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REVIEW

A Scientometric Analysis and Critical Review of Internet Gaming Disorder Behaviours

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ABSTRACT

There are increasing concerns about internet gaming disorder (IGD). No review of existing studies has systematically analyzed and visualized the trends of IGD and those early identification of symptoms related to IGD behaviors. This critical review focuses on the emerging trends for early identification of symptoms related to IGD behaviors in papers published in Web of Science Core Collection from 2009 to 2021 by scientometric analysis and critical review. Scientometric data analysis technique includes co-occurrence analysis, cluster analysis and burst analysis of authors, countries, keywords and co-citation to visualize those contributing and associated factors to develop IGD behaviors and their relationships to mental-emotional symptoms. About 81.8% of the papers were published in the following countries: United States, United Kingdom, Australia, China and South Korea. The top co-occurrence keywords were 'children', 'depression', 'anxiety' and 'attention deficit hyperactivity disorder (ADHD)', 'scale', identifying the population, characteristics and commonly used assessment tools that are susceptible to certain symptoms relating to IGD of which influencing factors facilitate the understanding of the association of sociodemographic characteristics. The main emerging topics were identified in this critical review after conducted the scientometric analysis. The results identified five topics: game impulse, motivation, evaluation scale, mediating effects and diagnostic criteria. This study provides an overview of the research trends on the identity and development of the IGD field of study.

KEYWORDS

Internet gaming disorder; bibliometric analysis; CiteSpace; scientometrics; trends

1 Introduction

With the rapid development of the internet, playing games has emerged as a leisure activity that appeals to all ages. However, excessive gaming may become problematic or addictive [1], leading to aggressive cognition and behaviours [2] and interfering in daily life [3]. Researcher highlighted that internet gaming disorder (IGD) is referred to as "internet use disorder, internet addiction, or gaming addiction [4]. While the conceptual definitions of IGD and internet addiction are still evolving, the attention of this disorder is

the "persistent and recurrent use of the Internet to engage in games, often with other players" [5]. Obviously, two of these terms are not specific to internet gaming and appear to combine different concepts under the rubric of internet overuse. Internet addiction is when a person has a compulsive need to spend a great deal of time on the internet, to the point where other areas of life (such as relationships, work or health) are allowed to suffer. Its symptoms differ from substance use and gambling disorder [6]. This disorder has also been referred to as 'gaming addiction', 'game dependence' and 'pathological or problematic gaming'. Empirical studies of IGD using the DSM-5 criteria are still lacking. The diagnostic criteria for IGD has more than 10. DSM-5 drafted diagnostic criteria for IGD and indicated that further research is warranted [7]. The diagnostic criteria of IGD has been updated and included in the fifth edition of the Diagnostic and Statistical Manual of Mental Disorders (DSM-5) in 2013 and the eleventh final revision of the International Classification of Diseases (ICD-11) in 2018 [8]. Both criteria pay attention to the condition of players in the past year and the IGD population has been increasing globally [9]. The worldwide prevalence of gaming disorder was 3.05% in 2021 [10]. The prevalence of IGD among Chinese adolescents (ages 12–19) was 4.6% in 2022. This study provides evidence for retaining or deleting specific diagnostic criteria by the DSM framework in the future. The IGD incidence has an inverted U-shaped relationship with age, which could be related to stress, responsibility and peer influence [11]. At present, IGD development is associated with personal characteristics, physiological factors, social and psychological environmental factors and structural characteristics. Due to its unknown aetiology and complex neuropathological characteristics, there are a lack of studies assessing the outcomes of treatment methods for people diagnosed with IGD. IGD-related protective factors and risk factors offer important insights into the formulation of prevention strategies; therefore, research that investigates the symptoms of IGD is urgently needed.

Tools that provide overviews of data, including systematic reviews, knowledge maps and bibliometrics, which are often used in scientometrics, offer advantages in the presentation of distribution characteristics. This technique measures the research impact, examines the citation process and maps the knowledge structure and evolutions in a domain based on a large-scale scholarly dataset [12]. CiteSpace is the main mainstream piece of software among these tools and can be used to visualise the structure and distribution of knowledge to identify key points and their development [13]. CiteSpace can more intuitively reflect existing research and identify hotspots and detect emerging trends to allow for a clear picture of the evolution of research. The present research aims to use CiteSpace to visualize a map based on the Web of Science Core Collection (WOSCC), summarise its conditions and provide guidance for future research.

2 Method

2.1 Search Strategy

Publications were obtained from WOSCC and included a comprehensive citation database with influential and multidisciplinary papers. The following keywords were used in the search strategy: (Internet gaming disorder or game disorder or internet gaming addiction or game addiction) and symptom. Relevant studies were identified when the defined terms appeared in the title, keywords or abstracts. Research results were restricted by language (English), paper type (article) and time span (until 2021). After manual screening, 181 papers were identified for analysis. All records were exported in plain text format named 'download _XXX'. The search was completed within a day (on 24 June 2021) to avoid bias caused by database updates.

2.2 Software Analysis and Interpretation

CiteSpace was used to conduct the bibliometric analysis and generate the visualization map [14], which was composed of many nodes and links. A burst analysis, co-occurrence analysis and cluster analysis of 'authors', 'countries', 'keywords', 'reference' were conducted using CiteSpace5.7.R5W (64 bit). Analysis focused on the frequency, centrality and the burst of nodes at the macro and micro level. The parameters

were set as follows: time slicing (from 2009 to 2021, one year per slice), node types (author, country, keyword and reference), strength (cosine), pruning (pathfinder, pruning) and TOPN (TOP5), while the others remained as default. Origin Pro 2021 was used to create the charts.

When 'circle' was selected for node shape, the size of the node was positively correlated with the number or frequency of publications. A line linking two nodes indicates that they are connected, cooperated or co-cited. The thickness of a line positively correlates with the density of cooperation. Each node or link is a different color that indicates the time of the first appearance. A change in color from a cold blue tone to a warm red tone in the time scale indicates the change of time from early to recent [15]. Betweenness centrality measures the degree of one node that connects to other nodes in the network on a score of 0 to 1. Nodes with high centrality are located in the center, which with great influence are the transitions of others. A node that is bright red or purple has a betweenness centrality that is greater than 0.10.

