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REVIEW ARTICLE

Ten years of research on the treatments of internet gaming disorder: A scoping review and directions for future research

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ABSTRACT

Background: Although internet gaming disorder (IGD) has been listed in section III of the DSM-5 for approximately 10 years, the study of treatments for IGD remains in early stages. Nonetheless, a summary of findings to date and discussion of future research needs are warranted. *Methods:* The current study reviewed scientific treatment studies with control groups and randomized controlled trials. We summarized the strengths and weaknesses of different treatment strategies and identified gaps in the research literature that may inform the direction of future research efforts. *Results:* Sixteen studies were reviewed. Existing treatment studies may be categorized into cognitive behavioural therapy (CBT), pharmacotherapies, non-invasive brain stimulation (NIBS), and others. *Conclusions:* CBT is the most widely studied treatment strategy for IGD thus far. Future studies should consider IGD-specific CBT treatment strategies. Medication-based treatment should be implemented with caution. NIBS is promising, and future studies should explore the most efficacious parameters and targets. In addition, studies should consider sex differences in the treatment of IGD.

KEYWORDS

addictive behaviours, internet addiction, video games, internet gaming disorder, impulsive behaviours, compulsive behaviours

INTRODUCTION

In 2013, internet gaming disorder (IGD) was included in the Fifth Edition of the Diagnostic and Statistical Manual of Mental Disorders (DSM-5) as 'a disorder warranting further study' (American Psychiatric Association, 2013). In 2019, gaming disorder was included as a "disorder due to addictive behaviours" when the 11th revision of the International Classification of Diseases (ICD-11) was adopted at the World Health Assembly. Although different names and criteria apply, both IGD and gaming disorder have at their cores excessive gaming as repetitive and persistent behaviours generating significant impairment in functioning.

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IGD has been studied globally. IGD has been linked to neurocognitive impairment, executive dysfunction, and emotional difficulties (Gao, Wang, & Dong, 2022; Wang et al., 2022), as well as physical, psychological, and behavioural concerns (Liu et al., 2021; Zhang, Zhou, Geng, Song, & Hu, 2020; W. Zhou, Zheng, et al., 2021). The global prevalence of IGD has been estimated at 8.8% among adolescents and 10.4% among young adults (Gao et al., 2022). Depressive symptoms, attention deficit/hyperactivity concerns, poor sleep, male gender, time spent gaming, aggression, hostility, neuroticism, and sensation-seeking are potential risk factors for IGD (Gao et al., 2022).

Imaging studies examining neural mechanisms underlying IGD have found altered brain structures, activities and functional networks associated with IGD (Dong, Wang, Zheng, et al., 2020; Wang, Zeng, et al., 2020). For example, people with IGD have exhibited impaired executive control over gaming cravings (Wang, Dong, Zheng, Du, & Dong, 2020; Weinstein & Lejoyeux, 2020). Altered brain activations have been observed in executive-control-related brain regions (Dong, Li, Wang, & Potenza, 2017), including the dorsolateral prefrontal cortex (DLPFC) and orbitofrontal cortex (Brand, Young, & Laier, 2014; Zheng et al., 2019). Individuals with IGD may experience strong gaming cravings involving brain activity in reward processing-related brain regions (Chun et al., 2020; Dong et al., 2018; Ma et al., 2019). In addition, interactions among brain regions involved in executive control and reward processing have been reported in people with IGD (Wang, Zeng, et al., 2020). For example, people with IGD have demonstrated lower functional connectivity (FC) between the orbitofrontal cortex and dorsal striatum (Dong et al., 2021; Wang et al., 2017) and the DLPFC and putamen (Han et al., 2018).

The DSM-based diagnostic criteria for IGD, largely similar to those for gambling disorder, have generated debate and controversy, especially regarding features of tolerance and withdrawal (Deleuze et al., 2017; Griffiths et al., 2016; Kardefelt-Winther et al., 2017; Petry et al., 2016). Prior to DSM-5, prevalence estimates of gaming problems varied widely, ranging from less than 1% to approximately 50% (Petry & O'Brien, 2013). More recently, somewhat more narrow ranges (0.7–27.7%) have been reported internationally (Mihara & Higuchi, 2017; Rehbein, Kliem, Baier, Mossle, & Petry, 2015), with lower estimates (0.3–1%) in an online survey (Przybylski, Weinstein, & Murayama, 2017). It has been suggested that more stringent criteria may be warranted (Dong, Wang, Dong, et al., 2020). Understanding better the core and related features of IGD may help promote treatment development.

Based on existing IGD findings and those involving other addictive disorders, treatment development efforts for IGD have included behavioural, pharmacological and neuromodulatory approaches. An increase in IGD treatment studies has been in part driven by individuals (youth and adults) experiencing IGD and clinical needs for empirically supported treatments. Several publications have reviewed treatment strategies and their efficacy in treating IGD (King & Delfabbro, 2014; King et al., 2017; Zajac et al., 2017, 2020). Recent reviews have also focused on treatment services for gaming disorder (King et al., 2022) and the importance of resources for recovery (Gavriel-Fried et al., 2023). Other reviews have focused on internet use disorder, a broader topic than IGD, and comment on directions for future research (Basenach, Renneberg, Salbach, Dreier, & Wolfling, 2023).

