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REVIEW

A Bibliometric Study of the Evidence About Applying Virtual Reality in Mental Health Care

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Background: Virtual reality (VR) technology has gained much traction related to mental health owing to its interactive features and immersive nature. A systematic bibliometric evaluation is necessary to guide researchers in identifying emerging trends and research priorities in VR technology applications for mental health, highlighting evolving challenges and research needs.

Objective: This study aimed to analyze the bibliometric characteristics and scope of evidence on the application of virtual reality in mental health care, synthesizing findings and exploring potential innovations.

Methods: We conducted a bibliometric analysis using CiteSpace to examine 1333 articles from the Web of Science Core Collection (from January 1, 1999, to February 14, 2025), retrieved via the search query TS=("Mental health" AND "Virtual reality"). The study mapped key research trends, including international and institutional collaboration networks, author co-citation networks, and the evolution of keyword co-occurrence to identify influential contributors, thematic clusters, and emerging developments in VR-based mental health research.

Results: The analysis revealed three key findings: (1) Exponential publication growth starting in 2020 with over 110 annual publications; (2) Robust collaboration networks featuring 3587 authors with Riva, G. as a central figure and the University of London as the most prominent institutional hub; (3) Virtual reality, exposure therapy, skin conductance, mild cognitive impairment, psychosis, augmented reality, and serious game are the main research clusters. Emergent word analysis of keywords from 2014 to early 2025 yielded 34 words/terms with the strongest citation bursts.

Conclusion: This study demonstrates VR's integration with traditional therapy and its expanding role in treating diverse mental health conditions, from anxiety to schizophrenia. Future research should focus on standardizing treatments and validating their efficacy.

Keywords: virtual reality, mental health, bibliometrics, CiteSpace

Introduction

The accelerated development of virtual reality (VR) technology has garnered increasing attention in academic research and clinical practice due to its applications in mental health.[1] By simulating immersive environments, VR offers unique therapeutic experiences, demonstrating substantial potential in treating mental disorders such as posttraumatic stress disorder (PTSD), anxiety, and depression.[2–5] Accumulating empirical evidence suggests that VR serves as an effective psychological intervention, enhancing emotional processing by providing realistic, controlled exposure to triggering scenarios under controlled conditions.[6,7]

However, despite notable progress in VR-based mental health applications, systematic evaluations of outcomes and comprehensive reviews of evidence remain relatively scarce. Given the interdisciplinary nature of VR research, which spans psychology, medicine, and technology, the literature is vast and fragmented. Consequently, synthesizing the current state of research and identifying emerging trends has become a critical task for the scientific community.

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To address this gap, bibliometrics—a quantitative method for analyzing scholarly literature—involve a systematic approach to uncovering temporal trends, research hotspots, and knowledge networks within a given field.[8] Our research uses CiteSpace, a bibliometric analysis tool, to examine VR applications in mental health. CiteSpace, developed by Dr. Chaomei Chen's research team, is a Java-based information visualization software designed to analyze and map the structural dynamics and emerging trends within scientific knowledge domains. This tool facilitates the identification of research hotspots, intellectual turning points, pivotal literature, and influential authors or institutions, thereby enabling the prediction of future disciplinary trajectories. By capitalizing on temporal analysis, co-word analysis, and co-citation analysis, CiteSpace enables the extraction of pivotal knowledge nodes, developmental trajectories, and conceptual frameworks within the field.[9] This approach offers researchers a comprehensive perspective on current advancements and future directions. Beyond mapping core contributors, seminal publications, and leading journals, bibliometric analysis can reveal underexplored research gaps and emerging frontiers. These insights inform theoretical frameworks and methodological strategies for future studies. This study, therefore, aimed to analyze the bibliometric characteristics and scope of the evidence on applying virtual reality to mental health care, synthesizing findings and exploring potential innovation.

Methods

We developed a comprehensive search strategy using the advanced retrieval function in the Web of Science (WOS) Core Collection. The search query (TS = ("Mental health") AND TS = ("Virtual reality")) was applied, with a publication timeframe spanning from January 1, 1999, to February 14, 2025. Document types were limited to articles and reviews, yielding 1398 initial publications. After screening titles and abstracts—and reviewing full texts when necessary—we excluded conference proceedings, editorial materials, irrelevant topics, and duplicate records. The final dataset comprised 1333 peer-reviewed publications, containing 985 articles and 348 reviews (Figure 1). This study analyzed Web of Science (WoS) data with a temporal range from January 1, 1999, to February 14, 2025, segmented into annual intervals. Employing the Top N per slice strategy (selecting the 50 most frequently cited publications within each time slice), we examined literature distribution patterns, international and institutional collaboration networks, author co-citation networks, and keyword co-occurrence evolution.

Within CiteSpace-generated visualizations, "Top N" identifies nodes appearing with a frequency equal to or greater than N each year. The Pathfinder algorithm eliminates redundant network edges, providing more precise and concise knowledge maps. Cluster analysis identifies core themes within disciplines, while burst keyword analysis highlights emerging research fronts within specific periods. Burst keywords are identified using Kleinberg's burst detection algorithm within CiteSpace, which detects significant increases in term frequency based on the rate of change over time, typically indicating emerging trends, hotspots, or major research breakthroughs. In the CiteSpace-generated knowledge maps, N denotes the number of nodes, and E denotes connections among nodes. Network density represents the ratio of actual links to possible links in the undirected graph (calculated as $2L/[N(N-1)]$), and centrality metrics (degree, betweenness) are unitless, standardized measures reflecting node importance within the network topology. Density measures network compactness, and Centrality reflects a node's importance and interconnectedness within the knowledge map, such as for countries, authors, institutions, or keywords. The quality of clustering is assessed using Modularity Q (Q-value) and Silhouette (S-value), with Q-values greater than 0.3 indicating significant cluster structures and S-values greater than 0.5 signifying robust clustering with high homogeneity. Citation rings illustrate the relative influence of corresponding nodes, with node frequency and line thickness representing the strength of co-occurrence relationships.[10–12]

Results

The annual publication trends in this field showed a clear growth trajectory for VR and mental health research (Figure 2). During the initial exploratory phase (pre-2010), publication output remained relatively low, indicating the field's nascent stage of development. However, beginning in 2015, coinciding with rapid technological advancements and increasing maturity of VR applications, publication volumes exhibited slight growth. This upward trend became particularly pronounced from 2020, and output continues to rise, reflecting VR's emergence as a research hotspot in mental health

