

Effectiveness of Non-Pharmacological Interventions on Gaming Disorder: A Systematic Review and Meta-Analysis

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Objective Non-pharmacological interventions (NPIs) are effective in treating gaming disorder (GD). However, studies have not comprehensively evaluated the most effective NPIs. This systematic review and meta-analysis aimed to evaluate the effects of NPIs on the prevention and reduction of GD in the general population with GD.

Methods We searched five databases (MEDLINE, Embase, Cochrane CENTRAL, PsycINFO, and CINAHL) for English-language randomized controlled trials (RCTs) published till May 12, 2024, using Preferred Reporting Items for Systematic reviews and Meta-Analyses guidelines. Two independent reviewers selected studies, extracted data, and assessed quality using the Cochrane Risk of Bias Tool (RoB2). Meta-analyses were conducted using a random-effect model, with effect sizes calculated using Hedges's g and heterogeneity assessed using I^2 statistics.

Results A total of 18 RCTs involving 1,950 participants were included. The NPIs included psychotherapy, behavioral interventions, and other strategies. The pooled analysis showed a significant reduction in GD severity (Hedges's $g = -0.82$; 95% confidence interval, -1.23 to -0.52 ; $I^2 = 90.36\%$). Psychotherapy, particularly cognitive-behavioral therapy, showed the most substantial effect (10 studies, 1,036 participants; Hedges's $g = -1.34$). Behavioral interventions (4 studies, 456 participants) and prevention-focused interventions (6 studies, 1,164 participants) had smaller but positive effects. Subgroup analyses revealed greater effectiveness of treatment interventions in adults than in adolescents. Sensitivity analyses confirmed the robustness of these results despite high heterogeneity ($I^2 = 90.36\%$).

Conclusion NPIs, particularly psychotherapy, are effective in reducing GD severity. However, more high-quality RCTs are needed robust, evidence-based treatment guidelines.

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Keywords Gaming disorder; Non-pharmacological intervention; Meta-analysis; Systematic review; Internet gaming disorder; Treatment effect.

INTRODUCTION

The popularization of gaming and the rapid advancement in digital technologies have established gaming as a primary leisure activity and a significant sociocultural phenomenon, particularly among adolescents and young adults. While gaming offers various cognitive and social benefits,¹ excessive gaming has been increasingly linked to psychological distress

and behavioral dysfunction, necessitating effective intervention strategies.² Gaming disorder (GD) is characterized by persistent and excessive engagement with online and/or offline video or digital games, resulting in impairment in daily functioning.³ Moreover, GD can encompass broader concepts such as internet gaming disorder (IGD), problematic or pathological video gaming, and excessive video game use.⁴

In 2013, the American Psychiatric Association introduced IGD as a proposed diagnostic category in the fifth edition of the Diagnostic and Statistical Manual of Mental Disorders, Fifth Edition (DSM-5).³ Subsequently, in 2019, the WHO formally included GD in the eleventh edition of the International Classification of Diseases (ICD-11).⁵ While both classification systems recognize GD as a condition of clinical and public health significance, they differ in their diagnostic criteria, leading to ongoing discussions about the boundaries of pathological

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gaming.^{4,6} Additionally, concerns persist regarding discrepancies in terminology between these classification systems and the potential pathologization of normative gaming behavior.⁷ Despite these differences, there is a consensus that excessive gaming can develop into a severe mental health issue, reinforcing the need for effective interventions and standardized treatment strategies.⁸

GD is associated with various psychiatric and physical symptoms that significantly impact an individual's well-being. Key symptoms of GD include insomnia, daytime sleepiness, and chronic fatigue, which are closely associated with increased gaming time.⁹ Moreover, individuals with GD often experience intense stress,^{2,10} which can disrupt family functioning and weaken social relationships,² and are prone to depression and emotional distress.¹¹ GD has also been strongly linked to attention-deficit/hyperactivity disorder (ADHD),¹ and affected individuals tend to exhibit significantly lower levels of self-esteem and life satisfaction,¹² which severely impact their overall mental health and functionality. Furthermore, compulsive behavioral patterns such as preoccupation with gaming, withdrawal symptoms, and loss of control are hallmarks of the disorder; if these symptoms persist, a diagnosis of GD may be warranted.^{3,5}

Given the increasing prevalence of GD, there is a growing interest in effective interventions for both its prevention and treatment.^{8,13} Individuals with GD can be treated using pharmacological and/or non-pharmacological interventions (NPIs), including psychological and behavioral therapies, with tailored approaches based on the patient's specific symptoms and needs.^{12,14} Pharmacological treatment involves the use of medications, such as bupropion or escitalopram, which are effective in alleviating depression and reducing the severity of GD.¹⁵ However, long-term use of these medications carries risks of side effects and drug dependence, limiting their role as standalone treatments.^{16,17} Consequently, NPIs, particularly psychotherapeutic and behavioral interventions, have gained attention as promising alternatives.¹⁸

NPIs have gained attention as treatment options that demonstrate short-term effectiveness without associated side effects. Cognitive behavioral therapy (CBT) is one of the most widely used psychotherapeutic approaches, as it is effective in modifying distorted cognitions and behavioral patterns related to gaming, with numerous studies supporting its efficacy.¹⁹ Family therapy is also a key NPI, enhancing treatment outcomes for adolescents with GD by improving family communication and strengthening support systems.^{20,21} Additionally, behavioral interventions such as digital detox programs help individuals with GD reduce their dependency on gaming and reintegrate into the real-life activities.²²

While NPIs have been increasingly recognized for their role

in the treatment and prevention of GD, previous systematic reviews have primarily focused on psychological interventions such as CBT and mindfulness.^{12,23} However, these reviews lacked a comprehensive evaluation of diverse NPIs,²⁴ including behavioral interventions and educational programs.^{8,25} Additionally, they were constrained by small sample sizes and inconsistencies in diagnostic classifications.^{26,27} Specifically, many studies have treated GD as a subcategory of internet addiction, often grouping it with other behavioral addictions such as online shopaholics, online gambling addiction, online pornography addiction, and online social networking service (SNS) addiction.²⁸ This lack of distinction may have affected the accuracy of treatment efficacy assessment. Furthermore, prior reviews did not systematically compare the effectiveness of prevention- and treatment-focused NPIs or analyze intervention effectiveness across different populations.^{7,29}

Given these gaps, this systematic review and meta-analysis aim to provide a more comprehensive evaluation of NPIs by incorporating a broader range of interventions, conducting detailed subgroup analyses, and assessing their effectiveness across diverse populations. Through this approach, we seek to provide clinically relevant insights and identify optimal intervention strategies for both the prevention and treatment of GD.

