-sectional studies. These were diverse and covered gaming, demographic and familial factors, interpersonal relations, social and school functioning, personality, psychiatric comorbidity and physical health conditions. Longitudinal studies identified risk and protective factors, and health and social consequences of IGD. The natural course of IGD was diverse but tended to be more stable among adolescents compared to adults.

Conclusion:

Although existing epidemiological studies have provided useful data, differences in methodologies make it difficult to compare the findings of these studies when drawing consensus. Future international studies using reliable and uniform methods are warranted.

Key words:

Internet gaming disorder, cross-sectional study, longitudinal study, epidemiology, review

Introduction

The rise in internet use has been matched by a growing concern about excessive usage of the medium and the consequences for health and social functioning. A variety of terms have been employed to describe this condition including: internet addiction[1)], compulsive computer use[2)], pathological internet use[3)], and problematic internet use[4)]. Since a globally approved term covering excessive Internet use, (encompassing gaming, social networking sites, video-viewing and other Internet services and the resultant impairment and distress) has not been developed, we shall tentatively employ the term "internet use disorder (IUD)" to describe these conditions in this review. Diagnostic criteria or guidelines for IUD have been proposed by several investigators, but none have achieved a global consensus. One widely used set of diagnostic criteria is Young's 8-item Diagnostic Questionnaire. This has been utilized both for screening and diagnostic purposes, and as an instrument to estimate the prevalence of IUD in epidemiological studies[5)]. Subsequently, two independent diagnostic criteria for Internet addiction were developed, based on clinical observations and empirical data of IUD[6,7)].

Recently, the American Psychiatric Association published the updated version of the DSM (DSM-5), which included Internet Gaming Disorder (IGD) in Section III as a condition requiring further research. This is expected to help establish a globally approved definition and diagnostic guidelines for IUD[8)]. As these criteria were not specifically included in DSM-5, it is necessary to gather research evidence to examine the validity, reliability and clinical utility of IGD criteria. A group of researchers involved in the establishment of these criteria have suggested areas in which research can be conducted to achieve this goal[9)]. These include: 1) ascertaining whether each of these criteria represent defining features of the conditions and whether the suggested wording is appropriate; 2) determination of optimal threshold; 3) evaluation of reliability and validity of the specific items; 4) frequencies with which symptoms must occur in order for a criterion to be met; and 5) evaluation of the validity across differences in age, gender and culture[9)]. The study also put special emphasis on the need to obtain data on the prevalence of IGD using representative samples, and the natural course of the disorder[9)].

Cross-sectional studies have been conducted in many parts of the world into the prevalence of IUD.

Results have demonstrated wide variations. This diversity in the prevalence rates can be explained by: lack of globally accepted diagnostic criteria of IUD, differences in assessment tools and cut-offs used in surveys, and the nature of subjects surveyed[10]. Among these studies, the number of surveys whose subjects were representative of the general population was limited. Two examples were studies in Norway and the USA, where rates were 1.0% and 0.7%, respectively[11,12]. Prevalence rates ascertained by other types of studies, especially in adolescents have been researched more extensively. Results show that in European samples prevalence rates range from 1.2% to 5.0%[13-18]. Similar prevalence rates have been reported in samples from North America[19,20], and from the Middle East[21,22]. Like random or representative samples, other types of studies showed a tendency towards higher prevalence rates (between 7.5% and 26.7%) in Asian samples compared to samples from other regions[23-28].

Longitudinal and prospective studies have been used to identify risk and protective factors and elucidate the natural history of the disorder. A recently published review on IUD, based on a systematic literature search, identified 9 longitudinal studies for analysis[29]. Risk or protective factors were broadly classified into three main categories: psychopathologies of the participants, family and parenting factors, and others such as internet usage, motivation, and academic performance. A number of factors were identified in each category, including protective factors such as the quality of communication between parents and children in relation to Internet use. In addition, a study that focused on the effects of IUD on mental health was included. Subjects who had been classified as having moderate to severe risk of IUD were about 2.5 times more likely to develop depressive symptoms at follow-up. After the publication of this review, a number of longitudinal and prospective studies on IUD, including IGD, have been published.

This review has attempted to systematically identify both cross-sectional and longitudinal epidemiological studies of IGD, and to briefly summarize the methodology of the included studies. The estimated prevalence of and factors associated with IGD was then ascertained from cross-sectional studies. With regard to longitudinal studies, analyses were focused on risk and protective factors, health and social consequences and the natural course or history of IGD.

Methods

Before and after the publication of the diagnostic criteria of IGD in DSM-5, cross-sectional and longitudinal epidemiological studies on problematic or pathological gaming that were comparable to IGD in DSM-5 have been published. To include these studies in this review, internet gaming disorder (IGD) is broadly defined as "problematic or pathological gaming condition comparable to IGD in DSM-5, including both online and offline platforms". Therefore, IGD in this review is not identical to IGD, as defined by DSM-5, and is likely to consider the disorder from a broader perspective.

We used the major medical and health and psychological databases, PubMed and PsychINFO to identify cross-sectional studies on IGD prevalence. The search included all publication years until May 2016. The keywords used for the search were ("prevalence" or "cross-sectional" or "screening" or "scale") AND ("internet gaming" or "gaming disorder" or "game addiction" or "video game and problematic" or "video game and excessive"). Recent review articles[10,30] were also referenced to cover all the relevant articles that should be included in this review. Candidate articles that were written in languages other than English were excluded from this review. After identifying candidate articles, the titles and abstracts were examined to ascertain whether these were appropriate for inclusion in this study. During this process, studies solely examining the use of either online or offline gaming, which were not related to pathological or problematic gaming, gaming disorder or addiction were excluded. At this stage 57 articles were identified for further evaluation. Next, the full text of articles that had been selected based on an evaluation of the titles and abstracts, was comprehensively examined to decide on their final inclusion in the review. The minimum requirements of the studies for inclusion in the review were as follows: 1) target disorder was IGD or a similar condition, including pathological or problematic gaming, gaming disorder or gaming addiction; 2) characteristics of samples and methods for data collection were clearly described and were deemed methodologically sound; 3) number of samples was 300 or higher; and 4) screening or diagnostic instruments used for the determination of IGD with cut-off points were mentioned. These were validated and standardized, or their suitability for

use in the respective studies clearly explained. Conference proceedings, abstracts and non-peer reviewed journal articles were excluded from this review. Following this careful evaluation of the original studies, 37 cross-sectional studies were selected as appropriate for inclusion in this study.