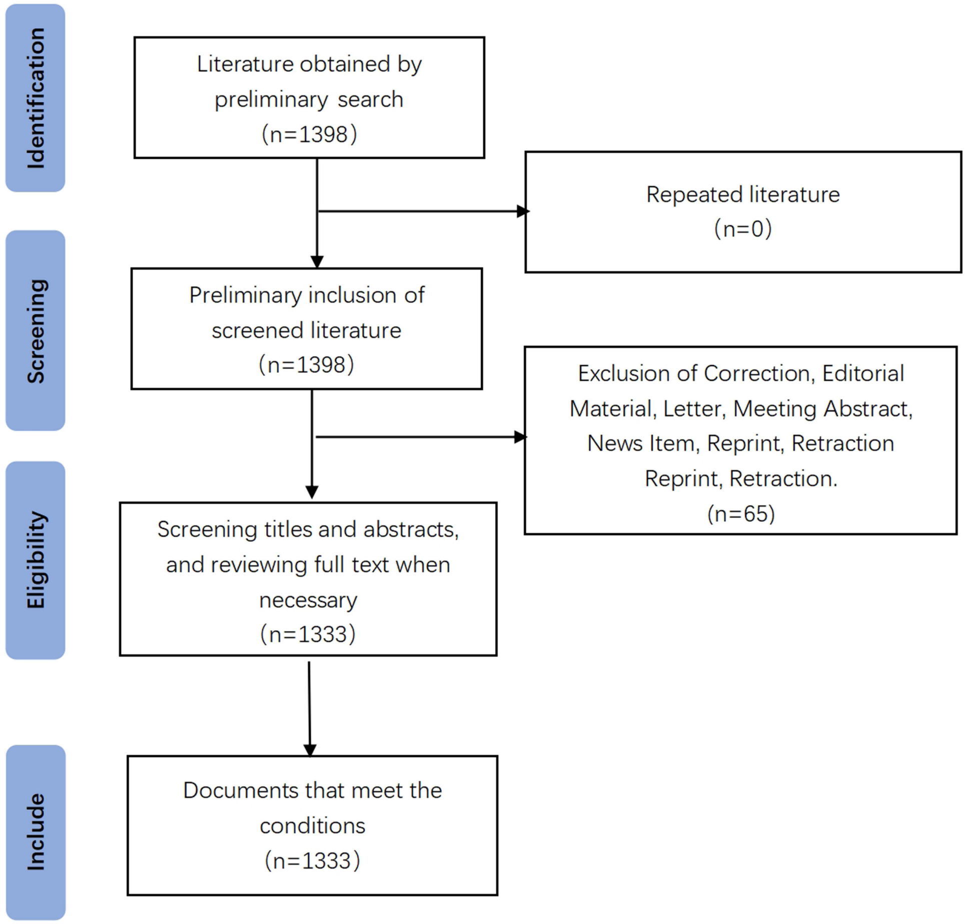

Figure 1 Flowchart of literature search for the application of VR in mental health care.

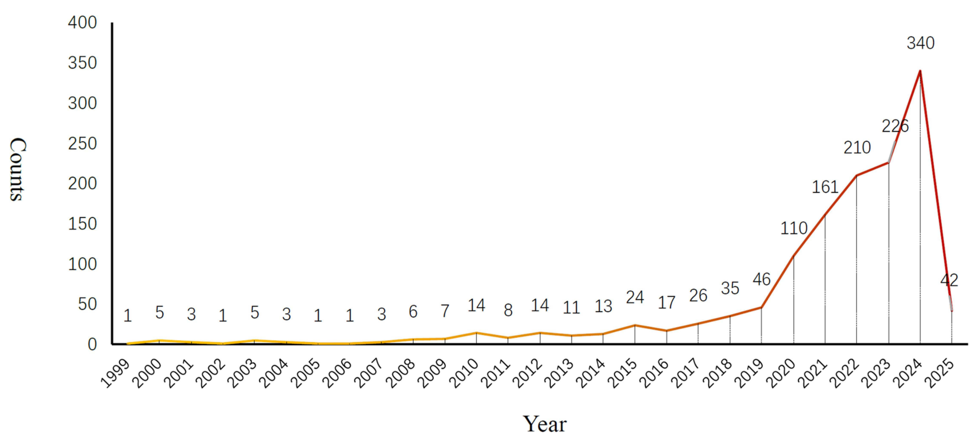

Figure 2 Analysis of annual publications about the application of VR in mental health care.

applications. This growth pattern may be associated with several factors, including the increasing accessibility of VR technology, reduced implementation costs, and demonstrated potential in mental health treatment. Current publication trends suggest sustained growth in this research domain, which is expected to drive further innovative studies and clinical applications. The author collaboration network was generated using co-authors as nodes, with the following parameters: Top N = 50 per time slice, timespan = 1999–2025, Pathfinder pruning algorithm, and keyword-based clustering. The resulting network (Figure 3) comprises 3587 nodes and 9439 links, with a density of 0.0015, demonstrating excellent structural properties (Q = 0.9831, S = 0.9886). In the visualization, yellow-background labels indicate primary research directions of author clusters, while white-background labels identify individual researchers. In recent years, multiple interconnected research themes have emerged, including self-guided interventions, mindfulness, cognitive therapy, psychological well-being, and psychoeducation, which have become predominant research directions (Figure 3). The network structure shows strong interdisciplinary connections among these themes, with researchers maintaining active collaborations within their respective domains. The most prolific authors were Riva, Giuseppe (22 publications), Wiederhold, Brenda K (12 publications), Valmaggia, Lucia (11 publications), Reger, Greg M (10 publications), and Riches, Simon (10 publications). The top five authors by Centrality were 0, which indicates that the influence of these authors in the author collaboration network is not significant enough, and there is still room for improvement.

The institutional collaboration network was constructed to examine cooperative patterns among research organizations in the VR and mental health field, using co-institutions as nodes with parameters set to Top N=50 per time slice (1999–2025), Pathfinder pruning algorithm, and keyword-based clustering. The resulting network (Figure 4) comprises 600 nodes and 1737 links with a density of 0.0097, revealing intensive interdisciplinary collaboration among leading institutions, including Harvard University, Oxford University, and the University of California system. These cooperative relationships have significantly advanced the application of VR in mental health. Analysis of publication output identifies the University of London (51 publications), King's College London (36), Catholic University of the Sacred Heart (33), Harvard University (27), and IRCCS Istituto Auxologico Italiano (26) as the most productive institutions. At the same time, centrality metrics highlight Veterans Health Administration (0.14), South London & Maudsley NHS Trust (0.09),