METHODS

The systematic review and meta-analysis evaluated the effects of NPIs on the prevention and reduction of GD. This study adhered to the Preferred Reporting Items for Systematic Reviews and Meta-analyses (PRISMA) statement (Supplementary Tables 1 and 2).³⁰ Additionally, this systematic review was pre-registered in the International Prospective Register of Systematic Reviews (PROSPERO; Registration No. CRD42024615740).

Literature search

The literature search was conducted in five electronic databases: MEDLINE (via PubMed), Embase, CENTRAL (via Cochrane Library), PsycINFO, and CINAHL (on Ebsco Host). Additionally, the reference lists were manually searched. The search keywords were categorized into two groups: 1) "gaming disorder" (MeSH Terms) OR "internet gaming disorder" (MeSH Terms) AND 2) "intervention" (Title/Abstract) OR "effect" (Title/Abstract) OR "treatment" OR "therapy" (Title/Abstract). Detailed search strategies for all databases are provided in Supplementary Table 3.

Inclusion and exclusion criteria

Studies in English published up to May 12, 2024, were screened according to the participants, intervention, compar-

ison, outcomes, time, setting, and study design (PICOTS-SD) criteria. Two independent reviewers (Ock and Lee) screened the titles and abstracts. The full texts of potentially eligible studies were obtained for further evaluation. Any disagreement between the two reviewers was resolved through discussion with a third researcher (Kim).

Participants (P): The participants included individuals diagnosed with GD (including IGD), based on diagnostic criteria derived from the Internet Addiction Test (IAT) and the DSM-5, with no age restrictions. This category also encompassed normal gamers as well as those with co-occurring mental disorders alongside GD. In contrast, studies focusing primarily on addiction symptoms or disorders related to online SNS), pornography, shopping, or gambling were excluded. Studies with a minimum sample size of 10 participants per group were included.

Intervention (I): All types of interventions for GD (including IGD), except pharmacological, were included. This encompassed indirect interventions, such as parental strategies to manage their children's gaming behavior.

Comparison (C): Both inactive controls (no intervention, waitlist, sham, or pseudo-training) and active controls (other types of interventions) were allowed as comparators.

Outcomes (O): The primary outcomes included only GD-related variables measured using objective or subjective diagnostic criteria, such as the IAT and the DSM-5.

Time (T): No restrictions were applied on the study duration or the follow-up period for trials.

Setting (S): No restrictions were applied regarding the study setting.

Study design (SD): Only randomized controlled trials (RCTs) were included. There were no restrictions on the follow-up period of the trial.

Quality assessment

The risk of bias in the included studies was independently assessed by two reviewers using the Cochrane Risk of Bias Tool for RCTs (RoB2).³¹ The assessment followed the guidelines outlined in the Cochrane Handbook for Systematic Reviews of Interventions.³² The primary outcomes were analyzed using the intention-to-treat (ITT) approach.

The RoB2 tool addresses five domains of bias: (D1) arising from the randomization process, (D2) due to deviations from intended interventions, (D3) due to missing outcome data, (D4) in the measurement of the outcome, and (D5) in the selection of the reported result. The risk of bias in each domain was rated as "high," "some concerns," or "low" and visualized using a traffic light plot. The overall risk of bias was summarized using a bar chart to provide a comprehensive overview of potential biases in the included studies.

Data extraction

Multiple publications using the same dataset were considered as a single study; however, data were extracted for all related publications. To record the basic characteristics of the included studies, a standardized data extraction form was utilized. In cases where a study contained two experimental groups which were independently compared to a control group, each comparison was treated as a separate study.³³

Statistical analysis

A meta-analysis was conducted using Comprehensive Meta-Analysis software (version 3.0; <https://www.meta-analysis.com/>) to assess the effectiveness of NPIs in reducing the severity of GD. Effect sizes and 95% confidence intervals (CIs) were derived from the pooled data, with a 5% significance level. Effect sizes were calculated using means and standard deviations, with Hedges's *g* applied under a random-effects model.^{34,35}

Heterogeneity was evaluated using the I^2 statistic, with thresholds of 25%, 50%, and 75% indicating low, moderate, and high heterogeneity, respectively.³⁶ In addition, Cochran's *Q* test was performed, with a *p*-value of <0.1 interpreted as evidence of significant heterogeneity.³⁷ In cases where the correlation coefficient between pre- and post-treatment measurements within the same group was not reported, a conservative estimate of $r=0.7$ was applied.³⁸ Publication bias was initially assessed through visual inspection of a comparison-adjusted funnel plot for asymmetry. Further analysis was conducted using the Egger test, where a *p*-value of <0.05 was considered indicative of potential publication bias.³⁹ To further evaluate the risk of publication bias, the trim-and-fill method was employed under both fixed-effect and random-effect models.⁴⁰

Sensitivity analysis was conducted by sequentially excluding each study to evaluate its influence on the pooled estimate of GD severity. This approach was used to assess the robustness and reliability of the overall findings. To explore heterogeneity across studies and examine variations in effect sizes based on specific factors, subgroup analyses were performed. The following categories were considered: intervention type (psychotherapy, behavioral, or other), intervention goal (prevention or treatment), age group (adolescent or adult), control type (active or inactive), outcome measure (DSM-5 or IAT), geographical region (Asia or Europe), and RoB2 ratings (low, some concerns, or high).

RESULTS

Search results

The preliminary search identified 3,508 potentially relevant articles. After removing 898 duplicates, 2,610 records remained

for initial screening. Following a review of titles and abstracts, 65 studies were selected for full-text assessment. Studies were excluded for the following reasons: lack of a relevant population,⁴¹⁻⁴³ absence of reported outcomes (GD severity),^{20,44-57} differing study designs,^{50,58-72} inability to access the full text despite thorough searches,⁷³⁻⁸² or being ongoing studies without conclusive results (Supplementary Table 4).⁸³⁻⁸⁶ Two additional studies were identified through reference checking of related meta-analyses and reviews. Finally, 18 studies were analyzed (Figure 1 and Supplementary Table 5).

Characteristics of the included studies

The characteristics of the included studies are presented in Table 1. All studies were RCTs published in English between 2013 and 2023. A total of 10 studies were conducted in Asia (Korea, China, and Hongkong)^{25,87-95} with 778 participants (39.90%); 6, in Europe (Germany, Switzerland, Turkey)⁹⁶⁻¹⁰¹ with 1,102 participants (56.51%); and 2, in other regions (Nigeria, USA)^{101,102} with 70 participants (3.59%). None reported conflicts of interest, and all were peer reviewed.

Participants

Of the total participants ($n=1,950$), 908 were allocated to the NPI group and 1,042 to the control group. The mean number of participants per study was 50.44 (range: 12–167) in the intervention group and 57.89 (range: 12–255) in the control group. The average age of participants ranged from 10.22 to 32.10 years in the NPI group and from 9.97 to 31.50 years in the control group. The proportion of male participants varied widely across studies, ranging from 18.8% to 100%, with 6 studies ($k=6$, where k denotes the number of studies) exclusively including male participants.