In cluster analysis, cluster labels are obtained via a log-likelihood ratio (LLR) because the quality of clusters generated in LLR are high intra-class similarity and low inter-class similarity [16]. The modularity of a network measures the extent to which a network can be decomposed into multiple modules. The modularity Q index ranges from 0 to 1; a value of over 0.3 suggests that the network is clearly divided into distinct groups. Silhouette is an index of cluster homogeneity, with values approaching 1 indicating the maximum in homogeneity, while values over 0.5 indicating that the clustering is reasonable. Size equals the number of cited papers within the cluster. Sigma ($\sum$) measures the combined strength of the structural and temporal properties of a node, its betweenness centrality and citation burst. Sigma is computed as (centrality+1) burstiness [17], with higher values indicating higher influential potential.

Chen [18] argued that burst analysis can be found a frontier direction. The CiteSpace emergent word detection function was used to explore the sudden increase and change rate of nodes and generate a node ranking table with a high strength burst rate. A bar represented a year in the ranking list. The strength of burst was a quantification of this outbreak. The length of the red line represented the duration of a sudden node emergence increase in that year.

3 Results and Critical Analysis

Changes in the volume of papers can reflect the development status and future research trends of a field. Fig. 1 shows the distribution of 181 bibliographic records from 2009 and 2021. The publications displayed an initial increase from 2015, followed by a slight decrease. The number of papers also dramatically increased from 2017 before slowing down from 2017 to 2019. However, the overall trend still tended towards an increase and reached a peak in 2020 (only part of papers in 2021). Diversified words appeared in papers published before 2017 for 'IGD symptoms', such as 'pathological symptom of video game' and 'problematic digital gaming behavior' and focused on children, adolescents and young adults. The related evaluation scale was single. Discussing and evaluating the description of IGD in the DSM-5 criteria. In 2017–2019, the research population gradually became more specific, such as vocational school students and freshmen. Research on the predictive factors related to IGD gradually increased using hypotheses and verification to explore multidimensional IGD-related influencing factors involving individuals, families and society and actively applying a variety of derivative evaluation tools around diagnostic criteria. Research from 2020 focused on comparing and evaluating the descriptions of IGD and GD in DSM-5 and ICD-11, actively constructing structural equation models to conduct mediating analysis and examining comorbidities and their relationships. Due to the long-term health problems associated with IGD, research aimed at identifying the IGD symptoms and behaviors from an early stage has gradually attracted increased attention, though this research remains insufficient at present.

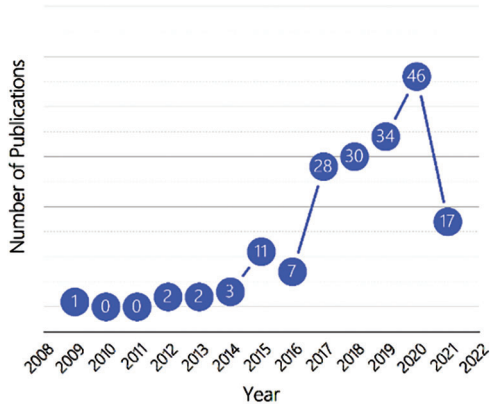

Figure 1: Papers on identification of IGD symptoms in the web of science core collaboration

3.1 Important Sources

The most important sources included Frontiers in Pediatrics, Computers in Human Behavior, Addictive Behaviors, the International Journal of Mental Health and Addiction and the Journal of Behavioral Addictions. Frequencies of publications by top sources are presented in Table 1.

Table 1: Top journals based on the number of publications

Journals	n
Frontiers in Pediatrics	8
Computers in Human Behaviour	7
Addictive Behaviours	5
International Journal of Mental Health and Addiction	5
Journal of Behavioural Addictions	5

Note: n = Number of papers published in each journal.

This review visually analysed 181 papers related to the identity of the IGD symptoms and behaviours. This is a relatively small number of papers due to the format and uniqueness of the CiteSpace software as it only allows to search one database at one time. The publications displayed an initial increase from 2015, while 2017 represented a turning point, with a boom in the total number of published papers that reached a peak in 2020. This could be related to the emergence of IGD diagnostic criteria and the long-term health problems of the IGD population, which have gradually attracted the attention of researchers. In terms of research cooperation, Mark D. Griffiths showed the highest centrality (0.23) and co-authorship of his research papers included scholars from other countries to strengthen research cooperation between other authors. Anise M. S. Wu published few research papers in the IGD field of study between 2018 and 2019. About 81.8% publications were published in these leading countries: United States, United Kingdom, Australia, China and South Korea. Norway played an important role in doing international exchange activities with communication and cooperation. Compared with the strong academic output ability and influence in the United States and the United Kingdom, the academic influence of China and South Korea was low, which could be related to the complex relation between language, culture and thought. There are many core teams in this field, and each team cooperates closely. However, external cooperation has been lacking in recent years, and thus academic exchange activities must be strengthened. Research directions and hotspots focus on children and adolescent population. IGD is often comorbid with depression or ADHD, and, in addition, presents with high aggressiveness. Players who

present with obvious ADHD, depression, high neurotic personality characteristics and psychopathological manifestations of anxiety disorders are at high risk of IGD. Research on the IGD population characterised by loneliness is relatively new. The current frontier is exploring the risk factors of psychopathological symptoms related to IGD to allow for the early diagnosis of IGD.

3.2 Analysis of Authorship

The researcher is the carrier of knowledge. Identifying collaborative relationships helps in understanding the research status, as well as in identifying influential authors from the microscopic perspective. A co-authorship network as shown in Fig. 2, where each node (226) represents an author and the links (384), is indicative of collaboration. The node size represents the number of publications. The results showed that there were 29 authors with a frequency of 3 or more (labelled in the figure). The top-five most productive authors are listed in Table 2, with Mark D. Griffiths from the Nottingham Trent University in the United Kingdom, Halley M. Pontes from the Birkbeck College at University of London in the United Kingdom and Marc Potenza from the Yale University in the United States were in the top-three positions. The thickness of the links indicates the level of the cooperative relationship. There were multiple core teams in this field and each team engaged closely with other scholars in conducting study on IGD field of research.