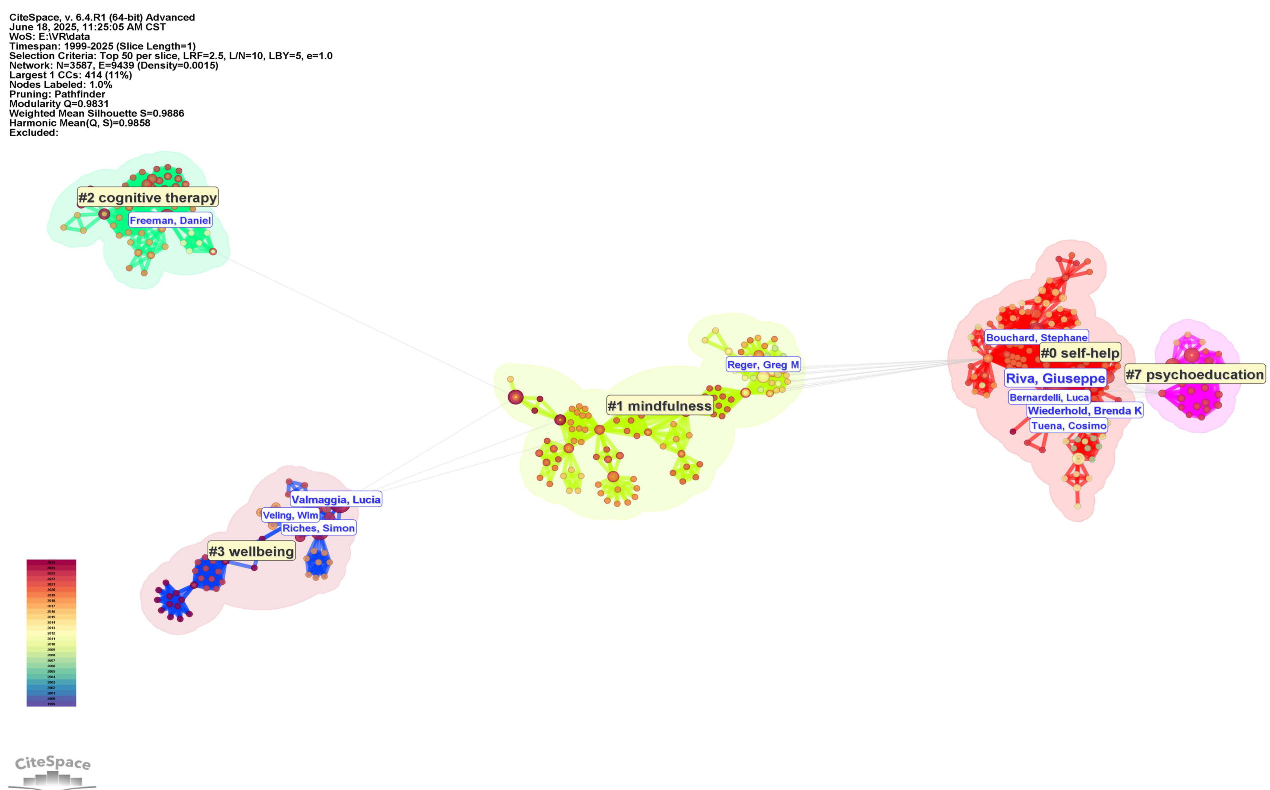

Figure 3 Author co-occurrence and keyword clustering analysis of publications about the application of VR in mental health care.

Notes: This figue is a keywords clustering map of author collaboration generated by CiteSpace, Visualizing the researh hotspots of author collaboration from 1999 to 2025. Each node represents an author; The size of a node reflects the level of its occurrence. The links between nodes represent co-citation or co-occurrence relationships. Clusters are labeled (eg. #0 self-+help, #1 mindfulness) and represent major research themes. The colors of the links and nodes reflect the pubication year (see the color bar in the lower left part of the figure). For example, larger nodes like Riva, Giuseppe indicate authors with high publication volume. This map helps determine the main research directions that authors collaborate on.

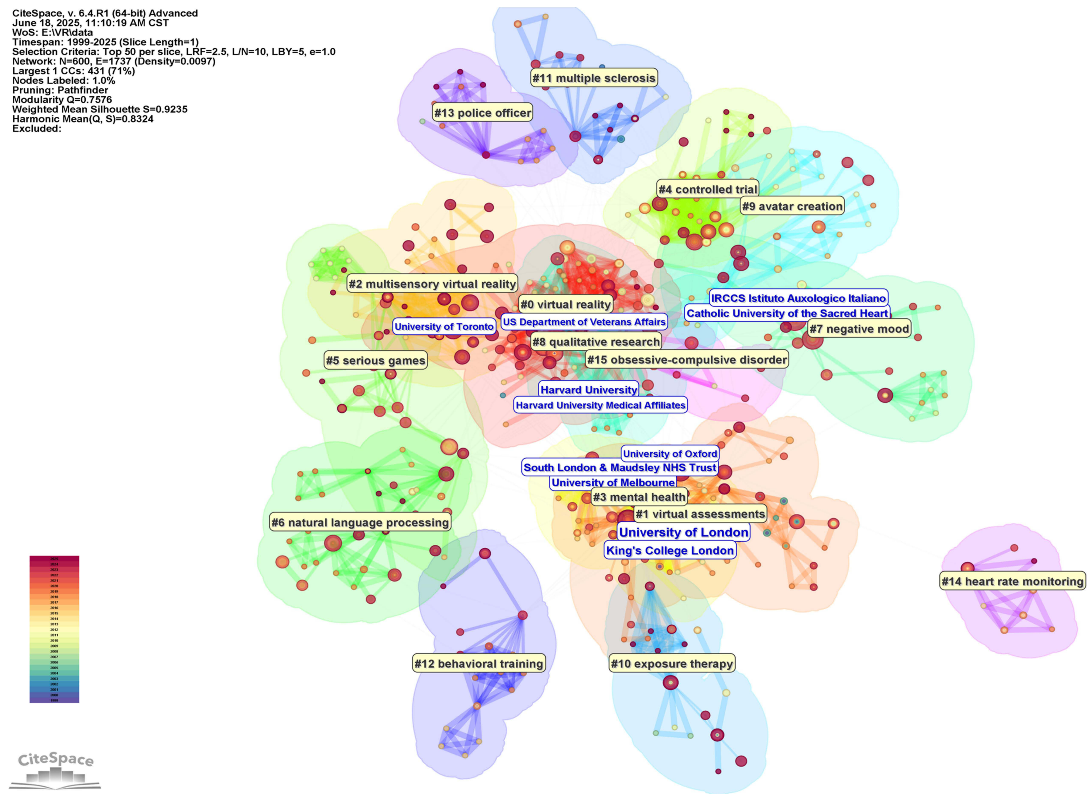

Figure 4 Institutional co-occurrence and keyword clustering analysis of publications about the application of VR in mental health care.

Notes: This figue is a keywords clustering map of author collaboration generated by CiteSpace, Visualizing the researh hotspots of Institutional collaboration from 1999 to 2025. Each node represents an institution; The size of the node reflects the number of mechanisms that appear. The links between nodes represent co-citation or co-occurrence relationships. Clusters are labeled (eg. #0 Virtual reality, #1 Virtual assessments) and represent major research themes. The colors of the links and nodes reflect the pubication year (see the color bar in the lower left part of the figure). This map is helpful for determinins the main research directions of institutional cooperation.

US Department of Veterans Affairs (0.09), KU Leuven (0.09), and University of California System (0.08) as the most influential network hubs facilitating cross-institutional knowledge exchange.