Interventions

The most commonly employed intervention type was psychotherapy ($k=10$), with most studies utilizing CBT ($k=8$) (Tables 1 and 2).^{87,89,92,93,97,98,100-103} Four studies implemented behavioral interventions, such as abstinence or response inhibition training using computerized tasks.^{25,94,95,101} For prevention, a parental program ($k=1$)⁹¹ and physical exercise ($k=1$)⁹⁹ were included. Brain stimulation interventions involved tran-

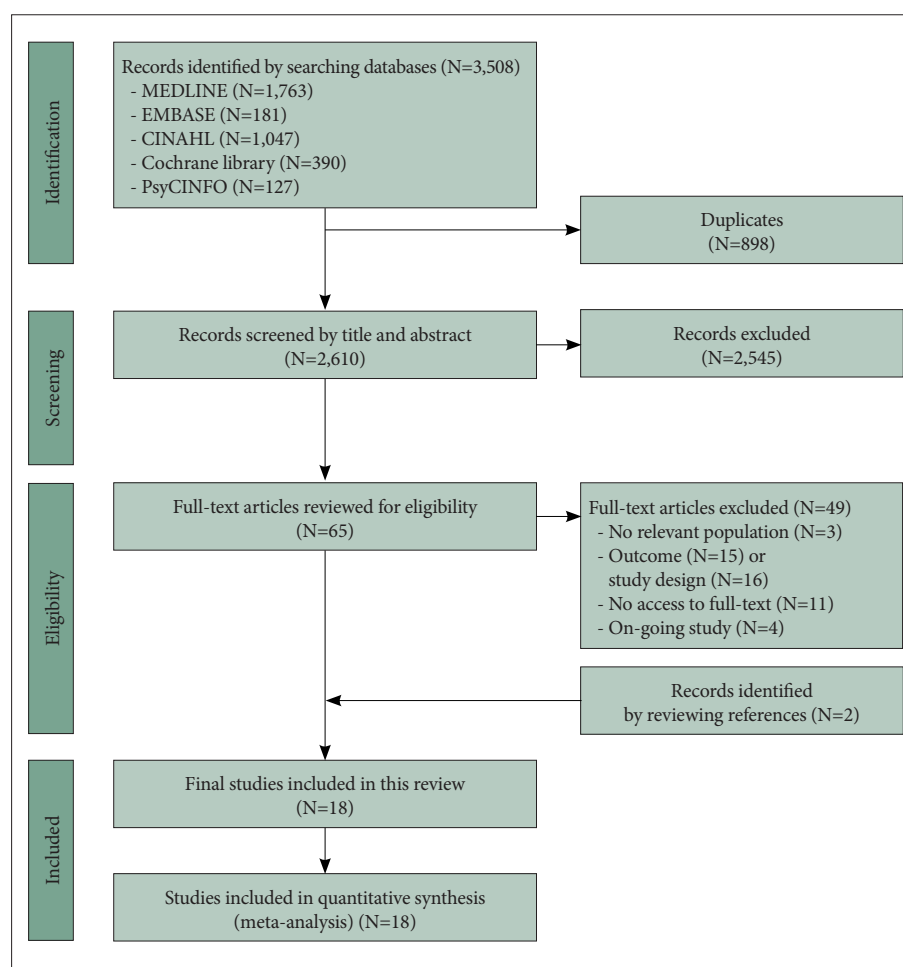


Figure 1. PRISMA flow of study selection process. N indicates the number of studies at each stage of the review.

Table 1. Characteristics of studies and interventions of randomized controlled trials, included in a systematic review and meta-analysis to reduce gaming disorder

Author	Country	Intervention goal	IGD diagnosis	Intervention			Control			Male (%)	IGD-related outcome measure	
				N	Mean age (yr)	Intervention description (length)	Intervention type	N	Mean age (yr)			Intervention description (length)
Brailovskaia et al. ⁸⁶ (2022)	Germany	Prevention	DSM-5 (5+ of 9 symptoms over 12 mon)	131	26.2±7.7	Abstinence from gaming (2 wk)	Behavioral	140	25.1±4.9	No treatment	71.2	IGD scale, daily gaming
Dieris-Hirche et al. ⁸⁷ (2023)	Germany	Treatment	DSM-5, ICD-11	89	32.1±13.0	OMPRIS [CBT+MI, ACT] (12 sess., 50 min, 4 wk)	Psychotherapy	91	31.5±11.4	Waiting list	75.6	AICA-S, CIUS, weekly internet usage
Ede et al. ¹⁰³ (2023)	Nigeria	Treatment	DSM-5, ICD-11	20	23.2±4.0	CBT (8 sess., 40 min, 8 wk)	Psychotherapy	20	24.0±3.8	Waiting list	75.0	GPIUS2
He et al. ²⁵ (2021)	China	Treatment	IGD severity scale (32+), gaming duration (2 h+/day) +1 yr [†] , Internet duration (gaming 50%+), "Honor of Kings"	24	20.0±2.0	ApBM (4 sess., 20 min, 4 wk)	Behavioral	24	20.0±2.0	Pseudomodification training (4 sess., 20 min, 4 wk)	18.8	IGD scale, craving
Hong et al. ⁸⁷ (2020)	Korea	Treatment	DSM-5, without comorbidities	25	15.4±2.9	CBT+PE CBT (8 sess., 1.5 h, 8 wk)	Psychotherapy	25	16.0±2.5	CBT + supportive counseling CBT (8 sess., 1.5 h, 8 wk)	100.0	YIAS
Jeong et al. ⁸⁸ (2020)	Korea	Treatment	DSM-IV, problematic online gamers: IAT score (40+)	13	22.2±1.7	tDCS (12 sess., 30 min, 4 wk)	Brain stimulation	13	23.2±1.6	Sham tDCS (10 sess., 20 min, 5 days)	57.7	IAT, average weekly hours spent on gaming
Ji and Wong ⁸⁹ (2023)	China	Treatment	CIAS-G (68+)	38	16.3±0.9	ICBT (8 sess., 1.5 h, 8 wk)	Psychotherapy	39	16.3±0.9	Waiting list	88.3	CIAS-G, weekly time spent on gaming
Lee et al. ⁹⁰ (2021)	Korea	Treatment	DSM-5, WAIS-IV (80+)	14	23.1± 5.8	tDCS (10 sess., 20 min, 5 days)	Brain stimulation	12	25.3±8.9	Sham tDCS (10 sess., 20 min, 5 days)	100.0	YIAT, craving
Li et al. ⁹¹ (2019)	Hongkong	Prevention	Parents of video gamers (weekly gaming time 0 min+/wk)	163	10.2±1.0	Game over intervention (1 sess., 4 h, 1 day)	Prevention	199	10.0±1.0	Effective learning for children (1 sess., 4 h, 1 day)	61.9	K-Scale, weekly gaming time, exposure to violent video games
Li and Wang ⁹² (2013)	China	Treatment	DSM-IV-TR, gaming duration (4 h/day or 30 h/wk), OGCAS (35+), IAS-CR (3+)	14	15.5±2.0	CBT (12 sess., 45 min, 6 wk)	Psychotherapy	14	15.5±2.0	Basic counseling (12 sess., 45 min, 6 wk)	100.0	OGCAS, IAS
Li et al. ¹⁰² (2017)	USA	Treatment	DSM-5 (3+)	15	22.2±3.8	MORE (8 sess., 2 h, 8 wk)	Psychotherapy	15	27.8±5.5	Social support (8 sess., 2 h, 8 wk)	80.0	DSM-5 criteria, craving, maladaptive cognitions associated with video gaming
Lindenberg et al. ⁸⁶ (2022)	Germany	Prevention	DSM-5, CIUS (20+)	167	14.6±2.0	PROTECT (CBT) (4 sessions, 1.5 h, 4 wk)	Psychotherapy	255	15.4±2.0	No treatment	45.7	CIUS, CSAS
Maden et al. ⁸⁹ (2022)	Turkey	Prevention	DSM-5, ICD-11, gaming duration (2 h+/day)	15	23.8±1.7	VRT (18 sess., 30 min, 6 wk)	Prevention	15	22.2±1.4	Waiting list	100.0	IGDS9-SF, gaming time (min/day)
Nielsen et al. ¹⁰⁰ (2021)	Swiss	Treatment	DSM-5 (5+)	12	14.9±2.7	MDFT (26 sess., 1.1 h, 6 mon)	Psychotherapy	30	14.9±1.8	FTAU (17 sess., 1.1 h, 6 mon)	97.6	DSM-5 criteria, average daily gaming time, gaming problem severity score
Park et al. ⁹³ (2016)	Korea	Treatment	DSM-IV-TR, YIAS (50+)	12	23.6±2.7	CBT (8 sess., 2 h, 4 wk)	Psychotherapy	12	24.2±3.2	VRT (8 sessions, 2 h, 4 wk)	100.0	YIAS