However, earlier reviews have included studies with relatively loose inclusion criteria or ones lacking control groups (for example (Zhao et al., 2022)) or randomized controlled structures, limiting conclusions that could be drawn. Given advances in this area, the current review focuses on treatment studies with control groups and considers directions for future research. In other words, to help understand progress and address potential shortcomings, we reviewed controlled treatment studies of IGD, summarizing strengths and weaknesses and identifying existing gaps that could be addressed in future research efforts. In doing so, we adopted a scientific method for evaluating published intervention research related to IGD. Based on the existing research, we have provided recommendations for future studies.

METHOD

Literature search strategy

PubMed, the Web of Science and ScienceDirect (Scopus) were searched using the following keywords: ['Internet gaming' OR 'gaming' OR 'video game' OR 'online gaming' OR 'digital gaming' OR 'game'] AND ['addiction' OR 'pathological' OR 'excessive' OR 'problem' OR 'disorder'] AND ['treatment' OR 'intervention'].

Selection criteria

Studies were selected for inclusion if the studies met the following criteria: (1) evaluated treatment efficacy; (2) included a control group; (3) had at least 10 participants assigned to each group; and (4) included outcome measures, symptoms and severity of IGD and duration of gaming. Exclusion criteria were as follows: (1) no treatment, intervention, or prevention; (2) review or theoretical manuscripts; and (3) no English version. We updated the database search to July 31, 2023.

Screening abstracts

The titles, abstracts, citation information, and descriptors of citations identified by the search strategy were filtered in two steps. Preliminarily screening removed irrelevant articles. Next, full-text articles were screened according to the inclusion and exclusion criteria, and the abstracts and text content were evaluated. The detailed screening steps are shown in Fig. 1.

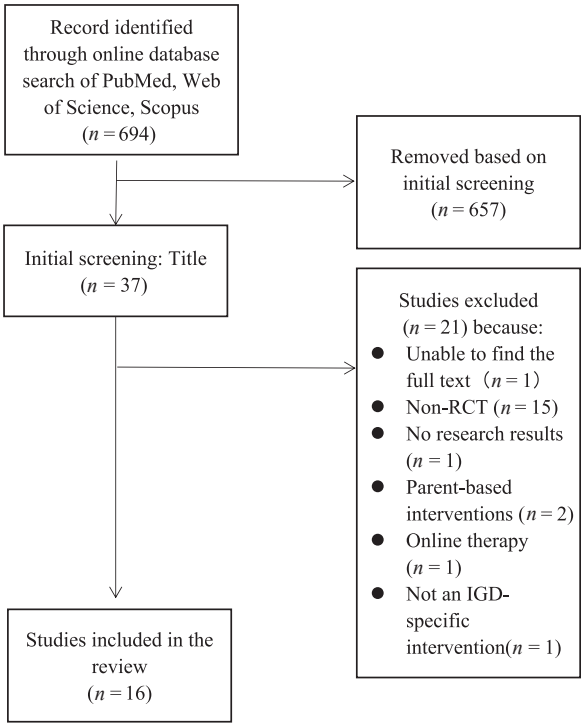

Fig. 1. The flowchart of the literature search used in the current study

Data extraction process

The following data were collected from all articles that met the inclusion criteria: type of treatment, sample size, mean age of the sample and standard deviation (or range when mean was not available), study design, nature of the comparison groups (when applicable), method of diagnosing IGD (specific measure and type of measure), primary outcome variables related to IGD or gaming behaviour, and study findings. Study findings were recorded for the primary outcome variables related to IGD (i.e., severity of IGD symptoms, time spent gaming). When a study included follow-up assessments beyond the immediate posttreatment assessment, the results from both the posttreatment assessment and the longest follow-up were presented. Finally, we organized all data points into a table to facilitate comparisons across studies.

RESULTS

Characteristics and critical appraisal of sources of evidence

Using search terms in the Methods section, 694 records were initially obtained. The screening process and results are shown in Fig. 1. Initially, 657 records were excluded based on titles and abstracts. The remaining 37 records were reviewed for content, leaving relevant 16 studies that were included for review.

Included studies

Supplementary Table 1 summarizes all 37 published treatment studies initially identified. However, some did not have a control group. After strict exclusion, 16 studies met inclusion criteria in the current review. The included studies are shown in Table 1.

The included studies could be categorized into cognitive-behavioural-therapy-based (CBT-based) approaches, pharmacotherapies, non-invasive brain stimulation (NIBS) and other treatments. Six studies evaluated CBT-based or CBT plus psychotherapy, two evaluated medications, two evaluated transcranial direct current stimulation (tDCS), one evaluated family therapy, one evaluated speaking and writing course therapies, and one evaluated mindfulness.