Keyword co-occurrence analysis was conducted to identify research hotspots using CiteSpace, with parameters set to cooperatively cited references as nodes, Top N = 50 (2014–2025), and the MST pruning method. The generated network (Figure 5) contains 992 nodes and 1240 links (density = 0.0025), exhibiting a radial diffusion pattern from central concepts, which indicates thematic diversification around core research areas. The highest frequency keywords include "virtual reality" (734 occurrences), "mental health" (408), "anxiety" (136), and "depression" (120), while the most central terms are "health" (0.16 centrality), "program" (0.13), and "symptoms" (0.12). Cluster analysis (Figure 6, Table 1) reveals 19 significant thematic clusters (Q=0.7746, S=0.8548), comprising #0 virtual reality,#1 exposure therapy,#2 skin conductance,#3 life quality,#4 mild cognitive impairment (MCI),#5 psychosis,#6 systematic review,#7 setting,#8 augmented reality,#9 serious game,#10 serious games,#11 Parkinson disease,#12 international assignees,#13 MCI, #14 video game,#15 voice simulations, #16 community-based participatory research, #17 functional assessment, #18 reality exposure therapy, with color-coding indicating temporal development patterns.

In addition, emergent word analysis of keywords from 2014 to early 2025 yielded 34 words/terms with the strongest citation bursts (Figure 7). They are reality exposure therapy, post-traumatic stress disorder, video game, posttraumatic stress disorder, cognitive behavior therapy, video games, internet, mental disorders, individuals, responses, adolescents, anxiety disorders, disorders, rehabilitation, quality of life, balance, care, virtual reality exposure, fear, scale, emotion regulation, education, students, program, stress, meta-analysis, psychotherapy, artificial intelligence, validity, digital health, validation, impact, augmented reality, recovery. In Figure 7, the red band specifically indicates the active peak period (emergent period) of this keyword. "Strength" indicates the intensity or severity of the keyword "sudden

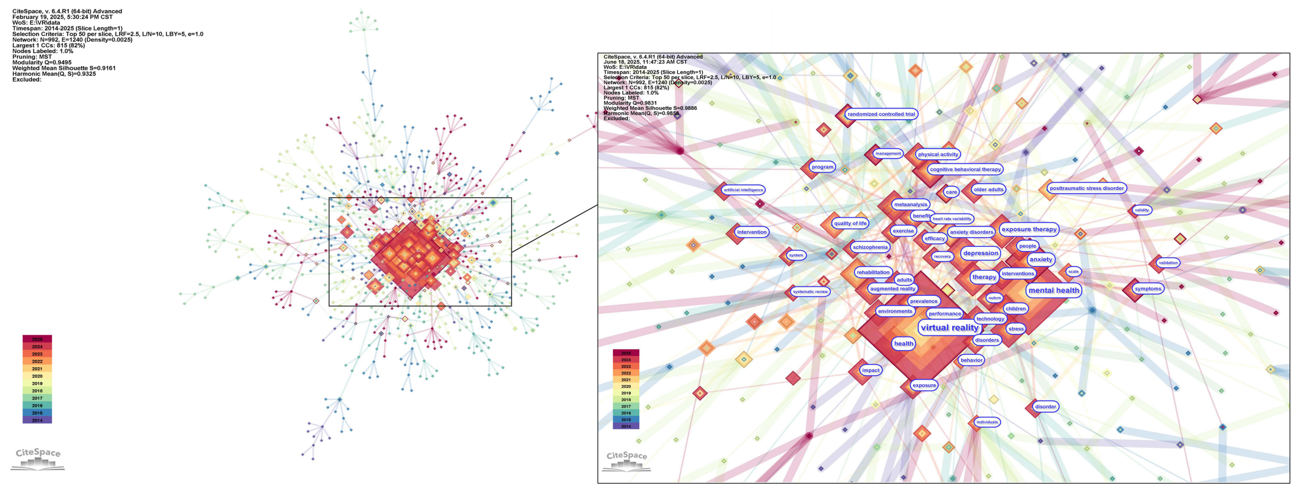

Figure 5 Keyword co-occurrence knowledge map of publications about the application of VR in mental health care.

Notes: This figure is the keyword co-occurrence map generated by CiteSpace, visualizing the co-occurrenceof keywords from 2014 to 2025. Each node represents a keyword; The size of the node reflects the quantity of keywords that appear. The links between nodes represent co-citation or co-occurrence relationships.The colors of links and nodes reflect the temporal disribution of keywords (see the color bar in the lower left part of the figure). This map is helpful for determining the main keywords and the connections among them.

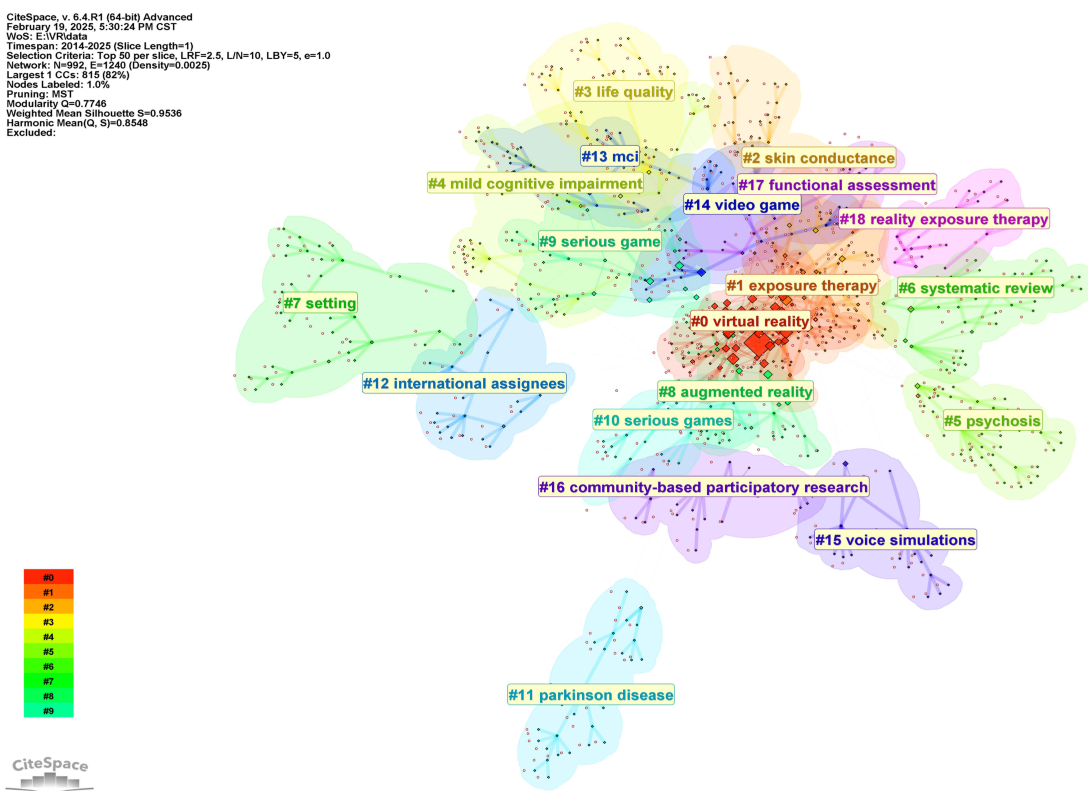

Figure 6 Keyword clustering analysis of publications about the application of VR in mental health care.