Table 1. Characteristics of studies and interventions of randomized controlled trials, included in a systematic review and meta-analysis to reduce gaming disorder (continued)

Author	Country	Intervention goal	IGD diagnosis	Intervention			Control			Male (%)	IGD-related outcome measure
				N	Mean age (yr)	Intervention description (length)	Intervention type	N	Mean age (yr)	Intervention description (length)	
Wölfling et al. ¹⁰⁰ (2019)	Germany	Treatment	AICA (7+), persistent for at least 6 mon, with comorbid disorders	72	26.2±8.7	STICA (CBT) group (15 sess., 100 min, 4 mon) Person (8 sess., 60 min, 4 mon)	Psychotherapy	71	26.2±6.9	Waiting list	100.0 AICA-C, AICA-S
Wu et al. ⁹⁴ (2022)	China	Treatment	DSM-5 (+5), IAT (+50), Internet duration (gaming 50%+), gaming duration (20 h+/wk) +1 yr†	45	20.6±1.4	EABM (12 sess., 40 min, 6 days)	Behavioral	42	20.6±1.5	Sham (12 sess., 40 min, 6 days)	83.9 IAT, weekly gaming time, compulsive gaming thoughts, compulsive gaming behavior
Zheng et al. ⁹⁵ (2022)	China	Prevention	IAT (+60), DSM-5 (+5), "King of Glory" +1 yr, right-handedness	25	21.4±1.8	Abstinence from gaming for 7 days	Behavioral	25	21.0±2.1	No treatment	NR DSM-5 criteria, IAT, craving score

ACT; Acceptance and Commitment Therapy; AICA-C, Assessment of Internet and Computer Game Addiction – Clinical; AICA-S, Assessment of Internet and Computer Game Addiction–Self-report; ApBM, Approach Bias Modification; AT, aerobic training; CBT, cognitive behavioral therapy; CIAS-G, Chen Internet Addiction Scale-gaming version; CIUS, Compulsive Internet Use Scale; CSAS, modified German video game dependency scale; DSM, Diagnostic and Statistical Manual of Mental Disorders; DSM-IV-TR, DSM Fourth Edition, Text Revised; EABM, Emotional Association Biases Modification; FTAU, family therapy as usual; GPIUS2, Generalized Problematic Internet Use Scale 2; IAT, Internet Addiction Test; IAS, Internet Addiction Scale; IAS-CR, IAS-Clinical Revised; ICBT, integrated cognitive-behavioral therapy; ICD, International Classification of Diseases; IGD, internet gaming disorder; K-Scale, Korean Internet Addiction Scale for Adolescents; MDFT, multidimensional family therapy; MI, Motivational Interviewing; MORE, Mindfulness-Oriented Recovery Enhancement; OMPRIIS, Short-term webcam-based telemedicine treatment; OGCAS, Online Game Cognitive Addiction Scale; PE, physical exercise; PROTECT, Professional Use of the Internet to Explore Topics and Engage in Communication and Training; STICA, Short-term Treatment for Internet and Computer Game Addiction; tDCS, transcranial direct current stimulation; VRT, virtual reality-based training; WAIS-IV, Korean version of the Wechsler Adult Intelligence Scale-IV; YIAS, Young's Internet Addiction Scale; YIAT, Young's Internet Addiction Test; NR, not reported

Table 2. Number of studies for each type of treatment within each of the groups

Group variable	Type of intervention	Study
Behavioral	Abstinence	2
	Approach Bias Modification (ApBM)	1
	Emotional Association Biases Modification (EABM)	1
Psychotherapy	Cognitive behavioral therapy (CBT)	7
	Integrated cognitive-behavioral therapy (ICBT)	1
	Mindfulness	1
	Multidimensional family therapy (MDFT)	1
Brain stimulation	Transcranial direct current stimulation (tDCS)	2
Prevention	Parental program	1
	Physical exercise	1

scranial direct current stimulation (tDCS, $k=2$).^{88,90} The intervention durations ranged from 4 hours to 6 months, with a mean duration of 6.37 weeks (Table 1). The number of sessions varied between 1 and 26, with an average of 10.88. The length of each session ranged from 20 minutes to 4 hours, with an average of 78.58 minutes per session.