Similar to cross-sectional studies, we searched PubMed and PsychINFO to identify longitudinal studies on IGD for all publication years up to May 2016. The keywords used for the search were ("longitudinal" or "prospective") AND ("internet addiction" or "internet game" or "gaming disorder" or "video game and problematic" or "video game and excessive"). We excluded non-English articles, and screened articles based on an examination of the titles and abstracts, as we did for the cross-sectional studies. Through these screening procedures, we identified 30 candidate longitudinal studies and subjected these to further evaluation. Determination for final inclusion of studies in the review was conducted by a thorough examination of the context of articles, according to the following criteria: 1) target disorder was IGD or a similar condition, including pathological or problematic gaming, gaming disorder or gaming addiction; 2) characteristics of samples and, methods for data collection were clearly mentioned and were deemed methodologically sound; 3) procedures for the baseline and follow-up surveys, and the follow-up duration were clearly explained; 4) follow-up duration was 6 months or longer; and 5) screening or diagnostic instruments used for the determination of IGD with the cut-off points were mentioned, and these were validated and standardized or at least their suitability for use in the respective studies was clearly explained. Based on the procedures mentioned above, 13 longitudinal studies were eventually included in this study.

Results

1. Prevalence of IGD

1.1. Overall prevalence

Table 1 shows the list of cross-sectional studies reporting the prevalence of IGD, including offline games using video game devices. Studies are listed according to geographical region and chronology.

The prevalence of IGD for the total sample of each study ranged from 0.7% to 27.5%[31-67]. Of the studies listed, 15 studies reported the prevalence of each gender separately. The lowest prevalence among male samples reported was 0.8% which came from a survey on video arcade game addiction among university students in Australia[64]. This figure was exceptionally low, probably because it only focused on the prevalence of video arcade games among subjects who were 17 years old or older. It was part of a larger study, and the prevalence among both younger sub-samples and computer game addicts was higher [64]. Other than this, the prevalence of IGD among male samples ranged from 2.0% to 22.7%[32,35,46,48-50,52,54,56-59,61,63,64]. Likewise, the prevalence of females was between 0% and 14.9%[32,35,46,48-50,52,54,56-59,61,63,64]. In all of these studies, with the exception of a study from Korea[63], the prevalence of males exceeded that of females.

1.2. Prevalence by factor

1.2.1. Age

Studies can be divided into two groups based on the age of samples. One group comprised only of adolescents, and the other included samples with a range of ages. The prevalence among the total samples in the adolescent group was between 1.3% and 19.9%[31-36,41-43,45,48-52,54,62,65]. The prevalence in the non-adolescent group was between 0.3% and 27.5%[37-40,44,46,47,53,63,64,66,67], which was similar to the adolescent group. However, the prevalence decreased with the advancement of the age of samples in some of the studies in the non-adolescent group[38,46,53,64].

1.2.2. Region

As previously mentioned, the existing literature has suggested a higher prevalence of IUD in Asian countries than in other regions. This trend has not been observed with regard to the prevalence of IGD in the studies examined in this review. Of course, the methodological differences between studies may make it difficult to compare directly. For example, 4 out of 6 studies from Asian countries used the Pathological Video Game Use Scale, which was developed by Gentile to identify IGD[55]. This screening test was not used in other regions, except for one study in the USA[55]. The cut-off level of the

Game Addiction Scale[68] employed in a study from China[61] was more generous than that used in the studies conducted in Europe[34,38-40,44,47,53]. In addition, the Asian studies that were included focused on China, Korea and Singapore. Likewise, a clear difference in the prevalence of IGD was not observed in other regions.

1.2.3. Survey methods

The studies included in this review conducted surveys in four principal ways: in the classroom, by post, telephone or online. The number of studies in each category were 22, 4, 2, and 9, respectively. The prevalence of IGD among total samples ranged from 0.3% to 19.9% for classroom surveys[31,34-36,41-43,45,48-51,54,56-62,64,65], 0.6% and 1.3% for postal surveys[38,44,52,53], 0.2% and 2.7% for telephone surveys[32,39] and 1.3% and 27.5% for online surveys[33,37,40,46,47,55,63,66,67]. Almost all studies using classroom surveys were conducted on adolescents, while the vast majority of studies using other channels were on both adolescents and adults. As mentioned previously, some studies reported a lower prevalence with the advancement of age. The higher prevalence of IGD identified by classroom surveys might be reflective of the younger samples. When the IGD prevalence of the other three channels was compared, online surveys clearly produced a higher prevalence than the other two survey types.

1.2.4. Gamers vs non-gamers

The percentage of gamers among study samples was reported in 30 of 37 studies. Of these 30 studies, 19 were a mixture of gamers and non-gamers and the remaining 11 solely comprised gamers. Four studies of the former group reported the prevalence of IGD among total samples and just those of gamers. These were 1.3% and 2.7% (the percentage of gamers: 49%)[40], 4.6% and 8.2% (65%)[41], 5.4% and 6.8% (79%)[46], and 0.33% and 0.89% (weighted percentages) (34%)[53], respectively. It is natural to observe a higher prevalence of IGD among gamers than among a mixture of gamers and non-gamers. The degree of difference in the prevalence seems to grow as the percentage of gamers decreases. Obviously, this is an important factor when the prevalence of IGD is examined and compared.

2. Associated factors in cross-sectional studies (Table 2)

2.1. Factors related to gaming

As expected, longer time spent playing games[32-34,39,40,42,43,45,47,55,58,61,63,64-67], higher frequency of playing games[32,40,43,55,58,64], and more years playing games[43,55,66] were all associated with IGD. Online rather than offline games[39,40,47], and certain types of games - massive multiplayer online role-playing games, first person shooters, fighting games and real time strategy games - were preferred by persons with IGD[32,35,39,63,66]. Some studies highlighted the involvement of affected individuals in few or no activities other than gaming[35,37], and that gaming was used both as an inadequate coping behavior and as a source of self-efficacy[35].

2.2. Demographic and familial factors

As mentioned previously, many studies reported that male gender[32,38,40,42,46,51,53,57,65] and younger age[32,38,46,53] were associated with an increased prevalence of IGD. Some studies indicated family and marital factors, including familial difficulties and disharmony[37,61], and marital difficulties, including marital status, namely whether single, separated or divorced[37,53].

2.3. Interpersonal relations and school/social functions

With regard to interpersonal relations, problems with peers, a higher prevalence of both being bullied and bullying others, and having friends who were addicted to video games was reported[49,51,54,55]. However, one study reported that having more friends than others was associated with IGD[61]. This relationship might be achieved through online interaction. Many studies reported lower educational and career attainment including: lower school grades, skipped school classes and truancy[48,50,53,55,58,61]. Likewise, lower social skills, competence and integration were also indicated[34,35,39,48,65]. These may be largely related to the consequences of IGD.

2.4. Personality, psychiatric comorbidity and physical health conditions

Higher impulsivity and neuroticism were reported to be associated with IGD[35,53,58,63]. Some personal-

ity traits such as extraversion and agreeableness were suggested to be negatively associated with IGD[23c)]. Aggression and violence were frequently observed among people with IGD[28,29,76)]. They were expressed in three different ways: aggressive tendencies in general[38,44)], psychological acceptance of aggression and violence[35,58)] and actual aggressive behavior, such as rule breaking, physically fighting and carrying weapons[33,48,54-56)]. Other psychological tendencies such as loneliness, low self-esteem, low self-efficacy and low life-satisfaction were also reported[34,38,39,42,65)]. Co-morbid psychiatric problems were reported to be associated with IGD in many studies. These disorders included attention deficit and/or hyperactivity disorder[47,51,54,55)], depression[38,42,44,47,51,56,65)], anxiety[35,38,65)], sleep problems[37,47,50,58)] and regular or early substance use[45,56)]. Some studies reported physical pain as a consequence of IGD[55,58)].