Figure 2: A network of authors

Table 2: The top five most productive authors

Author	Institution	Country/Region
Mark D. Griffiths	Nottingham Trent University	United Kingdom
Halley M. Pontes	Birkbeck College, University of London	United Kingdom
Marc Potenza	Yale University	United States
Bilge Evren/Cuneyt Evren	Bakirkoy Training and Research Hospital for Psychiatry Neurology and Neurosurgery	Turkey
Anise M. S. Wu	University of Macau	Macau

Collaborative authorship is the overwhelming norm in science. As shown in Fig. 2, there were strong collaborative relationships among four authors: Halley M. Pontes, Bilge Evren, Cuneyt Evren and Ercan Dalbudak in the research community. Halley M. Pontes was the central author who has shown more collaborative actions than other researchers. In the figure, the colors of the links including blue, green, yellow, orange and red lines correspond to the papers published in different years from 2009 to 2021. The publication time from past to present is shown by the color transition from a cool tone to a warm tone. The figure is mostly cool toned and lacking in red nodes and lines, indicating a lack of cooperation and exchanges in recent years. The influence of a researcher can be represented by the betweenness centrality. In a network, the nodes with high betweenness centrality may be the boundary spanners connecting different research groups. Mark D. Griffiths showed the highest centrality (0.23) and the co-authorship of his research papers include scholars from other countries. Mark D. Griffiths showed the highest centrality (0.23) and co-authorship of his research papers included scholars from other countries to strengthen research cooperation between other authors. The centrality of the four authors was ≥0.1, while the remaining authors (86.7%) had a value of zero. Most of the authors lacked external research cooperation. Fig. 3 lists the top ten authors with the strongest citation bursts in a bar chart analyzed by the scientometric data analysis technique.

Top 10 Authors with the Strongest Citation Bursts

Authors	Year	Strength	Begin	End	2009 - 2021
PAUL H DELFABBRO	2009	1.95	**2016**	2018	
DANIEL L KING	2009	1.64	**2016**	2018	
DAIJIN KIM	2009	1.56	**2016**	2018	
JUNGSEOK CHOI	2009	1.49	**2016**	2017	
CHIHHUNG KO	2009	1.56	**2017**	2018	
HALLEY M PONTES	2009	1.49	**2017**	2018	
ANISE M S WU	2009	2.2	**2018**	2019	
MERVE TOPCU	2009	1.74	**2019**	2021	
NILAY KUTLU	2009	1.74	**2019**	2021	
ERCAN DALBUDAK	2009	1.37	**2019**	2021	

Figure 3: Top 10 authors with the strongest citation bursts

For the strengths in higher-value-added research papers, Anise M. S. Wu published few papers with global collaboration between 2018 and 2019 when the strength was 2.2 in Fig. 3. This indicates that the author had higher research output in this period. Mark D. Griffiths was also an author with both high academic output and academic influence. The results indicated that collaboration between different research communities should be strengthened in future. More academic communication activities are needed to allow for the identification of the IGD symptoms and behaviors.

3.3 A Network of Countries and Regions

A network of countries or regions was generated to explain the collaborative relationships from the macroscopic perspective. Fig. 4 displays the cooperation network, which contains 48 nodes and 162 links. About 81.8% of the publications in the IGD field of study were published from these leading countries: United States (39 papers), United Kingdom (32 papers), Australia (28 papers), the People's Republic of China (25 papers) and South Korea (24 papers) in the last 12 years based on the first authors' reporting their working institutions. This indicates that these countries have contributed significantly to identify the symptoms related to IGD. In addition, US researchers showed wide collaborative relationships with other countries, such as England, the People's Republic of China, South Korea and Germany. In terms of betweenness centrality, a country with high centrality identified played a

core role and made contributed significantly. According to the results, the top-five countries were Sweden (0.41), United States (0.39), United Kingdom (0.35), Spain and Iran (0.19). It is noteworthy that the centrality of Norway. The publications in Norway were higher than that of other countries, suggesting that the Norway participated in international activities such as communication and cooperation related to the trends in identifying the topics for IGD symptoms while also strengthening cooperation between other countries. The United States, the United Kingdom, Spain and Hungary were high both in frequency and centrality, indicating both strong academic output ability and academic influence. In contrast, the frequency of the People's Republic of China and South Korea was relatively high, with centralities of 0.01 and 0, respectively, indicating that both countries had little academic influence. This could be due to differences in language, culture and thought. These countries should, therefore, continue to promote academic exchange activities and share research findings with the researchers from other countries in the nearer future. The burst citation algorithm was used to identify sudden increases in the frequency of citations over a short period as an indicator of outstanding scientific research output. The top-two regions were Switzerland and Luxembourg (burst strength = 1.02, 2018–2019). The result suggested that these countries generated several papers and that citations of these papers increased dramatically in the corresponding years.

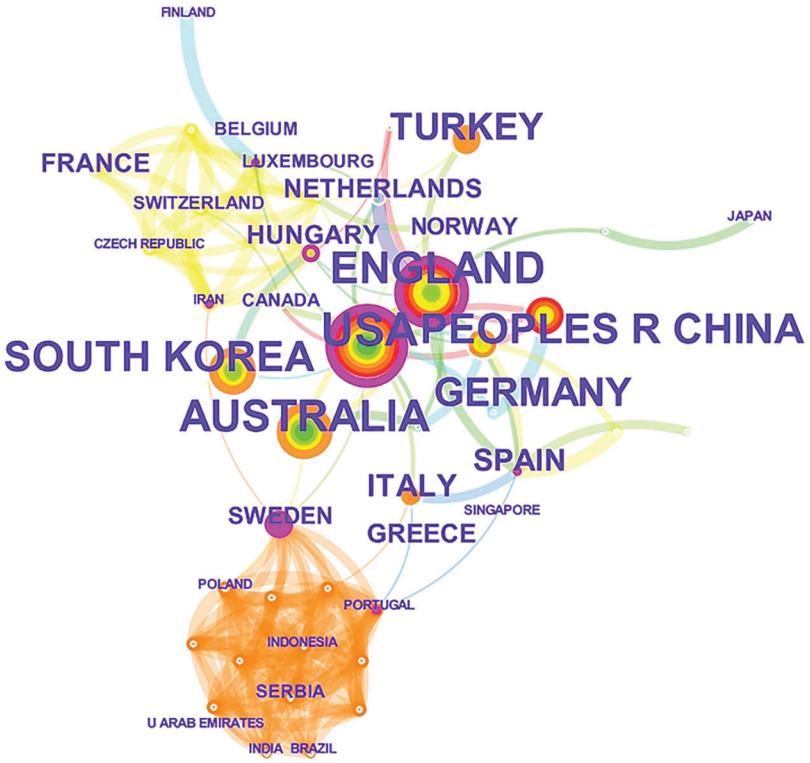

Figure 4: A network of countries/regions

3.4 Research Topic Analysis

3.4.1 Analysis of Co-Occurrence

Keywords reflect directions and research hotspots. Keywords mainly arise from the original keywords in the literature and those based on the subject classification extension of the journal or database. Fig. 5 shows that there were 281 nodes (keywords) and 1,116 links, which only shows nodes with times over 14. Fig. 6 shows the top-20 keywords of frequency and centrality. The top-five frequency keywords were 'IGD' (114), 'adolescent'

(109), 'addiction' (88), 'prevalence' (67), 'depression' (59). The top-five keywords of centrality were 'attention deficit/hyperactivity disorder (ADHD)' (0.13), 'game addiction (GA)', 'online', 'children' and 'aggression', (0.11). 'Depression' had both high frequency and high centrality. In addition to the keywords searched, the research hotspots for identifying IGD symptoms included 'children', 'depression', 'anxiety', 'ADHD', 'relationship' and 'scale'. The research mainly focused on children and adolescents. IGD was often comorbid with depression or ADHD. In addition, the IGD population showed strong aggression.