Comparison group

The comparison groups (control group) were primarily composed of no-treatment (no intervention) and waiting list controls (Table 1). For brain stimulation and certain behavioral interventions, sham interventions or pseudo-training were employed. Four studies utilized treatment-as-usual (TAU) as the control group, which included active comparators such as CBT,⁸⁷ support groups,¹⁰² educational programs,⁹¹ family therapy as usual (FTAU),¹⁰⁰ virtual reality therapy,⁹³ and basic counseling.⁹²

Outcome

All studies utilized self-report questionnaires to assess GD outcomes. The most frequently used tool was IAT, employed in 11 studies to categorize GD as a subdomain of internet-related activities (Table 3). This included various instruments such as the IAT,^{26,94} Young's Internet Addiction Test (YIAT),⁹⁰ Korean Internet Addiction Test (K-Scale),⁹¹ German version of the Compulsive Internet Use Scale (CIUS),⁹⁸ Generalized Problematic Internet Use Scale 2 (GPIUS2),¹⁰³ Young's Internet Addiction Scale (YIAS),^{87,93} Assessment of Internet and Computer Game Addiction–Self-report (AICA-S),^{97,101} and Online Game Cognitive Addiction Scale (OGCAS),⁹² which provided

Table 3. Number of studies for each type of outcome measurement within each of the groups

Diagnostic criteria	Name of outcome measurement	Study
IAT	IAT	2
	Young's Internet Addiction Test (YIAT)	1
	Korean Internet Addiction Test (K-Scale)	1
	German version of the Compulsive Internet Use Scale (CIUS)	1
	The Generalized Problematic Internet Use Scale 2 (GPIUS2)	1
	Young's Internet Addiction Scale (YIAS)	2
	Assessment of Internet and Computer Game Addiction–self-report (AICA-S)	2
	Online Game Cognitive Addiction Scale (OGCAS)	1
	DSM-5	3
	Internet Gaming Disorder Scale (IGD-scale)	2
DSM-5	Internet Gaming Disorder Scale–short form (IGDS9-SF)	1
	Chen Internet Addiction Scale–gaming version (CIAS-G)	1

IAT, Internet Addiction Test; DSM-5, Diagnostic and Statistical Manual of Mental Disorder, Fifth Edition

more detailed assessments of GD. Additionally, outcome assessment tools based on the DSM-5 diagnostic criteria were utilized in seven studies for diagnosing GD, employing tools such as the DSM-5,^{95,100,102} Internet Gaming Disorder Scale (IGD-scale),^{25,96} Internet Gaming Disorder Scale–short form (IGDS9-SF),⁹⁹ and Chen Internet Addiction Scale–gaming version (CIAS-G).⁸⁹

Quality of the included studies

The risk of bias in the included studies was assessed with equal weights for all domains (Figure 2A). Four studies had a “low risk” across all domains.^{97,101–103} In contrast, three had overall “high risk,” particularly in D1 and D3.^{91,93,100}

A domain-specific evaluation showed that, in D1, 10 studies employed sequence generation software or random number generators for random allocation, leading to a rating of “low risk.”^{25,89,90,92,94,97,99,101–103} In contrast, the studies by Li et al.⁹¹ and Park et al.⁹³ lacked specific information on the randomization methods and allocation concealment, with statistically significant baseline differences between intervention groups, and were classified as “high risk.” The remaining six studies lacked clarity on randomization and allocation concealment, leading

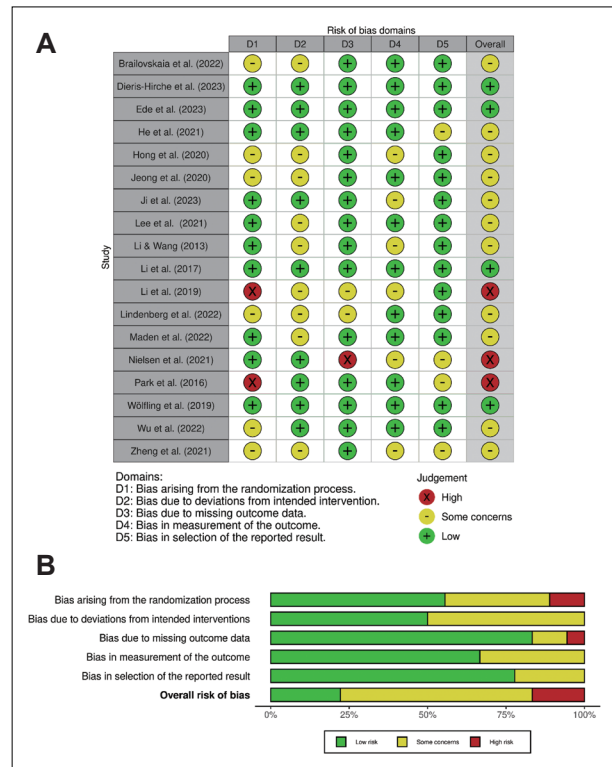


Figure 2. Evaluation of the risk of bias in the 18 studies: (A) individual assessments and (B) overall percentages. Green indicates low risk of bias, yellow indicates some concerns, and red indicates high risk.

to an assessment of “some concern.”^{87,88,95,96,98,100}

In D2, nine studies indicated that either participants or intervention providers were aware of the intervention group; however, the resulting attrition had a limited impact on the study outcomes; thus, these studies were rated as having “some concern.”^{87,88,90–92,95,96,98,99} Conversely, nine studies were assessed as “low risk” because neither participants nor providers were aware of the intervention group or no attrition affected the results.^{26,89,93,94,97,100–103}

In D3, 15 studies provided complete outcome data, resulting in a “low risk” rating.^{26,87–89,92–97,99–103} In contrast, the studies by Li et al.⁹¹ and Lindenberg et al.⁹⁸ had missing data, with insufficient evidence to confirm the absence of bias, leading to a rating of “some concern.” Notably, Nielsen et al.¹⁰⁰ reported IAT data only at baseline and at 5-week follow-up, with missing data for planned assessments at weeks 1 and 25, resulting in a classification of “high risk.”

In D4, 12 studies had appropriate outcome measurements with consistent methods across intervention groups, leading to a rating of “low risk.”^{26,88,90,93,94,96–99,101–103} However, six studies had evaluators who were aware of the intervention group and were rated as “some concern.”^{87,89,91,92,95,100}

In D5, 14 studies utilized data according to pre-specified analytical plans, which resulted in a “low risk” assessment.^{87–92,94,96–99,101–103}

Conversely, four studies lacked detailed information on multi-level analytical procedures, leading to a rating of “some concern.”^{25,93,95,100}

Distribution of risk of bias by domain (Figure 2B) revealed some “high risk” studies in D1 and D3. Notably, approximately 10% of studies in D1 were rated as “high risk,” while in D3, only one was classified as “high risk,” with a few others as “some concern.” In D2 and D5, although some studies had “some concern,” the majority had “low risk.”

Results of individual studies

The analysis of the effect of NPIs on GD included a total of 19 comparison-control studies. The NPI group ($n=908$) demonstrated a statistically significant reduction in GD symptoms compared to the control group ($n=1,057$) (Figure 3). The pooled effect size (Hedges's g) was -0.82 , indicating a significant effect of NPIs in reducing GD (95% CI, -1.23 to -0.52 ; $p<0.001$).