3. Longitudinal studies of IGD

Thirteen longitudinal studies that were identified provided a range of information, as shown in Table 3. However, this review focused on three measures: risk and protective factors of IGD, social and health consequences of IGD and the natural history of IGD. As the number of studies is not large, these measures covered relatively limited areas. A summary of information on the methodology of each study included can be found in Table 3.

3.1. Risk and protective factors

3.1.1. Risk factors

Like cross-sectional studies, factors related to gaming were identified in several studies. Lemmens et al.[77)] reported that higher level of pathological gaming identified with the Game Addiction Scale[68)] at baseline predicted an increase in game playing time at follow-up. Gentile et al.[55)] also suggested that more time spent gaming predicted a greater tendency to be a pathological gamer. A similar finding was reported in other studies[79.82)]. On the other hand, a positive attitude towards gaming and an intention to play too much were reported as risk factors of IGD[81)]. With regard to demographic factors, one study reported male gender and single-parent families as risk factors[80)]. Regarding personality and psycho-

logical problems, loneliness[78], impulsivity[55] and conduct problems[81] were reported as risk factors for IGD. Interestingly, Henchoz et al[86] reported that a lower level of involvement with sport and exercise predicted an increased risk of video game disorder, defined by the Game Addiction Scale[68] at an average of 15.5 months later. In this study, video game disorder predicted a subsequent lower level of involvement with sport and exercise[86].

3.1.2. Protective factors

Protective factors for IGD were also reported. Unexpectedly, factors or measures related to controlling the use of gaming and the Internet, such as physical control over the use of gaming were not included. Lemmens et al[78] reported at follow-up that higher level social competence and self-esteem at baseline played a preventive role in relation to IGD. Similarly, Rehbein et al[80] reported that social integration into class and school-related well-being were protective factors for IGD. In their studies, they identified the degree of social integration by asking the subjects about the last three birthday parties that they had been invited to, and whether or not the child who had invited them had been a classmate. School-related well-being was examined by asking "How do you feel at school?" According to Haagsma et al[81], among the 6 components of the "Theory of Planned Behavior"[88], perceived behavioral control was found to be the most important factor in predicting problematic video-game behavior. Based on this finding, the authors suggested that a client's perceived lack of control over gaming may be a simple but useful measure to evaluate risk of future problem play. A study conducted in China[62] reported that teacher autonomy support, which was evaluated using a 5-item questionnaire developed by Jia et al[90], was a protective factor against adolescent IGD. This association was mediated by basic psychological needs satisfaction and school engagement.

3.2. Health and social consequences

As mentioned previously, aggression is commonly observed in cases of IGD and internet addiction. Lemmens et al[77] reported that time spent on games increased levels of physical aggression, while higher levels of pathological gaming, regardless of whether content was violent, predicted an increase

in physical aggression among boys. Studying primary and secondary school students (grades 3, 4, 7 and 8), Gentile et al[55] reported that children who began with more pathological gaming symptoms at baseline demonstrated higher levels of depression, anxiety and social phobia, and lower school grades two years later. Similarly, in a study of adolescents in Norway, it was reported that video game addiction, but not time spent on games at baseline, was related to depression, lower academic achievement and conduct problems at a follow-up conducted two years later[82]. Negative health and social consequences were also identified among college students. A study in the USA reported that video game addiction at baseline was negatively related to average college grade points, and drug and alcohol violations occurring on campus, one year later[85].

Not all longitudinal studies reporting health and social consequences indicated negative consequences. A study conducted in Germany on computer game use did not find a systematic negative impact on psychosocial well-being two years after baseline[83]. In addition, the same study suggested the status of problematic gamers was unstable.

3.3. Natural course of IGD

Findings on the stability of IGD were diverse. Gentile et al[78] reported that 84% of pathological gamers at the baseline survey were still pathological gamers at the follow-up survey two years later. Another study on secondary school students who were online gamers, conducted in the Netherlands, indicated that 50% of addicted online gamers at the baseline survey were still addicted at the one-year follow-up[36]. Although actual percentages related to the stability of IGD were not mentioned, two studies suggested that the stability of pathological gaming[78] or video game addiction[82] was highly significant between the baseline surveys and the follow-up surveys, 6 months[78] and 2 years[82] later, respectively.

On the other hand, the unstable nature of the course of IGD has also been reported. Scharkow et al[83] reported that only 26.5% of problematic gaming at baseline continued to be problematic two years later. The incidence of IGD was 1.7% and 92% of study subjects were stable unproblematic gamers. Konkolÿ Thege et al[84] conducted a 5-year longitudinal study to examine the natural course of various behavioral addictions, including video game addiction. According to their results, the majority of re-

spondents reported excessive gaming only once and none had stable gaming addiction throughout the study period. A moderately strong decrease in symptom severity of gaming addiction was found for both genders. In addition, they reported that similar findings were found for other behavioral addictions. Another study from Australia reported that problem gamers at the baseline assessment scored approximately 10 points higher on the Problematic Video Game Playing Test (PVGT) adapted from the Internet Addiction Test[1,79]. The PVGT scores of problem and non-problem gamers significantly decreased at 6 and 18-month follow-ups.

Discussion

The prevalence of IGD reported in the studies included in this review was quite diverse, spanning from 0.7% to 27.5%. The diversification observed may reflect real differences in the prevalence of IGD in different parts of the world. However, the difference in the prevalence was most likely heavily influenced by the difference in study methodologies. For example, many studies used different screening tools to identify IGD. There were three instruments that were used in several studies: Game Addiction Scale[68], Pathological Video Game Use Scale[55] and Young's Diagnostic Questionnaire[5]. These were used in 9, 4 and 3 studies, respectively. However, the cut-off points employed by studies differed, even where the same instrument was utilized. For example, some studies used a cut-off of 7 out of 7 for the Game Addiction Scale[34,38,39,40,59,66], while other studies used 4 of 7[47,53] or even 3 of 7, in the case of one study[61]. The difference in cut-off levels makes it difficult to compare the prevalence of IGD even among studies using the same instrument. The estimated prevalence of IGD was evaluated using different cut-off levels of Game Addiction Scale[68] in several studies[34,38,39,66]. The prevalence of IGD ranged from 4.3 times higher, when 4 out of 7 was employed, to 18.5 times higher when 7 of 7 was used in these studies. As previously mentioned, other factors to be considered include the characteristics of study participants e.g. age, gender ratio and the rate of gaming, and data collection methods.