CBT-based approaches

CBT was were tested in 6 studies. One study directly compared CBT with basic counselling, with 14 subjects assigned to each group for 6 weeks. IGD severity decreased with both treatments, and there was no difference between groups (Li & Wang, 2013).

A second compared 72 CBT treatment subjects and 71 wait-list controls. After 15 weeks of CBT treatment, 50 of 72 men in the treatment group showed remission; however, only 17 of 71 men showed remission in the control group, reflecting superiority of CBT (King, Wolfling, & Potenza, 2020).

A third study compared the effects of adding CBT to medication. Participants were 32 assigned to CBT plus bupropion and 33 to bupropion-only. After eight weeks of intervention, the CBT group showed greater decreases in gaming time and internet-addiction severity than those in the medication group (Kim, Han, Lee, & Renshaw, 2012).

In a fourth study, 24 subjects were assigned to a stimulus-response-compatibility (SRC) training group or a SRC pseudo-modification group. After 4 days of training, IGD severity, anxiety and desire for gaming were reduced, and these effects were not found in the sham training group (He, Pan, Nie, Zheng, & Chen, 2021).

In a fifth study, 38 subjects were randomly assigned to two groups involving avoidance of or approach to gaming cues. Individuals were implicitly trained to avoid or to approach gaming cues by pushing or pulling a joystick. The results showed that a single-session training significantly decreased automatic action tendencies to approach gaming cues (Rabinovitz & Nagar, 2015).

A sixth study compared virtual reality therapy, CBT and casual game use in four-week treatment sessions. The results showed that both CBT and virtual reality therapy groups showed reductions in gaming addiction scores (Park et al., 2016).

A seventh study used a CBT-based intervention in individuals with gaming disorder and unspecified internet use disorder. After 4 sessions of training, the symptom severity of gaming disorder was significantly decreased (Lindenberg, Kindt, & Szasz-Janocha, 2022).

Table 1. The research selected in the current review

	First author, year	Country	Treating strategy	Comorbid	Number of subjects (male/female)	Treatment duration (sessions)	Age M (SD) or range	Study design	Assessment of IGD inclusion criteria; Type of measure	Primary outcome variable(s)	Significant results (follow-up timeframe)
						CBT-based Approach					
1	Kim et al. (2012)	South Korea	CBT+Bupropion Bupropion only	major depressive	32 (32.0) 33 (33.0)	8 wks (8) 8 wks	16.2 ± 1.4 15.9 ± 1.6	RCT	YIAS>50 + gaming >30 hr/wk + maladaptive treatment or distress;self-report	Weekly gaming time;IGD symptoms (YIAS)	Greater reductions in gaming time and YIAS for CBT+med than med only group (post-treatment) Group differences maintained at follow-up (4 wks post-treatment)
2	Li and Wang (2013)	China	CBT group therapy Basic counseling	NA	14 (14.0) 14 (14.0)	6 wks (12) 6 wks (12)	12–19	RCT	Gaming >30 hr/wk + OGCAS >35 + IAS >3 + distress or maladaptive behavior; self-report and diagnosed by a psychiatrist	IGD symptoms (YIAS)	YIAS decreased in both groups but no group differences (post-treatment)
3	Rabinovitz and Nagar (2015)	Israel	CBM(approach) CBM(avoid)	NA	19 (19.0) 19 (19.0)	1 time	23.1 (4.0) 22.5 (4.0)	RCT	high problematic gaming level on GAS +gaming >10 hr/wk for ≥1yr	The strength of motivational biases	Single session training significantly decreased automatic action tendencies to approach gaming cues. Furthermore, approach bias retraining reduced subjective urges and intentions to play, as well as decreased game-seeking behavior.
4	Park et al. (2016)	Korea	virtual reality therapy (VRT) group CBT group Participants with casual game use	NA	12 (12.0) 12 (12.0) 12 (12.0)	4 wks	23.6 ± 2.7 24.2 ± 3.2 23.3 ± 2.9	RCT (prospective trial)	Gaming >30 hr/wk + disruption of life + distress or maladaptive treatment + YIAS>50; self-report	IGD symptoms (YIAS)	VRT seemed to reduce the severity of OGA, showing effects similar to CBT
5	Wölfling et al. (2019)	Germany/ Australia	CBT Control group	NA	72 (72.0) 71 (71.0)	15 weeks 15 weeks	17–55	RCT	Meeting criteria for internet addiction in the past 6 months according to clinical expert ratings (AICA-C) and the AICA-S self-report measure	Internet and Computer Game Addiction Self-report (AICA-S)	50 of 72 men (69.4%) in the STICA group showed remission vs 17 of 71 men (23.9%) in the WLC group.