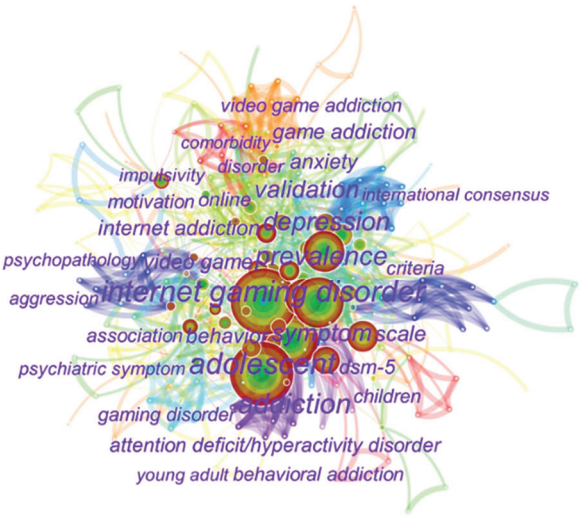

Figure 5: Network of co-occurring keywords

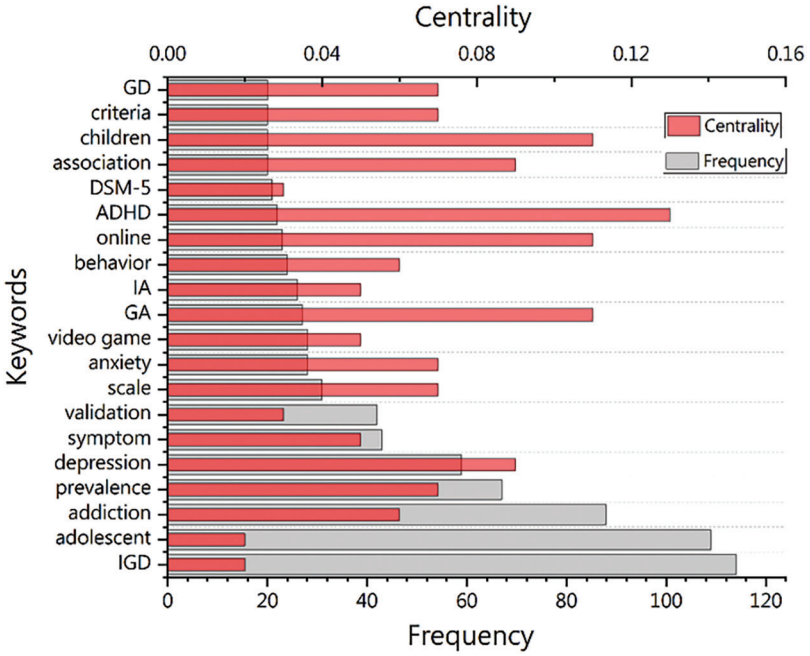

Figure 6: Top twenty keywords of frequency and centrality

3.4.2 Cluster Analysis

After the network of co-occurrence keywords was generated, cluster analysis was conducted to explore its similarity. If the size of cluster was below 10, due to the poor clustering effect, it was not analyzed [17]. The cluster labels were obtained by LLR, and 12 clusters were generated with a modularity Q index and an average silhouette metric of 0.56 and 0.81, suggesting moderate modularity and high homogeneity. The clustering was reasonable, and the structure was obvious. The top-eight clusters are shown in Fig. 7, and the cluster information is provided in Table 3. Cluster#0 contained the largest number of keywords, that is, this research commonly used human-centered clustering methods to group players, such as occasional players, passionate players, dedicated players and disordered players. Studies on the inclusion of the cluster labelled 'behavior' indicated that, when players had both symptoms of depression and ADHD at the same time, they were at high risk of IGD behaviors. The time of cluster#3 and cluster#5 was 2018, meaning the application research on the loneliness of IGD population and IGDS9-SF scale was relatively new. The personality characteristics of the IGD population often showed high neuroticism and psychopathology often shows anxiety disorder. DSM-5 IGD criteria were commonly used.

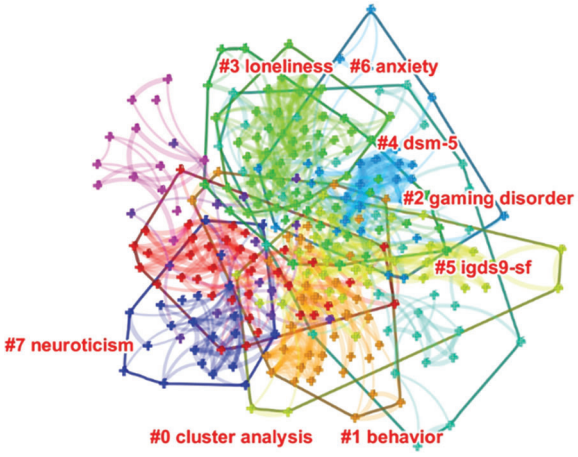

Figure 7: Keywords cluster map

Table 3: Partial results of cluster analysis

ID	Year	Label	LLR
0	2015	Cluster analysis	psychopathology, individual factors, maladaptive personality traits, genre, MMORPGS, protective factors, social support
1	2014	Behaviour	video game, ADHD, depression, adolescence, playing-time, symptoms, emotional dysregulation
2	2015	Gaming disorder	mental health, engagement, ICD-11, immersion, children and adolescents, coping skills, DSM-5
3	2018	Loneliness	self-esteem, parent-child interaction, motivations, undergraduate students, violent video games, familial factors, COVID-19
4	2016	DSM-5	internet addiction, resilience, suicide attempt, escape, psychometric, interpersonal relationships, mediation analysis

(Continued)

Table 3 (continued)

ID	Year	Label	LLR
5	2018	IGDS9-SF	internet gaming, self-regulation, compulsive social media use, collectivism, gamers, compulsive gaming, culture
6	2016	Anxiety	personality traits, depression, social phobia, big 5 personality traits, attachment avoidance/anxiety, students
7	2017	Neuroticism	psychiatric comorbidities, computer games, screening instrument, depression, ADHD, hostility, prevalence

Note: LLR = log-likelihood ratio.