One finding which may be worth discussing is the distinct difference in the prevalence of IGD between males and females. The prevalence of IGD tended to be higher among males than among females in almost all cross-sectional studies included in this review. With some exceptions[19,91)], a male preponderance has been also reported on the prevalence of IUD in many studies[15,18,24)]. It has been suggested that females typically prefer to use the Internet for communication, such as SNS, and social reasons, whereas males are more likely to play games[19,91,92)]. Because this review focuses only on gaming, differences in the prevalence between gender may have been exacerbated, compared with rates for IUD.

In the present review, a higher prevalence of IGD in Asian countries compared to other regions has not been confirmed. As mentioned previously, a higher tendency in terms of IUD prevalence in Asian countries has been suggested by original studies[23-28)] and review[10,93)]. There is a possibility that the methodological diversification mentioned above may have masked this tendency. It is highly recommended to develop common screening and diagnostic instruments that will be validated on a more global basis, and to conduct an international epidemiological study using the same methodology. This will allow valid comparisons of the prevalence of IGD worldwide. Hopefully, the World Health Organization will take the lead in conducting these projects.

Many factors associated with IGD have been reported in cross-sectional studies included in this review. These incorporate factors related to gaming, demographic and familial factors, interpersonal relations, social and school functioning, personality, psychiatric comorbidity, and physical health condition. As these factors were identified using a cross-sectional design, it is methodologically difficult to detect risk factors for IGD. Factors listed in Table 2 are a mixture of risk factors, comorbid disorders, and disorders and problems as a consequence of IGD. However, potential risk factors could be chosen if a chronological link between the existence of factors and the onset of IGD are taken into account. For example, for the majority of factors related to gaming, demographic factors such as gender, age and personality may serve as risk factors of IGD. Comorbid psychiatric disorders act as both risk factors and consequences. For example, attention deficit and/or hyperactivity disorder (ADHD) is most likely a risk factor of IGD, but sleeping problems, depression and aggressive behavior may also be consequences of IGD[10,29,76)]. On the other hand, social and school dysfunction and health conditions

such as physical pain may be better explained as a consequence of IGD.

These assumptions are, by and large confirmed by longitudinal studies. A longer time spent on gaming predicted a tendency toward pathological gaming in the future[55]. Male gender was identified as a risk factor[80]. Impulsivity and conduct problems conferring risks of IGD[55,83] have been known to be typical clinical characteristics of ADHD[94,95]. On the other hand, psychiatric disorders such as depression and phobia were identified as the consequence rather than the risk factors for IGD[55,82]. Similarly, lower school performance was reported as a consequence of IGD in two studies[82,84].

IGD causes serious health and social problems, but the development of treatment is in the early stages. Efficacious interventions for this disorder have not been well established[96.97]. Therefore, prevention of the occurrence of IGD is crucial. Risk and protective factors should serve to develop efficacious preventive measures. At this stage, longitudinal studies to identify these factors are obviously insufficient. They are methodologically diversified and therefore, hinder the identification of reliable factors.

Findings on the natural course or history of IGD are important. This was emphasized by the group of researchers who developed the diagnostic criteria of IGD for DSM-5[9]. If core symptoms of IGD are transient and show a self-recovering nature, IGD cannot be conceptualized as a discrete clinical entity. Several longitudinal studies included in this review provided data on the natural history of the disorder. Again, the data were diverse, the number of studies limited and the period of follow-up too short to draw a conclusion. However, there may be one factor that pertains to the stability of IGD. This was the age of study participants, where in studies on adolescents[36,55,78,82], the course of IGD tended to be more stable compared to those on adult populations[79,83,84]. In any case, further research that extends follow-up periods is warranted.

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Author contributions

All authors participated in the designing of the study, conducted literature searches and wrote the draft of the manuscript. All authors contributed to and approved the final manuscript.

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Table 1. Summary of cross-sectional studies: study designs and prevalence of internet gaming disorder (IGD)[a)]

Study		Study subjects				How IGD was identified	Survey type	Prevalence of IGD (%)	Comments
Country	Author, year	Character-istics	Age range	Number	% of gamers				
Studies from Europe									
UK	Griffiths et al, 1998[31)]	Students of a compre-hensive school in a UK city	12-16	T=387 (M=58%)	98.7%	Endorse ≧ 4 of 8 DSM-III-R pathological gambling adapted scale	Classroom survey	T=19.9	
Norway	Johans-son et al, 2004[32)]	Repre-sentative national samples	12-18	T=3,237	98.5% (63.3%, at least once a week)	Endorse ≧ 5 of 8 on Young's Di-agnostic Ques-tionnaire[5)]	Either tele-phone sur-vey or postal sur-vey	M=4.2 F=1.1 T=2.7	
Germa-ny	Grüsser et al, 2007 [33)]	Samples recruited online	Mean±SD, 21.11±6.4	T=7,069 (M=94%)	100%	Endorse ≧ 3 of 6 modified ICD-10 de-pendence syn-drome	Online survey	T=11.9	
Nether-lands	Lem-mems et al, 2009[34)]	Students from sec-ondary schools	Sample 1 & 2: 12-18	Sample 1 T=644 (M=48%) Sample 2 T=573 (M=49%)	Sample 1: 55% Sample 2: 65%	Endorse ≧ 7 of 7 on Game Addiction Scale (GAS)[68)]	Classroom survey	Sample 1 T=2.3 Sample 2 T=1.9	The preva-lence of subjects who en-dorsed 4 of 7 on GAS[68)] was 9.4% for sample 1 and 9.3% for sample 2.
Germa-ny	Rehbein et al, 2010 [35)]	Repre-sentative national student samples	9th grad-ers (mean±SD, 15.3±0.7	T=10,402	No data	Scores ≧ 33 on Video Game De-pendency Scale (CSAS)[69)]	Classroom survey	M=3.0 F=0.3 T=1.7	The preva-lence of at risk ado-lescents (CSAS[69)] ≧28) was 4.7% for males, 0.5% for females and 2.8% for total samples.
Nether-lands	Van Rooij et al, 2010 [36)]	Repre-sentative national student samples	13-16	T=4,559 (M=49%)	Online gamers: 34.5%	Latent class analysis of responses to Compulsive Internet Use Scale[70)]	Classroom survey	T=1.6	