(continued)

Table 1. Continued

	First author, year	Country	Treating strategy	Comorbid	Number of subjects (male/ female)	Treatment duration (sessions)	Age M (SD) or range	Study design	Assessment of IGD inclusion criteria; Type of measure	Primary outcome variable(s)	Significant results (follow-up timeframe)
6	He et al. (2021)	China	SRC pseudo modification training group SRC training group	NA	24 (4.20) 24 (5.19)	4 days 4 days	18–22	RCT	IGD scores ≥32 +gaming ≥ 2hr/day for ≥1 yr + most of the time (more than 50%) in the Internet + mainly play the game Honor of Kings; self-report	The response time to the gaming cues	The response time of the experimental group to the gaming cues significantly increased, whereas the scores for Internet gaming disorder severity, anxiety level and craving significantly decreased. However, the control group subjects did not show these effects.
7	Lindenberg, et al. (2022)	Germany	CBT-based intervention Assessment-only	NA	85 (NA) 126(NA)	4 sessions	12–18	RCT	Screen at-risk participants using German version of the Compulsive Internet Use Scale	The intervention group had a significantly greater reduction in symptoms	intervention group had a significantly greater reduction in symptoms over 12 months compared with the assessment-only control group (39.8% vs 27.7%).
							Medication				
8	Han and Renshaw (2012)	South Korea	Bupropion+education Placebo+education	major depressive disorder	25 (25.0) 25 (25.0)	8 wks 8 wks	21.2 ± 8.0 19.1 ± 6.2	RCT	YIAS>50 + gaming >30 hrs/wk + distress or impairment; self-report	Weekly gaming (hrs); IGD symptoms (YIAS)	Greater reductions in gaming time and YIAS in the bupropion compared to placebo group (post-treatment)Reductions and group differences maintained at follow-up (4 wks post-treatment)
9	Song et al. (2016)	South Korea	Bupropion Escitalopram No Treatment Control	NA	44 (44.0) 42 (42.0) 33 (33.0)	6 wks 6 wks 6 wks	20.0 ± 3.6 19.8 ± 4.2 19.6 ± 4.0	RCT	DSM-5 criteria, no specific measure identified; diagnosed by a psychiatrist	IGD symptoms (YIAS)	Decreased YIAS for active groups, but not control. Greater decrease for bupropion than escitalopram (post-treatment)
							Brain Stimulation				
10	Wu et al. (2020)	China	tDCS sham tDCS	NA	33 (33.0)	1 wk	18–25	RCT	At least 5 DSM-5 criteria + IAT score ≥50 + most of the time (more than 50%) on gaming + gaming >20 hr/wk for ≥1yr	Subjective ratings of craving and negative feelings and skin conductance responses (SCRs)	tDCS of the right dlPFC enhanced craving and negative emotion regulation after intervention

(continued)

Table 1. Continued

	First author, year	Country	Treating strategy	Comorbid	Number of subjects (male/female)	Treatment duration (sessions)	Age M (SD) or range	Study design	Assessment of IGD inclusion criteria; Type of measure	Primary outcome variable(s)	Significant results (follow-up timeframe)
11	Wu et al. (2021)	China	tDCS sham tDCS	NA	33 (33.0)	1 wk	18–25	RCT	DSM-5 criteria + scored ≥50 on a revised version of Young's online Internet addiction test + most of the time (more than 50%) on gaming + gaming >20 hr/wk for ≥1yr	Subjective desire to score online games;cue of interference effect (ms)	Compared to sham treatment, active tDCS reduced interference from gaming-related (versus non-gaming) distractors and attenuated background craving, but did not affect cue-induced craving
								Other			
12	Kim et al. (2013)	South Korea	MMORPG speaking and writing course General education	NA	27 (27.0) 32 (32.0)	8 wks (21) 8 wks (21)	17.4 ± 0.6 17.5 ± 0.6	RCT	Playing DF ≥ 4 hr/day;self-report	Average daily gaming in the past month (minutes)	The improvement in writing and speaking ability of subjects in the experimental group was much greater than that in the control group
13	Li et al. (2017)	USA	Mindfulness-oriented cognitive therapy Support group	NA	15 (14.1) 15 (10.4)	8 wks (8) 8 wks (8)	22.2 (3.8) 27.8 (5.5)	RCT	At least subthreshold IGD (≥3 DSM-5 symptoms [yes/no questions]); self-report	Checklist based on DSM-5 IGD criteria (yes/no questions)	Greater reduction in IGD symptoms in treatment vs support group (3 month post-treatment)
14	Li et al. (2018)	United States	Mindfulness-Oriented Recovery Enhancement (MORE) Support group (SG)	NA	15 (14.1) 15 (10.4)	8 wks 8 wks	25 (5.4)	RCT	3 ≥ proposed DSM-5 IGD criteria	IGD severity; levels of craving for video game playing; maladaptive gaming-related cognitions and positive reappraisal	Effects of mindfulness treatment in reducing maladaptive gaming-related cognitions might lead to reductions in IGD severity and cravings for video game playing.
15	Nielsen et al. (2021)	Switzerland	multidimensional family therapies (MDFT) group Family therapy as usual (FTAU) group	NA	12 (11.1) 30 (30.0)	6 months	44,914	RCT	5 or more DSM-5 symptoms;diagnostic interview	French version of Petry's DSM-5-based IGD scale; frequency of gaming; Abbreviated Self Completion Teen-Addiction Severity Index	Both family therapies decreased the prevalence of IGD across the one-year period and lowered the number of IGD criteria met, with MDFT outperforming FTAU.