Notes: This figure is the keyword clustering knowledge graph generated by CiteSpace based on Figure 5, visualizing the keyword clustering situation from 2014 to 2025. Each text represents the main name afer keyword clusterin. For example, The name of the #0 cluster is virtual reality. The color bar graph in the lower left corner shows the corresponding colors of the fonts in some clustered literature. This graph is helpful fo determining the research hotsports during this period.

Table 1 Keywords Clustering Details

Number	Frequency	Silhouette	Year	Top Terms (LSI)	Top Terms (Log-Likelihood Ratio, p-level)
0	76	0.779	2016	Virtual reality; computer game; structural imaging; intellectual disability; pain management | mental health; virtual reality exposure therapy; elderly population; internet-based intervention; cohort study	Virtual reality (45.78, 1.0E-4); mental health (30.06, 1.0E-4); well-being (18.59, 1.0E-4); physical activity (15.32, 1.0E-4); depression (14.81, 0.001)
1	74	0.909	2017	Virtual reality; cognitive processing; smartphone; social phobia; head-mounted display | mental health; cognitive processing; smartphone; social phobia; head-mounted display	Exposure therapy (23.57, 1.0E-4); telemedicine (20.44, 1.0E-4); anxiety disorders (12.9, 0.001); ptsd (11.95, 0.001); augmented reality (11.26, 0.001)
2	52	0.981	2017	Virtual reality; cognitive behavioral therapy; emotion regulation; inuit health; controlled trial | skin conductance; anxiety disorders; e-mental health; augmented reality exposure therapy; mixed reality	Skin conductance (12.11, 0.001); design characteristics (6.72, 0.01); inuit health (6.72, 0.01); hospital indoor restoration scale (6.72, 0.01); autonomic reactivity (6.72, 0.01)
3	46	0.978	2018	Virtual reality; life quality; green space; elderly care; clinical use | stress reduction; forest exposure; forest health benefits; preventive health care; german-speaking countries	Life quality (18.25, 1.0E-4); openness to experience (9.09, 0.005); psychological cognition (9.09, 0.005); high school students (9.09, 0.005); expertise (9.09, 0.005)
4	43	0.957	2018	Virtual reality; digital health; wearable devices; anxiety management; controlled trial | mild cognitive impairment; ambient intelligence; elderly population; addictive medicine; ecological momentary assessment	Mild cognitive impairment (13.26, 0.001); wearable devices (10.49, 0.005); simulator sickness (7.11, 0.01); surgery (7.11, 0.01); carinae (7.11, 0.01)
5	40	0.985	2017	Virtual reality; mental health; systematic review; high risk; mental state | schizophrenia spectrum; social phobia; other psychotic disorder; online psychosocial interventions; social anxiety	Psychosis (15.23, 1.0E-4); neuropsychology (10.27, 0.005); paranoia (10.27, 0.005); hallucinations (7.85, 0.01); stress sensitivity (7.85, 0.01)
6	38	0.98	2017	Virtual reality; systematic review; mental health; support group; surgical unit | mobile phone; severe mental disorders; environmental simulations; restorative environments; green space	systematic review (22.08, 1.0E-4); chronic illness (8.2, 0.005); aged (7.08, 0.01); major depression (6.79, 0.01); pediatric cancer (6.79, 0.01)
7	36	0.974	2016	Self-help programs; virtual reality therapy; e-mental health; internet-based psychotherapy; posttraumatic stress disorder | virtual reality; interior design; drug addiction; cue reactivity; family intervention	Setting (10.22, 0.005); family intervention (10.22, 0.005); relatives (10.22, 0.005); drug addiction (10.22, 0.005); cue reactivity (10.22, 0.005)
8	34	0.975	2020	Virtual reality; augmented reality; mental health; mixed reality; young adults | artificial intelligence; digital phenotyping; digital psychiatry; smartphone applications; sentiment analysis	Augmented reality (50.16, 1.0E-4); artificial intelligence (23.67, 1.0E-4); extended reality (19.65, 1.0E-4); mixed reality (17.1, 1.0E-4); metaverse (10.9, 0.001)
9	30	0.95	2017	Virtual reality; mental health; psychological well-being; immersive virtual reality; neurological disorder | serious game; stress reduction; diaphragmatic breathing; respiratory biofeedback; eye movement	Serious game (19.78, 1.0E-4); machine learning (16.4, 1.0E-4); eye movement desensitization (11.01, 0.001); placebo controlled trial (11.01, 0.001); virtual reality exposure (8.94, 0.005)
11	28	0.976	2014	Exercise therapy; parkinson disease; complementary therapies; computer interfaces; patient rehabilitation | computer interfaces; patient rehabilitation; parkinson disease; complementary therapies; exercise therapy	Parkinson disease (12.31, 0.001); exercise therapy (12.31, 0.001); engineering in medicine and biology (12.31, 0.001); computer interfaces (12.31, 0.001); patient rehabilitation (12.31, 0.001)
10	28	0.975	2016	Serious games; mental health; multimodal interaction; extended reality; mixed reality | virtual reality; human factors; psychological disorders; virtual environment design; user comfort	Serious games (19.49, 1.0E-4); aided vicarious exposure (7.57, 0.01); natural environment (7.57, 0.01); virtual environment design (7.57, 0.01); weight regulation intention (7.57, 0.01)
12	27	0.992	2018	Virtual reality; post-traumatic stress disorder; international assignees; hostile environments; schizophrenia spectrum disorder | schizophrenia spectrum disorder; differential diagnostics; emotion processing; galvanic skin response; borderline personality disorder	International assignees (9.66, 0.005); repatriates (9.66, 0.005); emotion processing (9.66, 0.005); hostile environments coping (9.66, 0.005); expatriates (9.66, 0.005)
13	26	0.994	2018	Cognitive impairment; executive function; alzheimers disease | alzheimers disease; cognitive impairment; executive function	Mci (10.85, 0.001); cognitive (10.85, 0.001); neuropsychological (10.85, 0.001); alzheimers disease (8.09, 0.005); dance (7.05, 0.01)
14	25	0.976	2017	Virtual reality; executive function; physical activity; psychological distress; immersive experiences | mental health; cognitive therapy; occupational stress injury; psychiatric rehabilitation technicians; psychological distress	Video game (17.37, 1.0E-4); trauma (14.07, 0.001); executive function (8.64, 0.005); immersive experiences (7.02, 0.01); forensic psychiatry (7.02, 0.01)
15	24	0.987	2019	Virtual reality; standardised patients; simulation-based training; mental health education; psychiatric nursing education | socio-environmental factors; high-risk states; network models; genetic risk; psychotic experiences	Voice simulations (8.42, 0.005); college student (8.42, 0.005); immersive technology (8.42, 0.005); video gaming (8.42, 0.005); osce (8.42, 0.005)
17	23	0.976	2017	Mental rehearsal; skills acquisition; surgical education; procedural training; technical skills | mental health; performance assessment; functional assessment; occupational therapy; cognitive frailty	Functional assessment (10.71, 0.005); procedural training (10.71, 0.005); skills acquisition (10.71, 0.005); surgical education (10.71, 0.005); mental rehearsal (10.71, 0.005)
16	23	0.942	2019	Human-computer interaction; virtual reality; computer-mediated communication; e-mental health; digital mental health | support group; spousal loss; virtual world; human-computer interaction; virtual reality	community-based participatory research (10.22, 0.005); patient-centered care (10.22, 0.005); endocrinology (10.22, 0.005); diabetes (10.22, 0.005); qualitative (10.22, 0.005)
18	22	0.976	2016	Virtual reality; flying phobia; controlled trial; internet-based exposure; computerized cbt | human factors; psychological disorders; serious games; self help; virtual reality	Reality exposure therapy (9.29, 0.005); self help (9.29, 0.005); e-therapy (9.29, 0.005); engagement (9.29, 0.005); computer games (9.29, 0.005)