The Forest plot analysis revealed that the study by Ede et al.¹⁰³ had a notably larger effect size compared to other studies, with the remaining studies displaying a wide range of effect sizes. The heterogeneity analysis showed a high level of variability, with an I^2 value of 90.36% and a Tau value of 0.653, indicating substantial heterogeneity ($p<0.0001$).

Synthesis of meta-analysis results

Sensitivity analysis confirmed that the pooled effect size (Hedges's g) was stable even after sequentially removing individual studies (Figure 4). The estimated pooled effect size for GD severity ranged -0.72 (95% CI, -1.05 to -0.39) to -0.96 (95% CI, -1.37 to -0.55) after excluding each study individually, with no significant changes in the overall effect size. Notably, even when the study by Ede et al.,¹⁰³ which had an outlier effect size, was excluded, the pooled effect size remained stable.

Publication bias

The funnel plot analysis revealed some asymmetry, suggesting potential publication bias (Figure 5). Most studies were clustered toward the top, indicating larger sample sizes; however, the study by Ede et al.¹⁰³ was outside the CIs, showing an outlier effect. Both Begg and Egger tests confirmed statistically significant publication bias (Begg, $p=0.043$; Egger, $p=0.002$; $SE=1.189$; intercept= -4.418).

The trim-and-fill method to adjust for publication bias showed a pooled effect size (Hedges's g) of -0.46 (95% CI, -0.55 to -0.37) before adjustment and -1.25 (95% CI, -1.17 to -0.90) post-adjustment, indicating a pronounced effect.

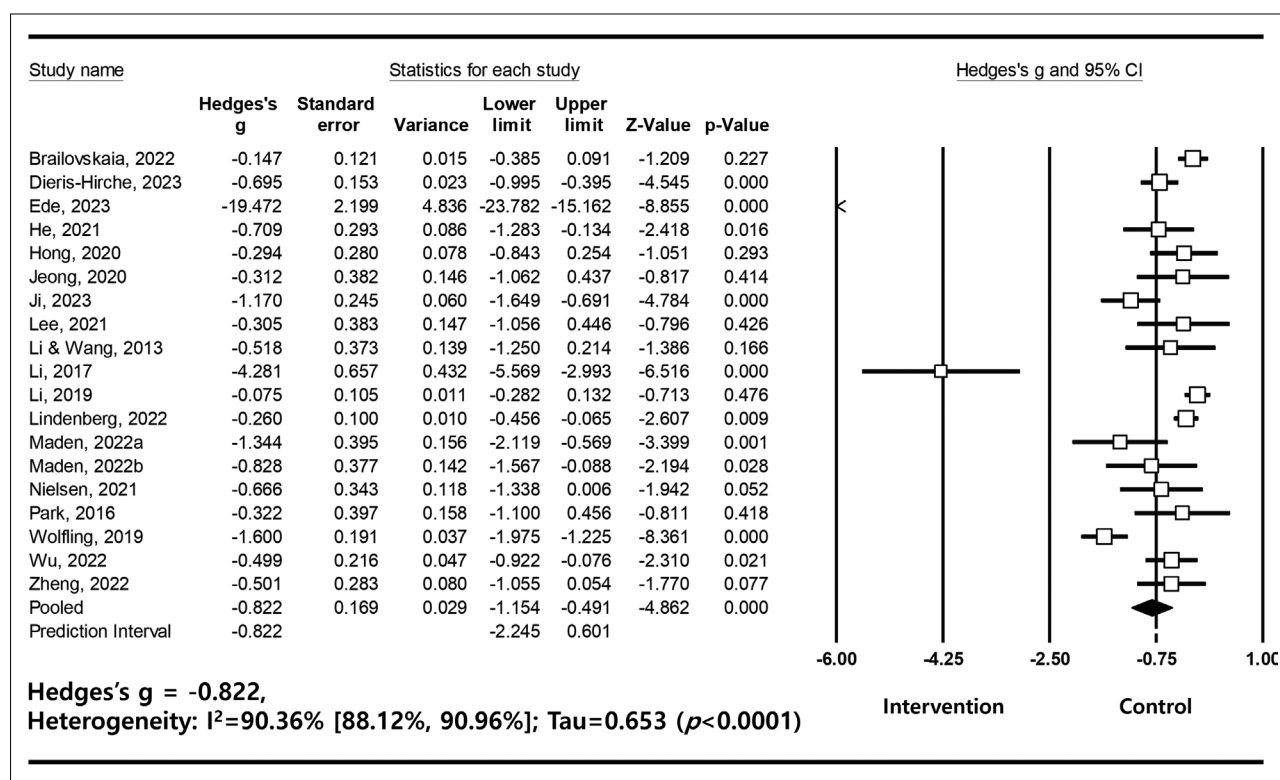


Figure 3. Forest plot showing effect sizes (Hedges's g) for non-pharmacological interventions on gaming disorder in 19 comparisons from 18 studies. Squares represent effect sizes with 95% CIs for individual studies, while diamonds indicate the pooled effect size. CI, confidence interval.