(continued)

Table 1. Continued

	First author, year	Country	Treating strategy	Comorbid	Number of subjects (male/ female)	Treatment duration (sessions)	Age M (SD) or range	Study design	Assessment of IGD inclusion criteria; Type of measure	Primary outcome variable(s)	Significant results (follow-up timeframe)
16	Wu et al. (2022)	China	Positive emotional association biases Sham training	NA	45 (35.10) 42 (38.4)	6 days 6 days	20.56 ± 1.42 20.57 ± 1.45	RCT	Scoring ≥5 items of the proposed DSM-5 criteria for IGD, scoring ≥50 on Young's online internet addiction test	The training decreased gaming-related positive bias and compulsive gaming thoughts and behaviours.	The traing reduces compulsive gaming thoughts and behaviours via reshaping functional organization of frontostriatal pathways.

Abbreviations:
SRC: stimulus–response compatibility
CBM: Cognitive bias modification
RCT: randomized controlled trial
wk: week
YIAS: Young Internet Addiction Scale
MMORPG: massively multiple online role-playing game
tDCS: transcranial direct current stimulation
DSM-5: 5th edition of the Diagnostic and Statistica L Manual
DF: Dungeon and Fighter
IGD: internet gaming disorder
med: medication
GAS: Game Addiction Scale

Medications

Two studies compared treatments involving two drugs, bupropion and escitalopram. Each drug was administered with IGD education, generating two groups (bupropion + education; escitalopram +education). Fifty subjects were assigned to the two groups. After eight weeks of treatment, bupropion was effective in reducing gaming time and IGD symptoms (Han & Renshaw, 2012). In a subsequent study, researchers included three groups: bupropion, escitalopram, and a control group. After 6 weeks of treatment, internet-addiction severity was reduced in both the bupropion and escitalopram groups, but not in the control group (Song et al., 2016). The severity was measured by Young's internet addiction scale (www.netaddiction.com), which consists of 20 items assessing problematic use of the internet, including psychological dependence, compulsive use, withdrawal, problems in school, work, sleep, or family, and time management. For each item, a graded response is selected from 1 = "rarely" to 5 = "always" or "does not apply". Previous studies have confirmed its reliability and validity (Widyanto, Griffiths, & Brunsden, 2011; Widyanto & Mcmurran, 2004).

NIBS treatment

Two tDCS manuscripts published by Wu and colleagues seem to have used data from one subject group and sessions but different dependent measures. The first study showed that tDCS of the right dorsolateral prefrontal cortex facilitated down-regulation and up-regulation of craving and emotional states (Wu et al., 2020). The second showed that active tDCS reduced interference from gaming-related distractors and attenuated background craving but not cue-induced craving (Wu et al., 2021).

Other treatment approaches

One study delivered writing and speaking education courses for people who played massive multiplayer online role-playing games, with 32 control subjects receiving general classes. After an 8-week course, improvements in the experimental group were observed to be greater than those in the control group (Kim, Kim, Shim, Im, & Shon, 2013).

Another study compared multi-dimensional family therapy to family therapy as usual. The results showed that both family therapies decreased the likelihood of meeting IGD criteria across a one-year period. Both therapies also lowered the number of IGD criteria met, with multi-dimensional family therapy outperforming family therapy as usual (Nielsen et al., 2021).

Two studies used mindfulness as treating methods. The first one compared mindfulness-based cognitive therapy (MBCT) with a control group. After eight weeks of treatment, symptoms in the treatment group were significantly reduced compared with the control group (Li et al., 2017). Another study compared 8 weekly sessions of mindfulness-oriented recovery enhancement and a support group control condition. Mindfulness treatment was associated with reductions in IGD severity and cravings for video-game playing (Li, Garland, & Howard, 2018).

A recent study tested an emotional association bias modification approach for treating IGD. Neurocognitive mechanisms were also explored. After six consecutive day's training, compulsive gaming thoughts and behaviours were significantly decreased, and this process was associated with changes in frontostriatal pathways (Wu et al., 2022).

DISCUSSION

Although IGD has received considerable attention from researchers and the general public, a relatively small number of controlled clinical trials have been conducted and few empirically validated treatments identified. Among treatments, there is at least preliminary support for CBT, bupropion and escitalopram, tDCS, mindfulness-based therapies, and family therapy. However, the study of treatments and identification of empirically validated therapies for IGD are still at early stages. At the time of writing this manuscript, only 16 studies were identified for inclusion in this review.