France	Achab et al, 2011 [37)]	MMORPG [b)] gamers recruited through web-based approach	18-54	T=448	100%	Endorse ≧ 3 of 7 DSM-IV-TR substance dependence adapted scale	Online survey	T=27.5	The prevalence of internet addiction was 44.2% on Goldberg Internet Addiction Disorder Scale[37).]
Norway	Mentzoni et al, 2011 [38)]	Representative national samples	15-40	T=816 (M=51%)	56.3%	Endorse ≧ 7 of 7 on Game Addiction Scale[68)]	Either postal survey or online survey	T=0.6	The prevalence of problematic users (≧ 4 of 7 on GAS[68)]) was 4.1%.
Germany	Festl et al, 2012 [39)]	Gamers identified from nationally representative samples	14-90	T=4,207 (M=58.4%)	100%	Endorse ≧ 7 of 7 on Game Addiction Scale[68)]	Telephone survey	T=0.2	The prevalence of problematic users (≧ 4 of 7 on GAS[68)]) was 3.7%.
Netherlands	Haagsma et al, 2012 [40)]	Representative national samples	14-81	M=425 F=476 T=902	49.1%	Endorse ≧ 7 of 7 on Game Addiction Scale[68)]	Online survey	T=1.3	The prevalence was 2.7% among gamers.
Hungary	Pápay et al, 2013 [41)]	Nationally representative student samples	9th and 10th graders	T=5,045	65.4%	Latent profile analysis of Problematic Online Gaming Questionnaire[71)]	Classroom survey	T=4.6	The prevalence was 8.2% among gamers.
Hungary	Király et al, 2014 [42)]	Nationally representative student gamer samples	9th and 10th graders (mean=16.4)	T=2,073 (M=69.1%)	100%	Scores ≧ 32 on Problematic Online Gaming Questionnaire Short-Form[42)]	Classroom survey	T=11.0	
Spain and UK	Lopez-Fernandez et al, 2014[43)]	High school students in Barcelona and London	11-18	Spain T=1,047 UK T=949	No data	Endorse ≧ 5 of 9 on Problem Video Game Playing (PVP) Scale[72)]	Classroom survey	Spain T=7.7 UK T=14.6	If the cut-off for PVP was set at 4 or more, as originally recommended, the prevalence would have been 15.1 in Spain and 30.1 in the UK.

Norway	Brunborg et al, 2015 [44]	Gamers identified from nationally representative samples	16-74	T=3,037 (M=58%)	100%	Endorse ≧ 7 of 7 on Game Addiction Scale[68]	Postal survey	T=0.7	
France	Coëffec et al, 2015 [45]	Middle and high school students in a region in France	11-17	T=1,423	92.1%	Endorse ≧ 3 of 7 on Problematic Use of Video Games (PUVG) Questionnaire[45] adapted from DSM-IV-TR diagnostic criteria for substance dependence	Classroom survey	T=17.7	
Netherlands	Lemmens et al, 2015[46]	Representative community samples	13-40	M=621 F=630 T=1,251	79%	Endorse ≧ 5 of 9 on the 9-item dichotomous Internet Gaming Disorder Scale[46]	Online survey	M=6.8 F=4.0 T=5.4	Prevalence among gamers: M=8.0 F=5.4 T=6.8
Finland	Männikkö et al, 2015[47]	Representative national samples	13-24	M=150 F=144 T=294	92.5%	Endorse ≧ 4 of 7 on Gaming Addiction Scale[68]	Online survey	T=9.1	
Germany and 6 other countries	Müller et al, 2015[48]	Representative student samples in 7 European countries	14-17	M=6,841 F=6,097 T=12,938	Regular online gamers: 60.5%	Scores > 13.5 on the Scale for the Assessment of Internet and Computer Game Addiction – Gaming Module[73]	Classroom survey	M=3.1 F=0.3 T=1.6	
Denmark	Ramussen, et al, 2015 [49]	Representative student samples in a Danish city	11, 13 and 15	M=1,031 F=1,069 T=2,100	No data	Endorse ≧ 3 of 3 on index score of perceived problems regarding computer gaming[49]	Classroom survey	M=3.9 F=1.7	If problem gamers were more broadly defined (≧ 2 of 3 index score), the prevalence would have been 22.0% for males and 7.7% for females.

Germany	Rehbein et al, 2015[50]	Random student samples in a state in Germany	13-18	M=5,621 F=5,382 T=11,003	No data	Endorse ≧ 5 of 9 on Video Game Dependency Scale[69]	Classroom survey	M=2.02 F=0.26 T=1.16	Endorsement of "giving up other activities" and/or "withdrawal" was associated with a probability of IGD.
Germany and 4 other countries	Strittmatter et al, 2015[51]	Representative student samples	Mean±SD, 15.0±1.3	M=3,918 F=4,889 T=8,807	No data	Endorse ≧ 5 of 8 Young Diagnostic Questionnaire (YDQ)[5] and those who frequently engaged in gaming activities	Classroom survey	T=3.6	The prevalence among non-gamers who met the criteria on YDQ[68] was 3.1%.
Sweden	Vadlin et al, 2015[52]	Representative community samples in one county in Sweden	13-15	M=806 F=977 T=1,783	No data	Endorse ≧ 5 of 7 on Gaming Addiction Identification Test (GAIT)[31]	Postal survey	M=2.9 F=0.0 T=1.3	Prevalence assessed by parents using GAIT-P: T=2.4%
Norway	Wittek et al, 2015[53]	Video gamers identified from representative national samples	16-74	M=2,038 F=1,351 T=3,389	100%	Endorse ≧ 4 of 7 on Game Addiction Scale[68]	Postal survey	T=1.41 (unweighted) T=0.89 (weighted)	Prevalence among whole population sample: unweighted, 0.53%; weighted, 0.33%
Germany	Dreier et al, 2016[54]	Free-to-play gamers from representative student samples in a German city	12-18	T=1,485	100%	Scores > 13.0 points on Assessment for Internet and Computer Game Addiction[73]	Classroom survey	M=5.7 F=4.6 T=5.2	The prevalence of risky users who met some criteria for IGD was 17.4%.
Studies from North America									
USA	Gentile, 2009[55]	Representative national samples	8-18	T=1,178	88%	Endorse ≧ 6 of 11 Pathological Video Game Scale[55]	Online survey	T=8.5	The prevalence varied from 7.9% to 19.8%, according to the scale classification.

USA	Desai et al, 2010[56]	Gamers from representative adolescent samples in Connecticut, USA	14-18	T=2,196	100%	Endorse ≧ 3 of 3 on Impulse Control Disorder, revised for gaming scale[56,74]	Classroom survey	M=5.8 F=3.0 T=4.9	
Canada	Turner et al, 2012[57]	Representative student samples in Ontario	12-19	M=1,394 F=1,438 T=2,832	85.9%	Endorse ≧ 5 of 8 on Problem Video Game Playing Scale, modified version[57,72]	Classroom survey	M=15.1 F=3.1 T=9.4	
Studies from Asia									
Singapore	Choo et al, 2010[58]	Students of primary and secondary schools	Primary 3 and 4 and secondary grades 1 and 2	M=2,179 F=819 T=2,998	82.6%	Endorse ≧ 5 of 10 on Pathological Video Game Use Scale[55]	Classroom survey	M=12.6 F=4.7 T=8.7	
Singapore	Gentile et al, 2011[59]	Students of primary and secondary schools	3rd, 4th, 7th and 8th graders	M=2,179 F=819 T=2,998	At least occasionally play: 83%; used to play: 10%	Endorse ≧ 5 of 10 on Pathological Video Game Use Scale[55]	Classroom survey	M=12.0 F=4.6 T=9.9	The baseline data of a longitudinal study
Korea	Soek et al, 2012[60]	Students of high and middle schools located near Seoul	7th through 12th graders	M=1,121 F=192 Missing=19 T=1,332	Online gamers: 63.4%	Endorse ≧ 10 of 10 core criteria on Pathological Online Video Game Play questionnaire[60,75]	Classroom survey	T=1.7	Prevalence varied with the change in the cut-off level
China	Wang et al, 2014[61]	Students of randomly selected schools	8th – 11th graders. Mean: M=14.5, F=14.6	M=249 F=254 T=503	94.1%	Endorse ≧ 3 of 7 on Game Addiction Scale[68]	Classroom survey	M=22.7 F=8.7 T=15.7	The cut-off set for IGD was relatively low.
China	Yu et al, 2014[62]	Students from junior high schools in southern China	14-16 (9th graders)	T=356 (M=41.01%)	No data	Endorse ≧ 5 of 11 on Pathological Video Game Use Questionnaire[55]	Classroom survey	T=4.78	The follow-up data of a longitudinal study. The prevalence at baseline (7th graders) was 5.80%.