3.4.3 Future Research Direction Analysis

Burst measures the rate of change of the citation frequency of the literature containing keywords. Sorting by the year of the emergence can reveal the trends over time in research hot spots in recent years from the original 'internet addiction' (2009–2012) to the recent 'context' (2013–2016), 'consensus' (2015–2017), 'DSM-5' (2016–2017), 'psychiatric symptom' '(2017–2018) and, lastly, to 'risk' (2019–2021). 'Psychiatric symptom', 'game use', 'self' and 'consensus' had a strength of burst of over 2. As researchers focused on the use of online games, a consensus and DSM-5IGD diagnostic criteria were gradually formulated to explore the protective and risk factors of IGD and methods continue to deepen and be specific. The current frontier is exploring risk factors of the psychopathological symptoms related to IGD to enable early diagnosis of IGD.

3.4.4 Paper Co-Citation Analysis

If two papers appeared in a reference list at the same time, they formed a co-citation relationship. paper co-citation analysis (DCA) is an important function of CiteSpace [18]. A node is identified by the first author's name and the publication year. Each link indicates a co-citation relationship between two papers, while the size of the node represents the co-citation frequency of the Papers. The top-five papers in terms of number total citations are presented in Table 4. A cluster analysis was conducted to explore the similarity of the cited papers. The quality of cluster labelling depended on the variety, breadth and depth of the set of terms from keywords in papers [17]. Cluster IDs decrease in order depending on the cluster size in Table 5. A network with a Q index and silhouette value of 0.70 and 0.85, respectively, was produced, suggesting moderate modularity and high homogeneity. The papers with sigma value ($\sum = 1$) notes that centrality and burstiness, just its structure and citation changes are both important. However, the analysed data of cluster analysis covered the papers cited in 181 papers, which may have included some papers that were not relevant to IGD symptoms. Thus, a manual review was needed to remove unrelated clusters by reviewing the content of the papers in each cluster. A paper co-citation network (including part of a cluster map) is shown in Fig. 4. Table 5 lists the cluster analysis of co-cited papers.

The rank of total citation papers is listed in Table 4. Petry et al. [19], Lemmens et al. [20], Pontes et al. [21], Griffiths et al. [22] and Rehbein et al. [23] were the top-five most cited papers. These papers were widely recognised by peers and had high value for assessing IGD. For example, Petry et al. [19] formed an international consensus for assessing IGD, while Griffiths MD [22] offered a critical commentary on Petry et al. [19]. Research by Lemmens et al. [20] and Pontes HM et al. [21] focused on an evaluation tool for assessing IGD, and Rehbein et al. [23] published research on the prevalence and risk factors of IGD in a paper that had the strongest connection with other papers. In the past, cited literature mostly focused on mechanism exploration. In recent years, more research on IGD evaluation had been cited, indicating an increase in researchers' attention.

Table 4: The top five papers in the total citations

Total citations	Paper's title	Year	First author
1221	An international consensus for assessing internet gaming disorder using the new DSM-5 approach	2014	Petry et al. [19]
728	The Internet gaming disorder scale	2015	Lemmens et al. [20]
672	Measuring DSM-5 internet gaming disorder: Development and validation of a short psychometric scale	2015	Pontes et al. [21]
615	Working towards an international consensus on criteria for assessing internet gaming disorder: A critical commentary on Petry et al. (2014)	2016	Griffiths et al. [22]
605	Prevalence of internet gaming disorder in German adolescents: diagnostic contribution of the nine DSM-5 criteria in a state-wide representative sample	2015	Rehbein et al. [23]

As shown in Fig. 8, Pontes et al. [21] received 47 co-citations and Lemmens et al. [20] received 42 co-citations, with both occupying the top-two positions according to DCA, followed by Petry et al. [19] (frequency = 39), Rehbein et al. [23] (frequency = 31) and Muller et al. [24] (frequency = 30). The betweenness of Rehbein et al. [25] and Grusser et al. [26] was the highest of all at 0.29, followed by Schou Andreassen et al. [27] and Miharaet al. [28], with 0.17 and 0.16. These papers represent the fundamental bedrock and had a significant influence on the development of the identification of symptoms related to IGD. Rehbein et al. [25] studied the prevalence and risk factors of IGD and had the highest centrality, indicating that their research was closely related to other papers.

Table 5: Co-citation clusters of IGD symptoms research

No.	Cluster label	Research themes/topics	Representative papers
4	Video gaming addiction	game impulse	Ko et al. [29]
3	Motivation	motivation	Kuss et al. [30]
1	Measurement invariance	evaluation scale	Lemmens et al. [20]
2	Impulsivity	mediating effects	Yen et al. [31]
0	Mental health	diagnostic criteria	Aarseth et al. [32]

Note: No. = Number.

The five major research clusters were numbered in descending order based on cluster size as shown in Table 5. In terms of the time span covered by the clusters, all in the time domain which presenting frequent overlaps in time. Cluster#4 ('video gaming addiction') was the oldest, with a mean year of 2009, as shown by its cyan-blue colour. Its representative work was a study on the relationship between brain activity and game impulse. Meanwhile, cluster#0 ('mental health') represented the most recent, with a mean year of 2017, as shown by its light-yellow colour. The representative work of this cluster was an international discussion on the GD standard. Through the co-citation cluster analysis of the literature, five emerging research topics were identified through clustering, namely, game impulse, motivation, mediating effects, evaluation scale and diagnostic criteria. The papers were published by Ko et al. [29], Kuss et al. [30], Lemmens et al. [20], Yen et al. [31] and Aarseth et al. [32]. Then, the critical review will be taken to find identify those challenges in this field. Impulsivity, risk taking, psychopathological symptoms and motivation for play

were the main risk factors leading to GD [33]. In addition to being directly related to IGD, impulse also indirectly affected IGD symptoms through other factors, such as the mediating effects of affect [34], interpersonal relationships and depression [35].