CBT-based approach

CBT-based approach is currently the most widely studied treatment strategy. CBT has a robust evidence base for many disorders. CBT may be superior to other treatments for various disorders (Pfeiffer, Heisler, Piette, Rogers, & Valenstein, 2011), including personality disorders, eating disorders, addictive behaviours, anger, criminal behaviours, pain management, and general stress related to medical conditions (Hollon & Beck, 2013). Compared to other therapies, CBT may have particular durability as people learn how to implement successfully skills taught, with data supporting this notion in other behavioural addictions like gambling disorder (Potenza et al., 2019).

For IGD, two components of CBT typically involve: 1) changing maladaptive beliefs regarding excessive gaming behaviours; 2) methods for coping with unpleasant emotional states after cutting back or quitting. For example, CBT approaches decreased automatic tendencies to gaming cues, and the approach bias retraining reduced subjective urges and intentions to play and game-seeking behaviours (Rabinovitz & Nagar, 2015). CBT-based therapy may be superior in treating IGD in these two areas as compared with other approaches.

One key feature of IGD is poorly controlled gaming behaviours. In addiction studies, craving reflects a strong motivational state that promotes seeking behaviours (Dong, Wang, Du, & Potenza, 2017). Craving may shift people's attention towards addiction-related cues and influence the evaluation of addiction-related information (Sayette, 2016). Craving may also motivate individuals to pursue immediate satisfaction rather than long-term rewards (Balodis & Potenza, 2015; Dong & Potenza, 2014). Multiple studies suggest that individuals with IGD have cognitive biases

towards gaming-related cues. For example, when facing gaming cues, IGD subjects show greater craving (Dong, Huang, & Du, 2011) than individuals with recreational game use. Gaming behaviours may increase IGD subjects' craving for gaming (Dong, Wang, et al., 2017). IGD subjects craving for gaming may make secondary rewards more salient than primary ones, which further promote their gaming behaviours (W. R. Zhou, Wang, et al., 2021). CBT may provide skills for coping with craving for gaming.

Individuals with IGD may show impaired executive control over gaming cravings, and this may link to specific brain activities (Dong & Potenza, 2014; Wang, Dong, et al., 2020; Weinstein & Lejoyeux, 2020). For example, IGD subjects show differences (smaller volumes, differential activity and connectivity) in executive-control-related brain regions (Dong, Li, et al., 2017). Enhanced gaming craving may be reflected in increased brain responses in reward-related regions (Chun et al., 2020; Dong et al., 2018; Ma et al., 2019). In addition, differential functional connectivity between executive-control-related and reward-processing-related brain regions have been observed in IGD, including within the striatum (Dong et al., 2021; Wang et al., 2017). The extent to which CBT may help IGD subjects enhance their motivations, tendencies or abilities to control their gaming behaviours through such involvement of such brain mechanisms warrants additional investigation.

Despite data supporting CBT-based therapied for treating IGD, questions remain. For CBT to be optimally beneficial, participants should be motivated and engaged. In clinical settings, some IGD subjects may have ambivalence or denial regarding impacts of their gaming behaviours. They may indicate that they can control negative aspects of their gaming behaviours when they wish to do so. Thus, some individuals may be reluctant to engage in treatment, and this may be reflected in poor attendance and failure to complete CBT homework. This situation may also impact treatment research. First, IGD subjects may be reluctant to enroll in treatment studies. Second, they may be reluctant to engage in CBT. These factors may introduce challenges when investigating CBT as well as other interventions for IGD. However, measures of motivation, engagement and CBT fidelity integrated into treatment trials can help overcome such challenges. In addition, most current CBT-based therapies have been adopted from CBTs used to treat substance use disorders or other psychiatric disorders, and thus they may lack IGD-specific CBT elements. Other current limitations include the shorter-term trials that have been conducted to date, limited consideration of possible effects related to fidelity of the intervention, differences in therapists to deliver the CBT and connections with participants in treatment. Furthermore, there has been limited investigation into active ingredients of treatments. The first point regarding shorter-term durations of studies may be particularly important given that CBT as compared to other therapies has been reported to have sustained effects (Potenza, Sofuoglu, Carroll, & Rounsaville, 2011), perhaps as people learn how best to utilize skills they have learned. In sum, although initial studies of CBT for IGD appear promising, additional well-designed studies are needed to further establish it as an evidence-based approach.

Medications

No medications currently have formal indications for IGD. There is evidence that bupropion, and escitalopram have effects in decreasing IGD symptoms (Zajac et al., 2020). For medication treatments, only two studies have been tested in randomized controlled trials; the first study showed initial evidence of efficacy for bupropion, but the sample was small. The second found that bupropion was more efficacious than either escitalopram or a no treatment control.