Korea	Kim et al, 2016[63]	Gamers recruited through web-based approach	20-49	M=1,824 F=1,217 T=3,041	100%	Endorse 5 of 9 on DSM-5 Internet Gaming Disorder Criteria[8]	Online survey	M=13.1 F=14.9 T=13.8	
Other areas									
Australia	Thomas et al, 2010[64]	Student samples in one area in Australia	Secondary school samples 12-17. College samples 15-19. University samples 17-54	Secondary school samples M=519 F=471 T=990 College samples: M=148 F=186 T=335 University samples: M-191 F=509 T=705	No data	Computer game addiction (CGA) Endorse ≧ 5 of 9 on Young's Diagnostic Questionnaire[5] Video arcade game addiction (VGA) Endorse ≧ 4 of 9 on screening checklist adapted from the DSM-IV criteria for pathological gambling	Classroom survey	Secondary CGA M=9.9, F=3.5 T=7.0 VGA M=9.0 F=4.0 T=7.0 College CGA M=5.5 F=1.3 T=3.3 VGA M=2.9 F=2.0 T=2.5 University CGA M=5.1 F=1.5 T=2.6 VGA M=0.8 F=0.0 T=0.3	
Australia	King et al, 2013[65]	Representative student samples in an Australian city	12-18	M=602 F=612 T=1,214	No data	Endorse ≧ 5 of 10 on Pathological Technology Use Checklist for Video Gaming[55]	Classroom survey	T=1.8	
Others									
USA and 12 other countries	Hussain et al, 2012[66]	Online gamers recruited online	12-62	M=1,095 F=325 T=1,420	100%	Endorse ≧ 7 of 7 on Game Addiction Scale[68]	Online survey	T=3.6	If addicted gamers were more broadly defined (≧ 4 of 7 of GAS[68]), the prevalence would have been 44.5%.

57 countries	Pontes et al, 2014[67)]	Gamers recruited online	16-58	M=855 F=148 T=1,003	100%	Latent profile analysis of Internet Gaming Disorder Test (20-item version)[67)]	Online survey	T=5.3	

[a)]M = male, F = female and T = total.
[b)]MMORPG = massive multiplayer online role-playing game

Table 2. Factors associated with IGD identified in cross-sectional studies

Studies	Factors related to gaming	Demographic and familial factors, interpersonal relations and social and school functions	Personality, psychiatric comorbidity and physical health conditions
Johansson et al, 2004[32)]	- Longer time on games - Higher frequency of playing games - Types of games e.g. shooting/war games, fighting games, and strategy games	- Male - Younger age	
Grüsser et al, 2007[33)]	- Longer daily hours of playing games		- Aggressive behavior
Gentile, 2009[55)]	- More years spent playing video games - Higher frequency of playing video games - Longer weekly duration of video game play - Larger number of video game rating symbols known - Having a video game system in the bedroom	- Having friends who are addicted to video games - Lower school grades	- Higher frequency of hand, finger and wrist pains - Diagnosis of attention deficit hyperactivity disorder - Having felt addicted to video games - Physical fight in the past year
Lemmems et al, 2009[34)]	- Longer time spent on games	- Low life satisfaction - Low social competence	- Higher level of loneliness and aggression
Desai et al, 2010[56)]		- Male	- Smoking regularly, other drug use and lower caffeine consumption - Depression - Serious fights and carrying a weapon to school
Choo et al, 2010[58)]	- Longer video game playing time - Higher frequency of internet use	- Poor school performance - Low social competence	- Impulse control problems - Normative belief in aggression - Body pains and sleeping problems
Rehbein et al, 2010[35)]	- Use of MMORPG[a)] - No success in leisure-time activities besides gaming - Gaming in terms of dysfunctional coping - Gaming as a source of self-efficacy	- Previous repetition of a school year - Lower social competence	- Higher impulsiveness - School-related anxieties - Acceptance of violence
Thomas et al, 2010[64)]	- Longer time spent on games - Higher frequency of playing games		
Achab et al, 2011[37)]	- Few other hobbies, going out less and seeing fewer friends	- Marital, family, work and financial difficulties - Insufficient purchases of essential items	- Sleeping problems - Adverse effect on mood, psychological and physical health - Confusion between real life and fiction

Mentzoni et al, 2011[38)]		- Male - Younger age	- Anxiety and depression - Low life satisfaction
Festl et al, 2012[39)]	- Longer time spent on games - Online rather than offline games - Role-playing and shooting games	- Low social competence and integration - Low sociability - Perceived lack of social support	- Aggressive tendencies - Low level of self-efficacy - Low life satisfaction
Haagsma et al, 2012[40)]	- Longer playing time - Higher playing frequency - Online gaming rather than offline gaming, only for males	- Male	
Hussain et al, 2012[66)]	- Longer total gaming time per week - More years spent playing MMORPG[a)]	- Student and unemployed, as employment status	
Turner et al, 2012[57)]		- Male	
King et al, 2013[65)]	- More time spent on video games	- Male - Poor social skills	- Higher level of loneliness - Depression, panic and separation anxiety
Király et al, 2014[42)]	- Longer use of Internet and more online game playing time	- Male	- Depressive symptoms - Lower self-esteem
Lopez-Fernandez et al, 2014[43)]	- Use of video games - Lower onset age of playing - Longer mean time per session - Higher frequency of playing		
Wang et al, 2014[41)]	- Longer average time spent gaming per week - High frequency/duration of spending on gaming, both money and time	- Male - Poor academic performance - perceived family disharmony - Reporting more friends than others	
Coëffec et al, 2015[45)]	- Longer playing time on video games in a school day		- Earlier onset of the use of alcohol, tobacco and cannabis
Lemmems et al, 2015[46)]		- Male - Younger age	
Männikkö et al, 2015[47)]	- Longer time spent on weekly gaming - Preference for online interaction		- Ill health and fatigue - Sleep problems - Concentration problems - Depression and anxiety - Less frequent physical activities