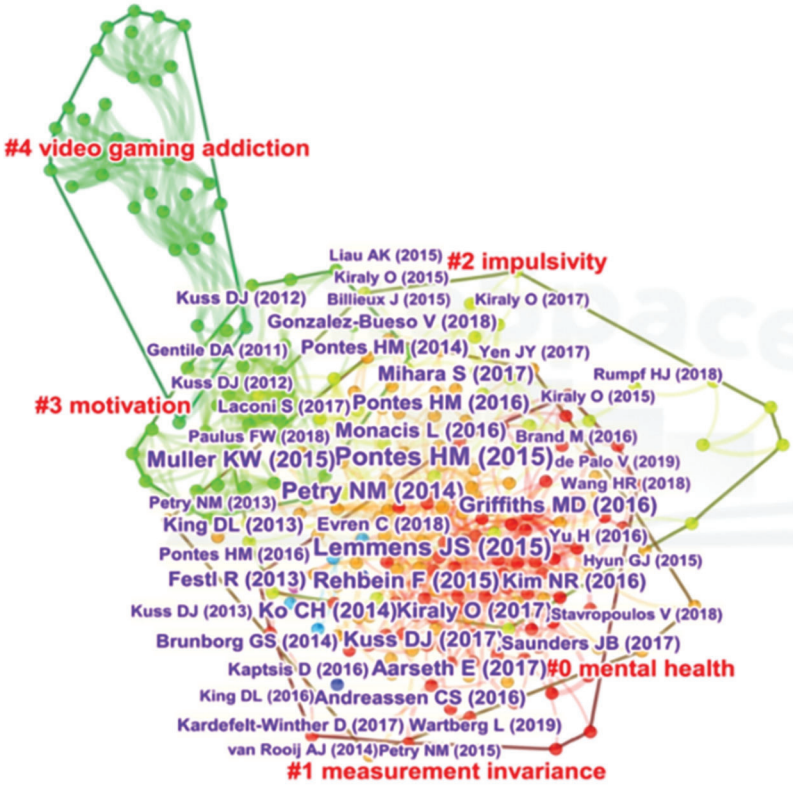

Figure 8: Co-citation network of papers

4 Discussion

The psychosocial characteristics of impulsivity were often comorbid with IGD as they offered early prediction for the identity of IGD symptoms in this field of research. The findings indicated that the self-assessment of individual impulsivity may be affected by gamers' willingness to respond, motivations and communication styles. Other rating scales could be developed and validate as multiple measurements of individual's impulsivity and motivations could be taken at different time points. A latent variable hierarchy model could first be used to identify and control the influence of individual response styles. Other statistical control methods could also be used to reduce the bias caused by the self-rating scale.

The findings of this study have identified the trends in the field of study on IGD behaviors. Psychometric testing of the reliability and validity for the relevance of the scales in different languages to predict the IGD behaviors among the children and adolescents is important. Clinicians and researchers have played a significant role in developing and testing the scales based on the identified trends in the research field of IGD behaviors like the findings of this study. In this study, impulsivity, self-control, parental influences and peer influences are the trends/themes identified by the scientometric data analysis technique.

The psychometric testing of a scale in assessing each individual's impulsivity to predict the IGD symptoms ad behaviors using different languages is very important. Although a quantitative approach in this field is needed, there is still very much a need for qualitative descriptions and case studies. It is

critically important that clinicians and practitioners from different continents consider international collaborating with academics for richer research projects in addressing this global issue.

4.1 Predictors for Internet Gaming Disorder

Types of motivation could be used as as the trend in the field of study on IGD symptoms and behaviors [36]. Gaming motivation of individual affects the choice of types of game relate to structural characteristics. Among the most common motivations with game, entertainment and skill development played protective roles, while avoidance was the opposite motivation. In addition, gaming motivation could have a mediating effect in affecting some of the contributing factors of to IGD [37]. Multiple gaming motivations have been given equal importance at the same time, and different weights can be considered by scholars. Further longitudinal research could help clarify the relationship between IGD and different gaming motivations. The assessment scale of IGD symptoms should be explored, focusing on behavioural and cognition aspects such as non-adaptive cognition [38]. The evaluation scale verifies whether the exploratory factors found in the research are compatible with the IGD standard scale, and psychometric measurements are highly correlated. Various derivative assessment scales are based on the IGD diagnostic criteria, such as the 7-item Game Addiction Scale (GAS), the Gaming Addiction Identification Test (GAIT), the Internet Gaming Disorder Scale (Internet Gaming Disorder Scale), the Internet Gaming Disorder Scale-Short-Form (IGDS9-SF) and the ten-item Internet Gaming Disorder Test (IGDT-10). General screening tools are yet to be determined, and cross-cultural verification of relevant scales have been conducted. Research on mediating effects has led to the active exploration of the identification and prevention of IGD symptoms. In investigating whether there is a direct or indirect influence between factors related to IGD symptoms, sample surveys in some regions and a structural equation model have been established to verify the assumptions. The model only controls some factors and cannot guarantee homogeneity. It is difficult to conduct an integrated comparative analysis of such research results. In evaluating research on the rationality of the ordinary structure and a single criterion, a horizontal comparison of the two diagnostic criteria were drafted, focusing on effectiveness, stability and consistency [39]. DSM-5 IGD is based on the diagnostic criteria for substance addiction, which can be easily misdiagnosed the highly involved and missed the attentive [40], which is not conducive to early screening and intervention. Meanwhile, the diagnostic criteria of ICD-11 is stricter [39,41]. The diagnostic criteria for IGD may not reflect uniqueness and consensus [42]. To adjust the IGD diagnostic criteria, reverse-scoring items could be added to combine the advantages of the two criteria to reduce the misdiagnosis rate.

4.2 Limitations

The study has three limitations. Firstly, the limitation of the CiteSpace software cannot accept those published papers' format as they were incompatible with the software. Therefore, less than 200 papers were included in this review. Secondly, the software only allows to search in one database to identify the trend in the field of study, not appraise the quality of papers. Thirdly, this critical review was restricted to English-language papers. It is likely that some relevant papers may have been published in other languages.

5 Conclusion

High-centrality papers were represented by Rehbein F. and her colleagues [25]. These papers are the fundamental bedrock and have had a significant influence on the development of the identification of IGD symptoms and behaviors in this field of study. Through a co-citation cluster analysis of the literature, five emerging research topics/themes were generated through clustering analysis including: game impulse, motivation, mediating effects, evaluation scale and diagnostic criteria. Studies evaluated the relationship between motivation and internet gaming disorder (IGD) and they showed that IGD was predicted by motivations using the self-determination theory. The motivation for IGD had been examined in terms of

the self-determination theory (STD) which is a theory of human motivation. According to this theory, different types of motivation determine different behaviors. These types of motivation differ in their inherent levels of self-determination that in seen as being on a continuum from high to low autonomy, hence, intrinsic motivation, extrinsic motivation, and amotivation. Therefore, it is conceivable that different types of motivations may underpin the different IGD symptoms, and that these associations can be revealed by conducting a network analysis that includes both the IGD symptoms and different types of motivation. To the best of our knowledge, no study to date has adopted this approach to address the whole range of IGD behaviors.