Pharmacotherapy should be considered cautiously at this stage. First, there is a limited understanding of the neurochemistry of IGD on which to base medication development. Second, as drugs may have adverse effects, risk-benefit ratios warrant consideration. Third, only one team in South Korea has published controlled trials of medication treatments, raising questions regarding generalizability. Fourth, most medication studies have included small samples and have been of limited durations, and larger longer studies are needed. Fifth, the extent to which co-occurring disorders may influence medication selection and impact clinical improvement warrants more study, especially given that treatment algorithms based on extant data for another behavioral addiction, gambling disorder, have been proposed (Bullock & Potenza, 2012; Potenza et al., 2019). In sum, more treatment studies of larger sizes and longer durations should be conducted across jurisdiction in order to examine potential cultural differences and generalizability.

Brain stimulation methods

NIBS techniques have been developed in recent years as psychiatric disorders involve differences in brain function (Perera et al., 2016; Philip et al., 2019). NIBS represent an approach for devising possible strategies for targeting specific brain regions and circuits (Pascual-Leone, Valls-Sole, Brasil-Neto, Cohen, & Hallett, 1994). tDCS to a specific region of the prefrontal cortex enhanced two regulatory processes involved in IGD, suggesting that this might be a useful avenue to pursue further in future interventions. However, targeted brain regions and stimulation parameters are not uniform across different studies. Future studies should identify the most effective stimulation locations and parameters. Brain stimulation may not effectively target all IGD-related domains; e.g., attitudes towards and motivations for gaming may persist. Thus, NIBS should be studied in conjunction with CBT and other therapies.

Other treatment approaches

Other treatment strategies include writing courses, family therapy, and mindfulness training. While each may be categorized separately, we have described them as "other" treatments given the small number of studies to date.

Writing and speaking courses appear useful in reducing gaming-related craving, but the underlying mechanisms

remain unclear. Family therapy is based on the notion that sound family function can promote children's physical and mental health, and interventions for IGD may improve poor family relationships (Paulus, Ohmann, von Gontard, & Popow, 2018). In addition, as the prevalence of IGD in teenagers is often higher than in other age groups, the treatment of underage youth benefits from and requires cooperation with and help from families. Thus, family therapy may be considered at least as a supplementary treatment method for youth with IGD. Mindfulness-based treatment appears effective in changing maladaptive cognitive processes and increasing adaptive coping among people with addictions or related behaviours/conditions (Brewer, Bowen, Smith, Marlatt, & Potenza, 2010; Garland & Howard, 2018), which may also be useful in treating IGD.

Most treatment studies to date have been conducted in Asia

One important finding is that 10 of 16 treatment studies were performed in Asia, especially in China and Korea. There may be several reasons for this. First, the prevalence of IGD in Asia is higher than in most Western countries (Cho et al., 2017; Gao et al., 2022). This finding might reflect cultural features as studies have suggested, for example, that individuals may be weaker in self-monitoring in collectivist cultures than in individualistic cultures (Li et al., 2023), although other possibilities exist. For example, roles for intrapersonal factors, including peer relationship, social support, or mental control from parents (parental psychological control may exert an indirect effect on adolescent IGD) also warrant consideration (Zhuang et al., 2023). Second, the government and researchers in East Asian countries have often focused on the negative effects of IGD and promulgated related policies. For example, the government of China regulated permissible gaming time of minors (less than 1.5 h on school days, and less than 3 h on weekends or holidays). Additionally, paralleling the policies, the government has provided considerable support for research into efficacious treatments (Montag & Becker, 2020). Regardless of the reasons, additional treatment studies from non-Asian jurisdictions are warranted.

The prevalence of IGD has increased, especially among adolescents and young adults (Gao et al., 2022). The factors associated with IGD may vary across age groups. For example, risk factors for young children may include family dysfunction, being bullied or engaging in bullying, and hyperactivity/inattention (Gao et al., 2022). For adults, interpersonal problems, escape motivations, loneliness or depression may represent important factors (Ropovik et al., 2023). Thus, treatment approaches may vary across developmental epochs. Other individual differences warrant consideration. For example, males and females may preferentially engage in gaming for different reasons, with positive reinforcement motivations more prominent in males and negative reinforcement motivations more prominent in females (King & Potenza, 2020). The extent to which these and other factors may be considered in interventions warrants consideration and study.

In summary, some current studies of IGD treatment have adopted and modified treatment strategies from other psychiatric disorders to examine their efficacy and tolerability in treating people with IGD. Thus, additional treatment approaches specific to IGD are important to consider in future studies. Second, given that rigorous trials of new treatments may take years to complete, progress in this area may be slow. Third, the majority of these "other" treatment strategies have not been evaluated in rigorously designed studies, although pilot studies suggest that additional studies may be warranted.

Future directions for treatment studies

Based on these findings, we believe that future research on IGD treatment development could focus on the following directions.