Müller et al, 2015[48)]		- Lower frequency of activities - Low social competence - Low academic performance	- Lower level of internalizing problems (depression and somatic complaints) - Higher level of externalizing problems (rule-breaking behavior and aggressive behavior)
Ramussen, et al, 2015[49)]		- Both genders: higher prevalence of both being bullied and having bullied others - Males only: Lower frequency and smaller number of informal relations and lower emotional support from parents and friends	
Rehbein et al, 2015[50)]	- Longer gaming time per day	- Lower grade point - Higher frequency of skipping school classes in previous 6 months and any gaming related truancy in past 6 months	- Sleep disturbance
Strittmatter et al, 2015[51)]		- Male - Problems with peers - Low well-being	- Depression - Conduct disorder - Emotional problems - Hyperactivity - Suicidal behaviors and self-injurious behaviors
Wittek et al, 2015[53)]		- Male - Younger age - Marital status - single, separated, divorced, widow and widower - Lower educational attainment	- Negatively associated with personality traits such as extraversion, agreeableness, consciousness - Positively associated with personality traits, such as neuroticism, and low scores on psychometric health
Dreier et al, 2016[54)]		- Problems with peers	- Higher level of emotional and behavioral problems - Hyperactivity - Lower level of prosocial behavior
Kim et al, 2016[63)]	- Longer playing time - Preferred game genre, such as role playing games, first-person shooters, real time strategy games and other online games		- Symptoms of obsession and compulsion, depression and somatization - High impulsivity

[a)]MMORPG: massive multiplayer online role-playing game

Table 3. Summary of the longitudinal studies of IGD: study designs and main findings[a)]

Country, study author and year	Study design and subjects	Baseline and follow-up surveys/studies	Screening or diagnostic measures of IGD and other measures	Data analysis	Risk and/or preventive factors	health and/or social consequences	Natural course of IGD
Netherlands, van Rooij et al., 2010[36)]	Design: - Self-reported surveys in classrooms on two occasions. Follow-up duration: - 1 year Study subjects: - 467 Dutch secondary school students, who were online gamers (males, 90%; mean age, 13.8 ±0.8 years old)	- Study subjects were those who had participated in surveys conducted in 2008 and 2009. - Total number of subjects participating in 2008 survey was 1,572 and 1,476 in 2009.	*Screening/diagnostic measures:* - Compulsive Internet Use Scale[70)] - Weekly hours online gaming *Other measures:* Measures to evaluate: - Self-esteem - Loneliness - Depression - Social anxiety	*Main statistical analysis:* - Latent class analysis - Statistical evaluation of model improvement was performed with the bootstrap likelihood ratio test.	NA	NA	- The stability of online game addiction for 1 year: 50%
Netherlands, Lemmens et al., 2011[77)]	*Design:* - Self-reported survey in classrooms two times *Follow-up duration:* - 6 months *Study subjects:* - 540 Dutch adolescents (males: 70%).	- 1,024 students (51% boys) of secondary education aged between 11 and 17 years old (mean age, 13.9±1.4) participated in the baseline survey in 2008. - 851 of 941 students who participated in the follow-up survey could be matched with those of the baseline survey participants. - Subjects were those in the two surveys who played games and gave pertinent information.	*Screening/diagnostic measures:* - Game Addiction Scale[68)] - Time spent on games - Weighted measure of time spent on violent games *Other measures:* - One measure to evaluate aggressive behavior	*Main statistical analysis:* Autoregressive cross-lagged panel models of structural equation modelling	*Risk factors:* - Higher level of pathological gaming	- Increased physical aggression (time spent on games) - Increased physical aggression among boys, regardless of violent	NA

						content (pathological gaming)	
Netherlands, Lemmens et al., 2011[78)]	*Design and follow-up duration:* - Same as above *Study subjects:* - 543 Dutch adolescents (males, 70%)	*Procedures were the same as above*	*Screening/diagnostic measures:* - Game Addiction Scale[68)] - Time spent on games *Other measures:* - Measures to evaluate loneliness, social competence, life satisfaction and self-esteem	*Main statistical analysis:* Autoregressive cross-lagged panel models of structural equation modelling	*Risk factors:* - Loneliness *Protective factors:* - Social competence - Self-esteem	NA	- The stability of pathological gaming for 6 months: highly significant
Singapore, Gentile et al., 2011[55)]	*Design:* - Self-reported classroom surveys on three occasions *Follow-up duration:* - 2 years *Study participants:* - 3,034 students in grades 3, 4, 7 and 8, in primary and secondary schools.	- Of 3,034 participants, 2,998 (2,179 boys and 819 girls) completed the baseline survey, and 2,974 provided pertinent information. - 2,605 and 2,530 questionnaires were collected in years 2 and 3, respectively, with attrition rates of 12.3% by year 2 and 14.7% by year 3.	*Screening/diagnostic measures:* - General Media Habits Questionnaire[87)] - Pathological video game use[55)] - Problematic gaming *Other measures:* - Measures to evaluate impulsivity, depression, school performance and others	*Main statistical analysis:* Latent growth mixture modelling was used to determine groups of students who were similar with respect to their growth trajectories in pathological gaming.	*Risk factors:* - Greater amount of gaming - Higher impulsivity - Lower social competence	- Higher levels of depression, anxiety and social phobia - Lower school grades	- The stability of pathological gaming for 2 years: 84%

Australia, King et al., 2013[79]	*Design:* - Self-reported online surveys three times *Follow-up duration:* - 6 and 18 months *Study subjects:* - 117 adults (males, 92%; mean age, 24 ±5.5 years old) with at least 95% completing survey data at 18 months follow-up.	- 393 adults who played video games at least 1 hour every week were recruited via popular survey hosting websites. Participated in the baseline survey in 2010. - Attrition at 18-month follow-up was 71%.	*Screening/diagnostic measures:* - Problematic Video Game Playing Test (PVGT) (adapted from the Internet Addiction Test[1]) - Video game play survey *Other measures:* - Measures to evaluate depression, anxiety and stress	*Main statistical analysis:* 2 problem gaming statuses (problem vs. no problem) x 3 time repeated measures ANCOVA to assess the effect of baseline problem gaming status on PGVT scores	NA	NA	- PVGT scores of problem gamers significantly decreased at 6 and 18-month follow-ups
Germany, Rehbein et al., 2013[80]	*Design:* - Self-reported survey in classrooms on two occasions *Follow-up-duration:* - 5 years *Study subjects:* - 406 German students (males, 45.3%; mean age, 9.7±0.63 years old at the baseline survey) for whom both a fourth- and a ninth-grade questionnaire were identified	- The baseline survey was conducted on 1,217 fourth-grade students in 2005 (return quota, 79.2%). - The follow-up survey was conducted on 1,070 ninth-grade students in 2010 (return quota, 87.9%)	*Screening/diagnostic measures:* - Video Game Addiction Scale[69] - Risk variables regarding ownership of screen media - Risk variables regarding media use *Other measures:* - Other risk variables related to social demographics, family, school performance and others	*Main statistical analysis:* - Ordinary least squares regression analysis - Five explanatory models were calculated.	*Risk factors:* - Male gender - Single-parent family - Problematic video game use *Protective factors:* - Social integration in the classroom - School-related well-being	NA	NA