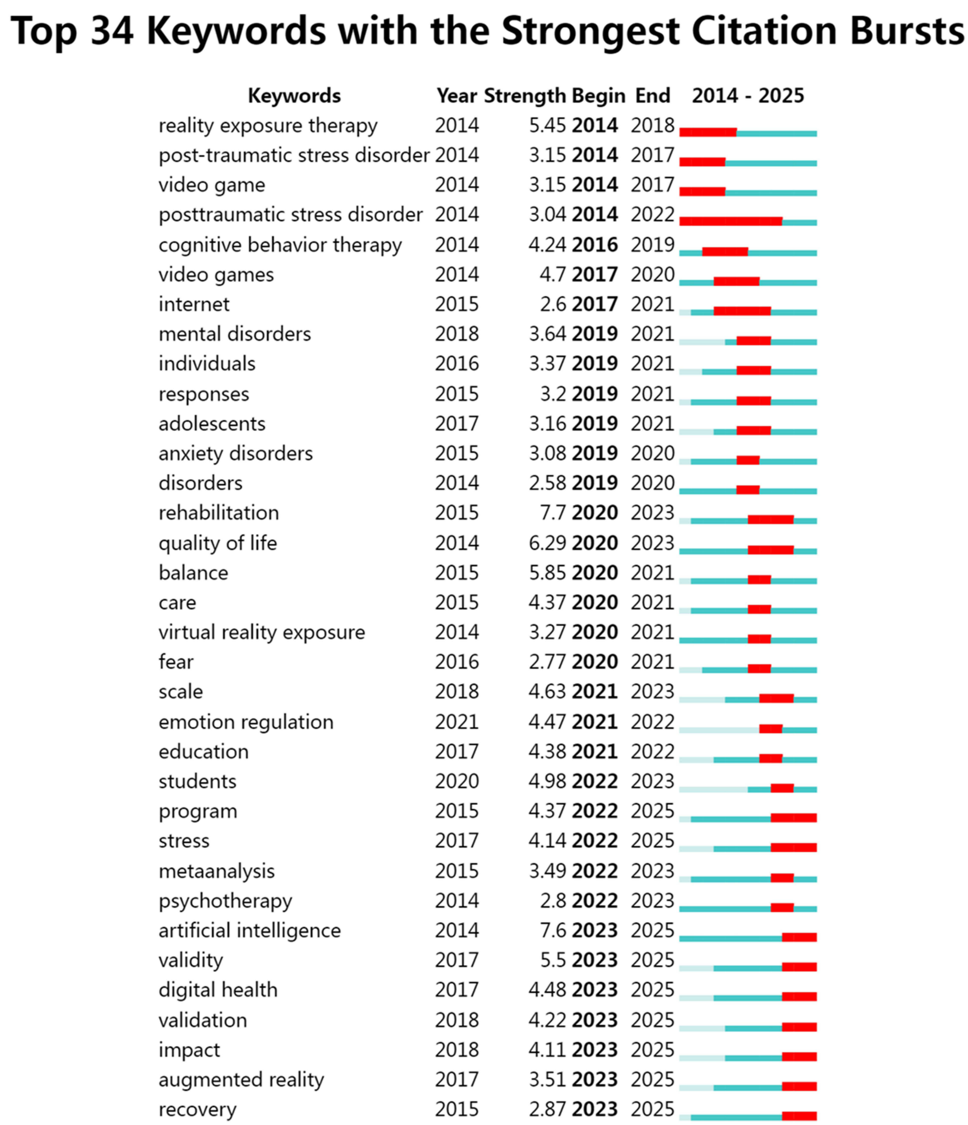

Figure 7 Analysis of keyword emergent words of publications about the application of VR in mental health care.

appearance". It quantifies the extent to which the frequency of the keyword's appearance in the literature suddenly increases within a specific period. "Begin" indicates the year when the "emergent" phenomenon of this keyword began to be detected, and "End" indicates the year when the "emergent" phenomenon of this keyword ended.

Discussion

General Data

A bibliometric analysis of the 1333 SCIE (Science Citation Index Expanded) papers published from 1999 to February 2025 about applying VR in mental health care showed a marked increase in output from 2020, reflecting growing academic and clinical interest in its therapeutic potential. Riva is the most prolific author in this domain, whose work has substantially advanced the application of VR in treating eating disorders, anxiety, stress, and broader psychotherapeutic intervention.[13,14] Her contributions underscore VR's versatility in addressing diverse mental health conditions through immersive technology.

The University of London is the most productive affiliation at the institutional level. Its research integrates VR with established psychological therapies, such as exposure therapy, cognitive behavioral therapy (CBT), and mindfulness therapy. This interdisciplinary approach highlights the institution's role in bridging cutting-edge technology with conventional treatment modalities to enhance efficacy across multiple psychiatric disorders.

Notably, the Veterans Health Administration (VHA) ranks first in Centrality, indicating its pivotal position in collaborative networks. VHA has pioneered the use of VR for mental health care, expanding from 5 pilot sites to 172 locations with over 2400 trained providers. Key applications include PTSD exposure therapy, anxiety/depression management, and chronic pain relief. VR enhances accessibility, particularly for rural veterans, and has demonstrated high patient and provider satisfaction.