Explore the most effective method for CBT and CBT plus other treatment approaches. CBT appears to be the most widely studied psychosocial treatment for IGD thus far. According to extant data, it will also be an important and promising treatment method to evaluate further in the near future. Future work should consist of more well-designed studies to provide evidence for IGD treatment. In addition, future CBT treatment for IGD should explore strategies to enhance treatment efficacy. Specifically, different times, frequencies and IGD-specific treatment approaches should be compared to maximize the effect of treatment. Researchers should also attempt to standardize treatment procedures (e.g., through manualized therapies and include fidelity checks within studies and clinical settings), which could enhance treatment efficacy. Following demonstration in research settings, implementation studies should be conducted.

Use medication treatment cautiously and judiciously. Although bupropion and escitalopram have been shown in preliminary studies to reduce gaming-related craving among IGD subjects, neurochemical mechanisms underlying these effects remain poorly understood and potential adverse effects warrant consideration. Thus, this approach should be administered with caution and by an experienced psychiatrist when clinically indicated. In this process, risks, benefits and alternatives should be discussed, and information that no medication has a formal indication for IGD should be communicated. As more information regarding the mechanisms of IGD become understood, testing of additional pharmacotherapies should be pursued.

Finding a specific stimulation target and effective stimulant parameters when using NIBS techniques. NIBS could be a potential technique for IGD treatment. In this process, individualized neural targets may increase efficacy of NIBS treatments for psychiatric disorders (Fitzgerald et al., 2012; Jha, Chadda, Kumar, & Bal, 2016). This approach might provide a potential direction for future research. Individualized targets may prove to be most effective, and this

approach warrants further examination for IGD. As greater understandings of brain circuitry implicated in IGD and impacted by NIBS are achieved, NIBS may offer significant promise.

In addition to the above main treatment strategies, each subject's individualized situation should be considered. For example, excessive online gaming may be a result of loneliness, an attempt to escape from society, or compensation for insecure attachment. For these IGD subjects, alternative strategies, including but not limited to family therapy, may be indicated.

Considering gender/sex in the treatment of IGD. Gender-/sex-related differences have been implicated in the development and maintenance of and recovery from IGD (Dong & Potenza, 2022). Gender-/sex-related differences are also observed in brain responses. For example, high impulsivity, impaired inhibitory control, and aggressive behaviours have been more frequently observed among males than females (Yen et al., 2017). At a maintenance stage, males may be more sensitive to gaming-related rewards than females, and acute gaming behaviours may elicit higher cravings among males than among females (Dong, Wang, et al., 2017). In recovery, females with IGD have reported more negative mood states than males, and the gaming behaviours of females have been linked to affective disorders (Ko, Yen, Yen, Lin, & Yang, 2007). These gender-/sex-related differences suggest differential vulnerability during different stages of IGD. Thus, future treatment studies should take gender/sex into consideration and generate gender-/sex-informed prevention and treatment strategies.

For males, one important step for treatment is to stop their gaming behaviours, which is to terminate the vicious cycle of "gaming-enhanced craving-diminished inhibitory control leading to more gaming" (Dong & Potenza, 2022). However, for females gaming behaviours may link more to relief of emotional distress. Thus, providing more emotional support or reducing emotional dependence on gaming may be particularly important, and this may help break a vicious cycle of "gaming-lonely/depressed/stress leading to more gaming."

For IGD treatments, most existing studies selected IGD subjects without other psychiatric disorders. However, in clinical settings, IGD often co-occurs with other psychiatric disorders, including major depression disorder and attention-deficit/hyperactivity disorder, among others. Two studies in our review reported IGD with major depression disorder, which showed that the severity of both IGD and major depression disorder were reduced after treatment. However, during the follow-up, the reductions in online gaming persisted, while depressive symptoms recurred. Future treatment studies should include more IGD subjects with specific co-occurring disorders.

LIMITATIONS

Several limitations of the current review should be mentioned. First, published treatment studies may be biased towards reporting positive effects as studies that did not find treatment effects may have been less likely to be published. Thus, publication biases should be considered. Second, all included studies were published in English as studies published in other languages were excluded. Considering a broader range of languages may have identified additional articles. Third, the inclusion/exclusion criteria may have missed relevant articles. Nonetheless, the current review identified multiple interventions with varying degrees of empirical support and highlights a need for additional research in this area.

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Conflicts of interest: The authors declare that they have no competing interests. Marc N. Potenza has consulted for and advised Opiant Pharmaceuticals, Idorsia Pharmaceuticals, Baria-Tek, AXA, Game Day Data and the Addiction Policy Forum; has been involved in a patent application with Yale University and Novartis; has received research support from the Mohegan Sun Casino and Connecticut Council on Problem Gambling; has participated in surveys, mailings or telephone consultations related to drug addiction, impulse control disorders or other health topics; and has consulted for law offices and gambling entities on issues related to impulse control or addictive disorders. Dr Potenza is an associate editor of the Journal of Behavioral Addictions. The other authors report no disclosures.

SUPPLEMENTARY MATERIAL

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