Netherlands, Haagsma et al., 2013[81]	*Design:* - Anonymous online questionnaire surveys on two occasions *Follow-up duration:* - 6 months *Study subjects:* - 288 adolescents and young adults (males, 69.1%) who were video game players and gave complete data in the two surveys.	- 1,488 students in pre-vocational and senior vocational schools (males, 50.6%: aged between 12 and 22 years old) participated in the baseline survey in 2010. - 967 students participated in the follow-up survey (attrition rate: 35%).	*Screening/diagnostic measures:* - Game Addiction Scale[68] - Average total weekly playing time *Other measures:* - Revised Theory of Planed Behavior Questionnaire[81]	*Main statistical analysis:* Structural equation modelling in which predictive models were constructed to examine whether the components of the "Theory of Planned Behavior"[88] predicted video gaming activity and problematic game use 6 months later.	*Risk factors:* - Positive attitude toward gaming - Intention to play too much *Protective factors:* - Perceived behavioral control	NA	NA
Norway, Brunborg et al., 2014[82]	*Design:* - Self-reported surveys in classrooms on two occasions. *Follow-up duration:* - 2 years *Study subjects:* - 1,928 junior and senior high school students at the baseline survey (female, 55.5%; age range 13 to 17 years old) who completed the baseline and follow-up surveys.	- 8,356 elementary, junior high school or senior high school students participated in the baseline survey in 2010. - 2,450 students out of 4,561 invited students participated in the follow-up survey in 2012. - Attrition rate was 70.7% from the baseline survey.	*Screening/diagnostic measures:* - Game Addiction Scale for Adolescents[68] - Two-item questions on video game use *Other measures:* - Measures evaluating depression, academic achievement, heavy episodic drinking and conduct problems	*Main statistical analysis:* - First differencing (FD) model - Using FD, depression, academic achievement, heavy episodic drinking and conduct problems were regressed on video game addiction and time spent gaming.	*Risk factors:* - Gaming amount - Conduct problems *Protective factors:* - Academic achievement - Heavy episodic drinking	- Depression, lower academic achievement and conduct problems.	- The stability of video game addiction for 2 years: highly significant

Germany, Scharkow et al., 2014[83]	*Study design:* - Computer-assisted telephone interview on three occasions *Follow-up duration:* - 2 years *Study subjects:* - 902 computer gamers (males, 56%, mean age 40.2 years old) who completed the baseline survey and the two follow-up surveys.	- 4,500 computer game users were recruited from a representative omnibus survey. The baseline survey was conducted in 2011. - Follow-up surveys were conducted on a random subset of 50% of the respondents from each previous survey. - 2,199 and 902 subjects completed surveys in 2012 and 2013, respectively, with attrition rates of 59% and 51% in relation to each preceding survey.	*Screening/diagnostic measures:* - Gaming Addiction Scale[68] *Other measures:* - Berlin Social Support Scales[89] and others	*Main statistical analysis:* - Autoregressive and cross-lagged structural equation model	*Risk and protective factors:* Not identified	- Not related systematically to negative changes in the gamers'' lives	- The stability of problematic gaming for 2 years: 26.5% - Incidence rate: 1.7% - The stability of unproblematic gaming: 92%

Canada, Konkolÿ Thege et al., 2015[84]	*Study design:* - Self-reported online survey on six occasions *Follow-up duration:* - 5 years *Study participants:* - 4,121 adults (males 45.3%, mean age, 46.1±14.1 years old)) consisting of 3,065 from a general population sample and 1,056 at risk of problem gambling.	- A 5-year longitudinal study to examine the natural course of 6 excessive behaviors including exercising, sexual behavior, shopping, online chatting, online gaming and eating. - The study participants contributed to the baseline survey in 2006-2007. Follow-up surveys were conducted every year for the subsequent 5 years. - Attrition rate was 6.1%	*Screening/diagnostic measures:* - A question on significant problems associated with over-involvement in video or internet gaming - The Behavioral Addiction Measure (21-item questionnaire)[84] *Other measures:* - Questions on seeking help for problematic behaviours - Instruments to examine substance use characteristics	*Main statistical analysis:* - Repeated measures general linear model to investigate the severity of behavioral addiction symptoms over time	NA	NA	- The majority of respond spondents: excessive gaming only once for 5 years - Moderately strong decrease in symptom severity of gaming addiction for both genders
USA, Schmitt et al., 2015[85]	*Design:* - Self-reported online and paper-and-pencil surveys on two occasions *Follow-up duration:* - 1 year *Study subjects:* - 383 university students	- The baseline survey was conducted on 477 students entering a residential liberal arts university (males, 100%; mean age, 18 years old) - The follow-up survey was conducted at the end of their first year of college. - The study subjects were those who regularly played video games at baseline.	*Screening/diagnostic measures:* - Revised Video Game Addiction Scale[68] developed for this study. - Type of video games, time spent on gaming and others *Other measures:* - Engagement with college experience, number of reported drug and alcohol violations, and others	*Main statistical analysis:* - Hierarchical linear regression analysis	NA	- Negatively correlated with college grade point average and drug and alcohol violations at follow-up	NA

China, Yu et al., 2015[62]	*Study design:* - Self-reported surveys in classrooms *Follow-up duration:* - 2 years *Study subjects:* - 356 junior high school students (males, 41.0%; mean age,14.8±0.5 years old) who completed the baseline and the two follow-up surveys	- 431 7th grade students were recruited from two junior high schools, and the baseline survey was conducted in 2011. - 407 students completed the 1-year follow-up, and 356 students completed the 2-year follow-up surveys.	*Screening/diagnostic measures:* - Pathological online game use (POGU) was assessed with 11-item questionnaire adapted from Gentile's Pathological Video-Game Use Questionnaire[55] *Other measures:* - A 5-item questionnaire to measure perceived teacher autonomy support and others	*Main statistical analysis:* - Structural equation model controlling for age, gender, sensation seeking, and self-esteem	*Protective factors:* - Teacher autonomy support	NA	NA
Switzerland, Henchoz et al., 2016[86]	*Design:* - Self-reported surveys on two occasions *Follow-up duration:* - 15.52±2.74 months *Study subjects:* - 4,933 representative sample of young Swiss men (males, 100%; mean age, 19.95±1.20 years old)	- 5,990 young Swiss men who were enrolled at national army recruit centers, participated in the baseline survey. - Of these, 5,223 subjects completed the follow-up survey (attrition rate: 12.8%). - The subjects were those who gave complete information.	*Screening/diagnostic measures:* - Game Addiction Scale[68] *Other measures:* - Level of sport and exercise	*Main statistical analysis:* - Cross-lagged path analysis controlling for covariates including demographics, family information and substance abuse disorders.	*Risk factors:* - Lower levels of sport and exercise.	- Lower levels of sport and exercise	NA

[a]NA: Not applicable.