The Knowledge Base and Current Research Characteristics

The bibliometric analysis of VR applications in mental health reveals a rapidly evolving research landscape characterized by diverse thematic clusters. The synthesized data underscore VR's versatility as both an adjunct to traditional psychotherapies and a standalone intervention, with substantial implications for mental health practice and research. Below, we contextualize these findings within the broader literature and highlight critical trends, gaps, and future directions.

A prominent research cluster focuses on VR exposure therapy. VR exposure therapy facilitates the development of adaptive responses and coping strategies in patients, demonstrating efficacy in treating anxiety disorders[15,16] and various specific phobias,[3] including acrophobia,[17] driving phobia,[18] and agoraphobia.[16] For patients with PTSD, like military veterans from the Iraq wars or assault victims, VR exposure therapy provides aided vicarious exposure related to their specific traumas, allows individuals to confront and process their traumatic memories gradually, and reduces PTSD-related depression and suicidal ideation.[19–21]

In the "psychosis" cluster, VR-CBT, which integrates VR and cognitive behavior therapy, is effective in the treatment of schizophrenia-related persecutory delusions[22,23] and paranoid thinking patterns.[24,25] The application of VR-CBT is also practical in supporting the treatment of mood disorders like anxiety, depression, and bipolar disorder widely,[26] targeting and modifying maladaptive thoughts and beliefs. Moreover, several VR interventions are applied to schizophrenia. VR training promotes psychosocial function and job interview skills,[27] and auditory verbal hallucinations have been shown to significantly improve through VR Avatar therapy.[28]

Another prominent research cluster is virtual reality cue exposure therapy (VR-CET).[29] This intervention has demonstrated varying efficacy levels in treating substance use disorders or addictive behaviors,[30] primarily targeting relapse prevention, craving reduction, and skills acquisition. VR-CET operates by putting individuals into simulated environments containing craving-inducing cues associated with drug addiction, alcohol abuse, or gambling. Within these controlled settings, participants can practice coping strategies, enhance craving resistance, and develop relapse prevention techniques based on their cue reactivity profiles.[26] The application of VR has similarly extended to eating disorder treatment. Early adoption stemmed from VR's capacity to elicit food cravings in simulated environments, with VR-CBT reducing craving intensity and improving body image perception.[31,32] Subsequent research revealed that patients with feeding and eating disorders can develop body ownership illusions in virtual environments. This embodied VR approach enables manipulation of both the virtual environment and the virtual body, potentially enhancing treatment outcomes for body image disturbances, anorexia nervosa, and bulimia nervosa.[33]

Skin conductance is a special cluster. It is primarily used to assess the user's emotional arousal and stress response level and is a critical indicator of psychological and physiological relaxation.[34,35] The natural environment in VR is usually applied with interventions like mindfulness or meditation, and the effects are commonly assessed by skin conduction. Settings in VR, such as forests, grasslands, caves, and the sea, are important elements in VR-based mindfulness training.[36] This intervention demonstrates multifaceted benefits, including reduced anxiety and depressive symptoms, enhanced sleep quality, and improved mood states.

Furthermore, it effectively facilitates the development of comprehensive cognitive, emotional, and behavioral self-regulation competencies. These combined effects increase psychological need satisfaction.[34] Similarly, VR meditation and relaxation are promising for stress reduction and emotional regulation.[37]

VR's efficacy in neurodevelopmental disorders is a crucial area of research. By simulating social scenarios, VR has been shown to significantly improve executive function, cognition, attention, memory, and task switching in children with ADHD.[38] It also enhanced social-emotional functioning, daily functioning, and stress reduction.[39,40] For ASD, VR aids in emotion regulation and executive function training.[41,42]

For the cluster "MCI", studies indicate that the use of VR in screening for mild cognitive impairment (MCI) is promising, and VR training is an effective treatment for enhancing psychological cognition in individuals with MCI or Alzheimer's disease.[43] Older adults with MCI and their families who participated in the VR sessions reported improved psychological and relational well-being, with greater improvements in quality of life.

In the "Parkinson's disease" cluster, VR training significantly improved physical functioning, stability control, motor coordination, cognitive performance, and psychological well-being while enhancing overall quality of life. These comprehensive benefits suggest its potential for incorporation into standard rehabilitation protocols for patients with Parkinson's disease.[44,45] Additionally, VR-based exercise or training can help improve depressive symptoms, social engagement, and mental health in patients with CKD and undergoing dialysis.[46] The intertwined physical and mental health outcomes are also seen in the elderly[47] and stroke patients.[48,49]

Psychoeducational tools based on VR are a crucial domain. VR simulations, as high-fidelity experiences, offer a repeatable practice platform where participants can engage actively with varied, complex, and rare conditions, leading to observed gains in knowledge and skills.[50] VR is widely used for clinical care and medical education, focusing on training healthcare practitioners or students. It serves as an effective psychoeducational tool for mental health conditions, enhancing disease-related knowledge and improving attitudes and empathy while reducing stigma toward individuals with mental diseases.[51,52]

VR's utility in alleviating distress among people with chronic illness is a vital domain. Studies suggest that VR interventions have superior efficacy compared to conventional therapy in managing fatigue and pain.[53] Chronic patients can also benefit from VR due to the recreation of non-hospital settings, which provides novel stimuli that promote mental health improvement.[54] Pediatric applications demonstrate that children reduce anxiety, stress, and pain, and improve emotional resilience by being immersed in VR scenarios.[55]

The cluster "augmented reality" highlights key technological trends in VR-based mental health research. With recent advances in computerized technologies, augmented reality (AR) is emerging as the most prominent node, suggesting strong research interest in blending virtual and real-world elements for therapeutic applications.[56] Artificial intelligence (AI) plays a critical supporting role, likely in personalizing interventions, analyzing user behavior, or adapting VR environments in real time.[57] The presence of extended reality (XR) and mixed reality (MR) reflects a broader shift toward immersive, multimodal technologies beyond traditional VR.[58] Together, these trends indicate a move toward more integrated, intelligent, and adaptive digital mental health solutions, where VR converges with AR, AI, and other immersive technologies to enhance therapeutic outcomes in mental health.

The cluster "serious game" and "video game" highlights the significant forms of VR interventions. VR interventions incorporate gaming elements to implement empirically validated therapeutic protocols. The integration of gamification enhances appeal and engagement, reflecting a broader shift toward user-friendly mental health care.[59] VR games, provided by self-help or e-therapy, are becoming increasingly popular, highlighting a shift toward scalable and accessible mental health solutions.[60] While therapist-guided VR remains valuable for complex cases, automated VR treatments can expand access, lower costs, ensure standardized care, and overcome barriers like stigma and geography.[61]

Emerging Research Frontiers and Research Trajectories

Keywords reflect established research themes, whereas burst keywords signify transformative developments and cutting-edge innovations. Our analysis identified 34 significant keyword bursts, revealing several prominent research frontiers that demonstrate the most substantial citation surges. It started to use reality exposure therapy in posttraumatic stress disorder in 2014, followed by CBT in 2016. The application of VR expanded to mental disorders like anxiety disorder and fear from 2017 to 2021. Additionally, using VR in rehabilitation has an indirect impact on mental health, enhancing quality of life. From 2021 to 2023, VR will be applied in education and psychotherapy. After that, artificial intelligence and augmented reality developed, and the validity and impact of VR were further upgraded.