Other statistical control methods could be added to reduce bias; multiple motives are given importance at the same time. Further longitudinal research could be conducted to clarify the relationship between IGD symptoms and different motives [43]. General screening tools are yet to be determined, and cross-cultural verification of relevant scales has been conducted [44]. It is difficult to conduct an integrated comparative analysis of such research results. The results must be scientifically integrated to reveal directions for future research.

Based on the WOSCC database, this review conducted a bibliometric and critical analysis of the literature related to the identification of IGD symptoms. It outlined the current status of the research and hotspots and frontiers in the field, as well as establishing emerging topics and challenges and applying statistical control methods in various ways in the evaluation. Determine standard evaluation tool of IGD; further clarify the relationship between IGD and different factors longitudinally, scientifically integrate various results, and point out the direction for future research.

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References

1. Cheng, C., Cheung, M. W. L., Wang, H. Y. (2018). Multinational comparison of internet gaming disorder and psychosocial problems versus well-being: Meta-analysis of 20 countries. *Computers in Human Behavior, 88,* 153–167. DOI 10.1016/j.chb.2018.06.033.
2. Zhen, S., Xie, H., Zhang, W., Wang, S., Li, D. (2011). Exposure to violent computer games and Chinese adolescents' physical aggression: The role of beliefs about aggression, hostile expectations, and empathy. *Computers in Human Behavior, 27(5),* 1675–1687. DOI 10.1016/j.chb.2011.02.006.
3. Yuan, K., Qin, W., Wang, G., Zeng, F., Zhao, L. et al. (2011). Microstructure abnormalities in adolescents with internet addiction disorder. *PLoS One, 6(6),* e20708. DOI 10.1371/journal.pone.0020708.
4. Griffiths, M. D., Dancaster, I. (1995). The effect of type a personality on physiological arousal while playing computer games. *Addictive Behaviors, 20(4),* 543–548. DOI 10.1016/0306-4603(95)00001-S.
5. Johansson, A., Götestam, K. G. (2002). Internet addiction: Characteristics of a questionnaire and prevalence in Norwegian youth (12–18 years). *Scandinavian Journal of Psychology, 45(3),* 223–229. DOI 10.1111/j.1467-9450.2004.00398.x.
6. Petry, N. M., Rehbein, F., Gentile, D. A., Lemmens, J. S., Rumpf, H. J. et al. (2014). An international consensus for assessing internet gaming disorder using the new DSM-5 approach. *Addiction, 109(9),* 1399–1406. DOI 10.1111/add.12457.
7. Svenaeus, F. (2013). *Diagnosing mental disorders and saving the normal: American Psychiatric Association Diagnostic and statistical manual of mental disorders* (5th edition). Washington DC: American Psychiatric Publishing.

8. Organization, W. H. (2018). The ICD-11 Classification of Mental and Behavioral Disorders: Diagnostic Criteria for Research. World Health Organization. https://www.who.int/standards/classifications/classification-of-diseases.
9. Feng, W., Ramo, D. E., Chan, S. R., Bourgeois, J. A. (2017). Internet gaming disorder: Trends in prevalence 1998-2016. *Addictive Behaviors, 75(2),* 17–24. DOI 10.1016/j.addbeh.2017.06.010.
10. Stevens, M. W., Dorstyn, D., Delfabbro, P. H., King, D. L. (2021). Global prevalence of gaming disorder: A systematic review and meta-analysis. *Australian & New Zealand Journal of Psychiatry, 55(6),* 553–568. DOI 10.1177/0004867420962851.
11. King, D. L., Delfabbro, P. H., Perales, J. C., Deleuze, J., Király, O. et al. (2019). Maladaptive player-game relationships in problematic gaming and gaming disorder: A systematic review. *Clinical Psychology Review, 73(2),* 101777. DOI 10.1016/j.cpr.2019.101777.
12. Börner, K., Chen, C., Boyack, K. W. (2005). Visualizing knowledge domains. *Annual Review of Information Science and Technology, 37(1),* 179–255. DOI 10.1002/aris.1440370106.
13. Chen, C., Song, M. (2019). Visualizing a field of research: A methodology of systematic scientometric reviews. *PLoS One, 14(10),* 1–25. DOI 10.1371/journal.pone.0223994.
14. Chen, C. (2017). Science mapping: A systematic review of the literature. *Journal of Data and Information Science, 2(2),* 1–40. DOI 10.1515/jdis-2017-0006.
15. Brandes, U. (2001). A faster algorithm for betweenness centrality. *Journal of Mathematical Sociology, 25(2),* 163–177. DOI 10.1080/0022250X.2001.9990249.
16. Olawumi, T. O., Chan, D. M. A. (2018). A scientometric review of global research on sustainability and sustainable development. *Journal of Cleaner Production, 183,* 231–250. DOI 10.1016/j.jclepro.2018.02.162.
17. Chen, C., Ibekwe-Sanjuan, F., Hou, J. (2010). The structure and dynamics of co-citation clusters: A multiple perspective co-citation analysis. *Journal of the Association for Information Science and Technology, 61(7),* 1386–1409. DOI 10.1002/asi.21309.
18. Chen, C. (2004). Searching for intellectual turning points: Progressive knowledge domain visualization. *PNAS, 101(suppl_1),* 5303–5310. DOI 10.1073/pnas.0307513100.
19. Petry, N. M., Rehbein, F., Gentile, D. A., Lemmens, J. S., Rumpf, H. J. et al. (2014). An international consensus for assessing internet gaming disorder using the new DSM-5 approach. *Addiction, 109(9),* 1399–1406. DOI 10.1111/add.12457.
20. Lemmens, J. S., Valkenburg, P. M., Gentile, D. A. (2015). The Internet gaming disorder scale. *Psychological Assessment, 27(2),* 567–582. DOI 10.1037/pas0000062.
21. Pontes, H. M., Griffiths, M. D. (2015). Measuring DSM-5 internet gaming disorder. *Computers in Human Behavior, 45(2),* 137–143. DOI 10.1016/j.chb.2014.12.006.
22. Griffiths, M. D., Van Rooij, A. J., Kardefelt-Winther, D., Starcevic, V., Király, O. et al. (2016). Working towards an international consensus on criteria for assessing Internet Gaming Disorder: A critical commentary on Petry *et al.* [2014]. *Addiction, 111(1),* 167–175. DOI 10.1111/add.13057.
23. Rehbein, F., Kliem, S., Baier, D., Mößle, T., Petry, N. M. (2015). Prevalence of Internet gaming disorder in German adolescents: Diagnostic contribution of the nine DSM-5 criteria in a state-wide representative sample. *Addiction, 110(5),* 842–851. DOI 10.1111/add.12849.
24. Müller, K. W., Janikian, M., Dreier, M., Wölfling, K., Beutel, M. E. et al. (2015). Regular gaming behavior and internet gaming disorder in European adolescents: Results from a cross-national representative survey of prevalence, predictors, and psychopathological correlates. *European Child & Adolescent Psychiatry, 24(5),* 565–574. DOI 10.1007/s00787-014-0611-2.
25. Rehbein, F., Kleimann, M., Mössle, T. (2010). Prevalence and risk factors of video game dependency in adolescence: Results of a German nationwide survey. *Cyberpsychology, Behavior and Social Networking, 13(3),* 269–277. DOI 10.1089/cyber.2009.0227.
26. Grüsser, S. M., Thalemann, R., Griffiths, M. D. (2007). Excessive computer game playing: Evidence for addiction and aggression? *Cyberpsychology & Behavior, 10(2),* 290–292. DOI 10.1089/cpb.2006.9956.
27. Schou Andreassen, C., Billieux, J., Griffiths, M. D., Kuss, D. J., Demetrovics, Z. et al. (2016). The relationship between addictive use of social media and video games and symptoms of psychiatric disorders: A large-scale cross-sectional study. *Psychology of Addictive Behaviors, 30(2),* 252–262. DOI 10.1037/adb0000160.