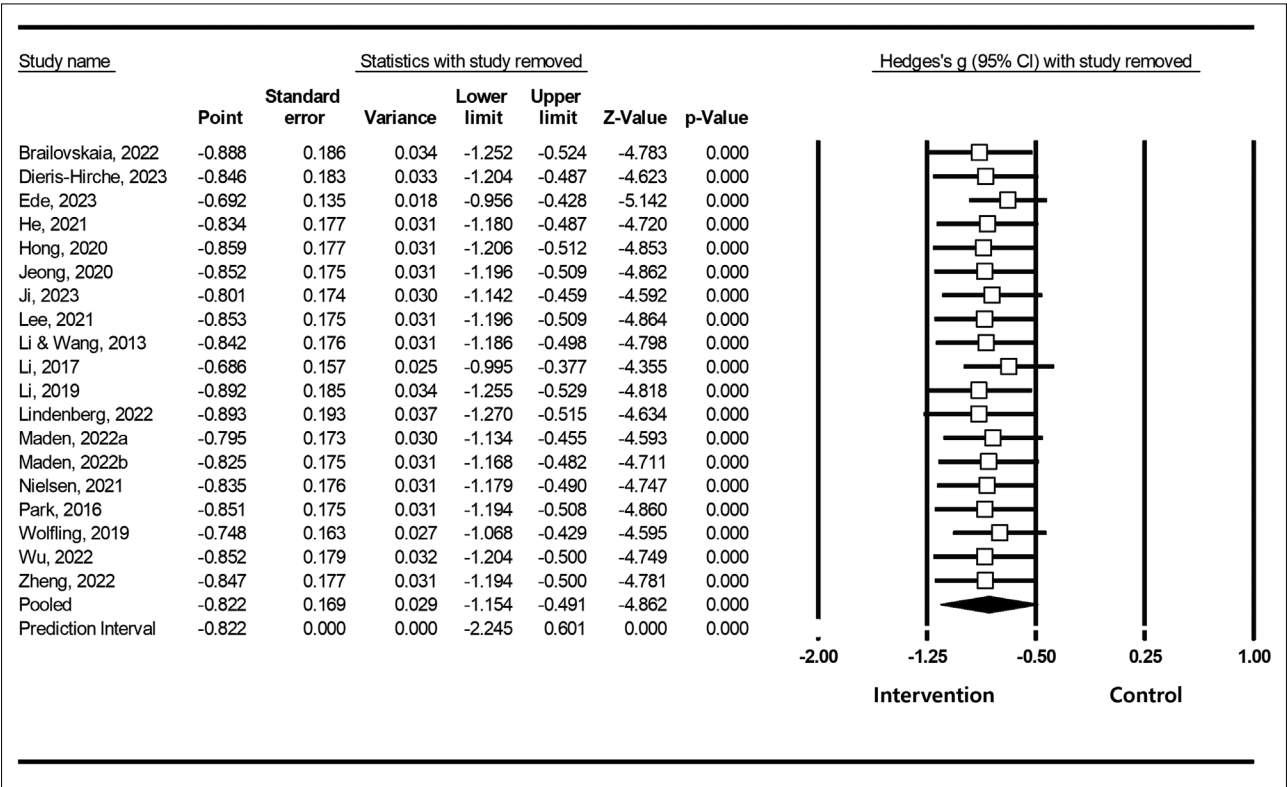


Figure 4. Sensitivity analysis assessing the effect on pooled effect size (Hedges's g) by removing each study sequentially. Squares show re-calculated effect sizes with 95% CIs after excluding one study at a time, while the diamond represents the overall pooled effect size, indicating stability across analyses. CI, confidence interval.

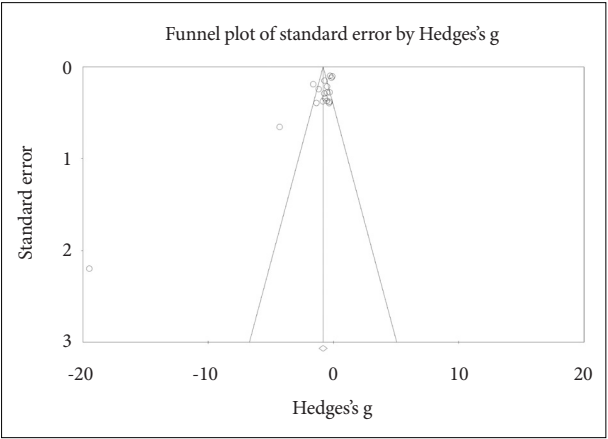


Figure 5. Funnel plot assessing publication bias in studies on the effect of non-pharmacological interventions on gaming disorder.

Subgroup analysis

Subgroup analyses evaluated the variation in the effectiveness of NPIs (Table 4). The mixed-effects model analysis revealed that psychotherapy had the most significant effect, with a Hedges's g of -1.34 (95% CI, -1.97 to -0.70), indicating a greater reduction in GD symptoms compared to behavioral interventions. In intervention goals, treatments were more effective than preventions, with a Hedges's g of -1.13 (95% CI, -1.67

to -0.59). Additionally, the adult group showed a stronger effect compared to the adolescent group (Hedges's g=-1.14 vs. -0.45). Notably, studies with a low risk of bias exhibited the most substantial effects (Hedges's g=-4.08).

DISCUSSION

This study conducted a systematic review and meta-analysis to evaluate the impact of NPIs on reducing GD. A total of 18 RCTs were analyzed, which demonstrated that NPIs significantly reduced GD symptoms compared to control groups (Hedges's g=-0.82; 95% CI, -1.23 to -0.52). Sensitivity analysis confirmed the robustness of the results, and publication bias assessments indicated that the effect sizes remained stable even after adjustment.

NPIs were effective in reducing GD in both adolescents and adults. In particular, this study demonstrated positive outcomes of psychosocial interventions such as CBT, multidimensional family therapy (MDFT), and virtual reality-based trainings (VRT). Sharma and Weinstein¹⁰⁴ reported that CBT is one of the most effective and well-established interventions for managing GD, while Stevens et al.¹⁸ confirmed through a meta-analysis that CBT significantly reduced IGD symptoms (Hedges's g=0.92; 95% CI, 0.50 to 1.34). Similarly, the me-

Table 4. Subgroup analyses of non-pharmacological interventions for the prevention and reduction of gaming disorder across various demographic and methodological factors (based on 19 comparative studies)

Measure	K	N	g	g [95% CI]	p	I ²	I ² [95% CI]	PI	Q	p sg
Intervention type										
Psychotherapy	10	1,036	-1.34	[-1.97, -0.70]	****	94.03	[90.43, 94.96]	[-3.60, 0.93]	7.36	*
Behavioral	4	456	-0.38	[-0.65, -0.12]	**	38.51	[37.19, 39.05]	[-1.31, 0.55]		
Other	5	473	-0.51	[-0.99, -0.03]	*	68.43	[66.34, 69.50]	[-2.09, 1.07]		
Intervention goal										
Prevention	6	1,164	-0.33	[-0.56, 0.10]	***	64.46	[63.46, 64.80]	[-1.00, 0.34]	7.13	**
Treatment	13	801	-1.13	[-1.67, -0.59]	****	90.82	[87.63, 91.75]	[-3.19, 0.93]		
Age group										
Adolescent	6	713	-0.45	[-0.75, -0.14]	**	73.48	[72.09, 73.97]	[-1.38, 0.49]	4.92	*
Adult	13	1,252	-1.14	[-1.68, -0.61]	****	92.13	[88.94, 93.03]	[-3.19, 0.90]		
Control type										
Active	7	586	-0.75	[-1.33, -0.18]	*	86.09	[83.41, 87.26]	[-2.68, 1.17]	0.13	-
Inactive/no intervention	12	1,379	-0.88	[-1.33, -0.45]	****	91.95	[89.43, 92.70]	[-2.52, 0.75]		
Outcome measure										
DSM-5	7	500	-1.04	[-1.66, -0.42]	**	87.37	[84.23, 88.45]	[-3.14, 1.07]	0.62	-
IAT	12	1,465	-0.73	[-1.16, -0.30]	**	92.10	[89.76, 92.97]	[-2.33, 0.86]		
Geographical region										
Asia	10	778	-0.47	[-0.73, -0.22]	****	56.52	[55.31, 56.78]	[-1.21, 0.26]	1.33	-
Europe	7	617	-0.76	[-1.18, -0.34]	****	89.05	[86.88, 89.70]	[-2.17, 0.65]		
RoB2										
Low	4	393	-4.08	[-5.91, -2.25]	****	97.18	[84.87, 101.33]	[-12.31, -4.15]	17.09	****
Some concerns	12	1,144	-0.52	[-0.72, -0.31]	****	55.92	[54.80, 56.87]	[-1.13, 0.95]		
High	3	428	-0.23	[-0.57, 0.11]		31.97	[28.48, 34.99]	[-3.48, 3.02]		