28. Mihara, S., Higuchi, S. (2017). Cross-sectional and longitudinal epidemiological studies of Internet gaming disorder: A systematic review of the literature. *Psychiatry and Clinical Neuroscencesi, 71(7),* 425–444. DOI 10.1111/pcn.12532.
29. Ko, C. H., Liu, G. C., Hsiao, S., Yen, J. Y., Yang, M. J. et al. (2009). Brain activities associated with gaming urge of online gaming addiction. *Journal of Psychiatric Research, 43(7),* 739–747. DOI 10.1016/j.jpsychires.2008.09.012.
30. Kuss, D. J., Louws, J., Wiers, R. W. (2012). Online gaming addiction? Motives predict addictive play behavior in massively multiplayer online role-playing games. *Cyberpsychology, Behavior and Social Networking, 15(9),* 480–485. DOI 10.1089/cyber.2012.0034.
31. Yen, J. Y., Liu, T. L., Wang, P. W., Chen, C. S., Yen, C. F. et al. (2017). Association between internet gaming disorder and adult attention deficit and hyperactivity disorder and their correlates: Impulsivity and hostility. *Addictive Behaviors, 64(5),* 308–313. DOI 10.1016/j.addbeh.2016.04.024.
32. Aarseth, E., Bean, A. M., Boonen, H., Colder Carras, M., Coulson, M. et al. (2017). Scholars' open debate paper on the World Health Organization ICD-11 Gaming Disorder proposal. *Journal of Behavioral Addictions, 6(3),* 267–270. DOI 10.1556/2006.5.2016.088.
33. Brand, M., Young, K. S., Laier, C., Wölfling, K., Potenza, M. N. (2016). Integrating psychological and neurobiological considerations regarding the development and maintenance of specific Internet-use disorders: An Interaction of Person-Affect-Cognition-Execution (I-PACE) model. *Neuroscience and Biobehavioral Reviews, 71(2),* 252–266. DOI 10.1016/j.neubiorev.2016.08.033.
34. Shin, D., Choi, A. R., Lee, J., Chung, S. J., Kim, B. et al. (2019). The mediating effects of affect on associations between impulsivity or resilience and internet gaming disorder. *Journal of Clinical Medicine, 8(8),* 1102. DOI 10.3390/jcm8081102.
35. Ryu, H., Lee, J. Y., Choi, A., Park, S., Kim, D. J. et al. (2018). The relationship between impulsivity and internet gaming disorder in young adults: Mediating effects of interpersonal relationships and depression. *International Journal of Environmental Research and Public Health, 15(3),* 458. DOI 10.3390/ijerph15030458.
36. Weinstein, A., Livny, A., Weizman, A. (2017). New developments in brain research of internet and gaming disorder. *Neuroscience & Biobehavioral Reviews, 75(5),* 314–330. DOI 10.1016/j.neubiorev.2017.01.040.
37. Kircaburun, K., Demetrovics, Z., Griffiths, M. D., Király, O., Kun, B. et al. (2020). Trait emotional intelligence and internet gaming fisorder among gamers: The mediating role of online gaming motives and moderating role of age groups. *International Journal of Mental Health and Addiction, 18(5),* 1446–1457. DOI 10.1007/s11469-019-00179-x.
38. Komnenić, D., Filipović, S., Vukosavljević-Gvozden, T. (2015). Assessing maladaptive cognitions related to online gaming. *Computers in Human Behavior, 51(3),* 131–139. DOI 10.1016/j.chb.2015.04.051.
39. Ko, C. H., Lin, H. C., Lin, P. C., Yen, J. Y. (2020). Validity, functional impairment and complications related to Internet gaming disorder in the DSM-5 and gaming disorder in the ICD-11. *The Australian and New Zealand Journal of Psychiatry, 54(7),* 707–718. DOI 10.1177/0004867419881499.
40. Jo, Y. S., Bhang, S. Y., Choi, J. S., Lee, H. K., Lee, S. Y. (2019). Clinical characteristics of diagnosis for internet gaming disorder: Comparison of DSM-5 IGD and ICD-11 GD diagnosis. *Journal of Clinical Medicine, 8(7),* 945. DOI 10.3390/jcm8070945.
41. Montag, C., Schivinski, B., Sariyska, R., Kannen, C., Demetrovics, Z. (2019). Psychopathological symptoms and gaming motives in disordered gaming-a psychometric comparison between the WHO and APA diagnostic frameworks. *Journal of Clinical Medicine, 8(10),* 1691. DOI 10.3390/jcm8101691.
42. Petry, N. M., Zajac, K., Ginley, M. K. (2018). Behavioral addictions as mental disorders: To be or not to be? *Annual Review of Clinical Psychology, 14(1),* 399–423. DOI 10.1146/annurev-clinpsy-032816-045120.
43. Wu, A. M. S., Chen, J. H., Tong, K. K., Lau, J. T. F., Yu, S. (2018). Prevalence and associated factors of Internet gaming disorder among community dwelling adults in Macao, China. *Journal of Behavioral Addiction, 7(1),* 62–69. DOI 10.1556/2006.7.2018.12.
44. Wu, A. M. S., Lau, J. T. F., Cheng, K. M., Law, R. W. M., Tse, V. W. S. (2018). Direct and interaction effects of co-existing familial risk factors and protective factors associated with Internet addiction among Chinese students in Hong Kong. *Journal of Early Adolescence, 38(4),* 429–450. DOI 10.1177/0272431616671826.