Subgroup analyses were conducted only when data from at least ten studies were available within the respective comparison. Subgroups with fewer than three studies were excluded from the analysis. * $p < 0.05$; ** $p < 0.01$; *** $p < 0.001$; **** $p < 0.0001$. g, Hedges's g effect size; CI, confidence interval; p, significance level; I², heterogeneity; PI, prediction interval; Q, Q-value for heterogeneity; p sg, subgroup significance p-value; DSM-5, Diagnostic and Statistical Manual of Mental Disorder, Fifth Edition; IAT, Internet Addiction Test

ta-analysis by Jiang et al.¹⁰⁵ demonstrated that both CBT and physical activity-based interventions are effective in reducing GD symptoms. These NPIs primarily focus on correcting distorted cognitions and negative behavioral patterns related to gaming, while promoting positive alternative behaviors, reaffirming their efficacy as viable treatment options for managing GD.

This study extends previous findings by systematically comparing the effectiveness of treatment- and prevention-focused NPIs, a distinction that was not explicitly examined in earlier reviews. The findings indicate that treatment-focused NPIs are significantly more effective than prevention-focused NPIs, suggesting that existing prevention strategies may require further refinement to enhance their impact. This distinction provides critical insights into the development of targeted interventions, as prevention-focused NPIs often involve school-based education or parental control programs, which may not adequately address gaming-related cognitive distortions and

behavioral reinforcements.

The subgroup analysis comparing the effectiveness of NPIs based on intervention goals showed that treatment interventions were significantly more effective than prevention interventions. Studies with a treatment focus primarily aimed at alleviating GD symptoms and reducing the negative impacts of excessive gaming. For instance, Nielsen et al.¹⁰⁰ highlighted an approach where the objective was not to completely eliminate gaming but to help adolescents reduce harmful effects and adopt healthier gaming habits. In contrast, prevention-focused studies primarily employed school-based programs and abstinence strategies to proactively manage gaming behavior. These prevention interventions mainly targeted at-risk youth, focusing on education and behavioral regulation to prevent GD development.

In the age group-based analysis, young adults showed a significantly greater reduction in GD symptoms through NPIs compared to adolescents (Hedges's $g = -1.14$ vs. -0.45). This find-

ing aligns with those of Stevens et al.,¹⁸ who reported higher effectiveness in adults. Adolescents often exhibit lower motivation to engage in treatment and a greater resistance to seek external help.¹⁰⁶ Many of them believe they do not have a problem or feel capable of managing it on their own, which limits their engagement in therapeutic interventions.¹⁰⁷ Additionally, the stigma associated with IGD may discourage adolescents from seeking help, thereby diminishing the effectiveness of interventions.¹⁸ Given these differences in treatment responsiveness, identifying intervention strategies tailored to specific populations is crucial.

To address these challenges, this study incorporated a detailed subgroup analysis based on age groups, intervention goals, and control types, providing a clearer understanding of which intervention strategies are most effective for different populations. Such stratified analyses were not extensively covered in prior reviews, making this study an important addition to the literature.^{26,27}

The analysis of various intervention types revealed that MDFT demonstrated particularly positive outcomes in adolescents. This approach, involving family members, facilitated improvements in perceptions and behaviors related to gaming and enhanced communication within the family, thereby fostering sustainable behavioral changes.^{108,109} These findings suggest that adolescents may show better treatment responsiveness when supported by their families. In contrast, digital detox and physical activity-based interventions exhibited relatively lower effectiveness. These approaches primarily focused on behavioral control but did not sufficiently address cognitive components, potentially limiting their impact on long-term changes.⁹³ However, VRT positively influenced engagement in real-life activities and reduced gaming behavior.¹¹⁰ Specifically, it was effective in decreasing gaming time and enhancing real-life social interactions among adolescents.⁹³ These results indicate that a multidimensional approach, which combines psychological and behavioral components, may lead to more substantial treatment outcomes in managing GD.

This study has several limitations. First, the heterogeneity among studies was notably high ($I^2=90.36\%$), which may be attributed to differences in intervention methods, sample characteristics, and assessment tools. Second, some studies exhibited a risk of bias, potentially lowering the reliability of the results due to uncertainties in the randomization process and deviations during intervention implementation. Notably, Li et al.⁹¹ and Park et al.⁹³ demonstrated a high risk of bias due to selective outcome reporting. Third, this study primarily assessed short-term effects, which limits the evaluation of the long-term sustainability of NPIs. Although some interventions, particularly psychotherapeutic approaches, demonstrate

promising results, more longitudinal studies are required to determine whether these effects persist over time.

Despite these limitations, this study synthesized findings from a total of 18 RCTs, demonstrating that NPIs have a significant effect in reducing GD. Sensitivity analysis indicated that the consistency of results was maintained even after the removal of specific studies, suggesting the robustness of the effects of NPIs. Importantly, the pooled intervention effects demonstrated the potential for application across diverse clinical settings. Furthermore, this study systematically compared the effects of NPIs among both adolescents and adults, and evaluated the impact of various intervention methods on reducing GD. By distinguishing between treatment- and prevention-focused NPIs, this study provides critical insights for tailoring interventions to specific populations. In particular, psychosocial interventions such as CBT, MDFT, and VRT were effective in reducing GD symptoms and improving treatment outcomes, highlighting their potential for future clinical applications.

Future research should focus on long-term follow-up to evaluate the sustained effects of NPIs and explore their applicability across diverse population. Additionally, the use of standardized assessment tools and consistent intervention protocols is necessary to reduce heterogeneity across studies and minimize bias. Large-scale, high-quality RCTs with pre-registered designs are needed to further validate these findings. Such efforts would facilitate the development of more effective strategies to reduce and prevent GD.

In conclusion, the findings highlight the promising effect of NPIs—particularly CBT-based interventions—in reducing GD symptoms. However, the current evidence is limited by the small number of high-quality studies available. To enhance the evidence base, future studies should prioritize well-designed, large-scale RCTs with pre-registered protocols, standardized outcome measures. Such efforts will be crucial in establishing robust, evidence-based treatment guidelines for GD.

Supplementary Materials

The Supplement is available with this article at <https://doi.org/10.30773/pi.2024.0358>.

Availability of Data and Material

The datasets analyzed in this study are available from the corresponding author upon reasonable request.

Conflicts of Interest

The authors have no potential conflicts of interest to disclose.

Author Contributions

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