Limitations

The current analysis was deliberately restricted to VR-related mental health literature indexed in the Web of Science core collection, excluding publications from supplementary databases. The primary reason for this limitation is that CiteSpace currently only supports data import from a single database. However, compared to other databases, CiteSpace demonstrates higher efficiency in analyzing WoS data,[62,63] which justifies our selection of WoS for this analysis. Subsequent investigations would benefit from cross-database aggregation to establish a more robust and multidimensional analytical framework. Additionally, researchers may consider employing alternative analytical tools or methodologies to process multi-source database data, thereby enhancing the breadth and reliability of research findings.

Conclusion

This study's bibliometric analysis reveals the multifaceted role of VR in mental health. The combination of VR with traditional therapy or VR training is widely used for many kinds of mental disorders, including stress-related disorders, neurodevelopmental disorders, schizophrenia, mood disorders, anxiety and fear-related disorders, substance use disorders, feeding and eating disorders, or addictive behaviors. As the field matures, psychometrics, neuroscience, and human-computer interaction will be essential to optimize VR's therapeutic potential while addressing its challenges. While this study maps the field's research landscape, it is important to emphasize that bibliometric analysis reflects scholarly activity and collaboration patterns rather than therapeutic efficacy or study quality. Moving forward, the field must prioritize rigorous comparative trials, develop standardized clinical outcome measures, and address critical ethical considerations. These include protecting sensitive biometric data collected through VR systems, ensuring equitable access across socioeconomic groups, and mitigating risks of overreliance on immersive technologies for vulnerable populations. The evolution of VR in mental health care will depend on bridging disciplinary gaps between clinical science, neuroscience, and technology design. Bibliometric insights provide valuable context for these developments.

Author Contributions

All authors made a significant contribution to the work reported, whether that is in the conception, study design, execution, acquisition of data, analysis and interpretation, or in all these areas; took part in drafting, revising or critically reviewing the article; gave final approval of the version to be published; have agreed on the journal to which the article has been submitted; and agree to be accountable for all aspects of the work.

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References

1. Bruno RR, Wolff G, Wernly B, et al. Virtual and augmented reality in critical care medicine: the patient's, clinician's, and researcher's perspective. *Crit Care*. 2022;26(1):326. doi:10.1186/s13054-022-04202-x
2. Caponnetto P, Triscari S, Maglia M, Quattropani MC. The simulation game-virtual reality therapy for the treatment of social anxiety disorder: a systematic review. *Int J Environ Res Public Health*. 2021;18(24). doi:10.3390/ijerph182413209
3. Wiebe A, Kannen K, Selaskowski B, et al. Virtual reality in the diagnostic and therapy for mental disorders: a systematic review. *Clin Psychol Rev*. 2022;98:102213. doi:10.1016/j.cpr.2022.102213
4. Tas FQ, van Eijk CAM, Staals LM, Legerstee JS, Dierckx B. Virtual reality in pediatrics, effects on pain and anxiety: a systematic review and meta-analysis update. *Paediatr Anaesth*. 2022;32(12):1292–1304. doi:10.1111/pan.14546
5. Rousseaux F, Dardenne N, Massion PB, et al. Virtual reality and hypnosis for anxiety and pain management in intensive care units: a prospective randomised trial among cardiac surgery patients. *Eur J Anaesthesiol*. 2022;39(1):58–66. doi:10.1097/EJA.0000000000001633
6. Wang S, Sun J, Yin X, Li H. Effect of virtual reality technology as intervention for people with kinesiophobia: a meta-analysis of randomised controlled trials. *J Clin Nurs*. 2023;32(13–14):3074–3086. doi:10.1111/jocn.16397
7. Gao Y, Xu Y, Liu N, Fan L. Effectiveness of virtual reality intervention on reducing the pain, anxiety and fear of needle-related procedures in paediatric patients: a systematic review and meta-analysis. *J Adv Nurs*. 2023;79(1):15–30. doi:10.1111/jan.15473

8. Cheng P, Tang H, Lin F, Kong X. Bibliometrics of the nexus between food security and carbon emissions: hotspots and trends. *Environ Sci Pollut Res Int*. 2023;30(10):25981–25998. doi:10.1007/s11356-022-23970-1
9. Chen C. CiteSpace II: detecting and visualizing emerging trends and transient patterns in scientific literature. *J Am Soc Inf Sci Technol*. 2006;57(3):359–377. doi:10.1002/asi.20317
10. Li J. *CiteSpace: Text Mining and Visualization in Scientific Literature*. 2nd ed. Capital University of Economics and Business Press; 2017:301.
11. Luo H, Cai Z, Huang Y, et al. Study on pain catastrophizing from 2010 to 2020: a bibliometric analysis via CiteSpace. *Front Psychol*. 2021;12:759347. doi:10.3389/fpsyg.2021.759347
12. Alonso-Betanzos A, Bolon-Canedo V. Big-data analysis, cluster analysis, and machine-learning approaches. *Adv Exp Med Biol*. 2018;1065:607–626. doi:10.1007/978-3-319-77932-4_37
13. Riva G, Serino S. Virtual reality in the assessment, understanding and treatment of mental health disorders. editorial material. *J Clin Med*. 2020;9(11):3434. doi:10.3390/jcm9113434
14. Riva G, Wiederhold BK, Mantovani F. Neuroscience of virtual reality: from virtual exposure to embodied medicine. Editorial material. *Cyberpsychol Behav Soc Netw*. 2019;22(1):82–96. doi:10.1089/cyber.2017.29099.gri
15. Schröder D, Wrona KJ, Müller F, Heinemann S, Fischer F, Dockweiler C. Impact of virtual reality applications in the treatment of anxiety disorders: a systematic review and meta-analysis of randomized-controlled trials. *J Behav Ther Exp Psychiatry*. 2023;81:101893. doi:10.1016/j.jbtep.2023.101893
16. Lundin J, Lundström A, Gulliksen J, et al. Using 360-degree videos for virtual reality exposure in CBT for panic disorder with agoraphobia: a feasibility study. *Behav Cogn Psychother*. 2022;50(2):158–170. doi:10.1017/s1352465821000473
17. Hong Y-J, Kim HE, Jung YH, Kyeong S, Kim -J-J. Usefulness of the mobile virtual reality self-training for overcoming a fear of heights. Article. *Cyberpsychol Behav Soc Netw*. 2017;20(12):753–761. doi:10.1089/cyber.2017.0085
18. Elphinston RA, Vaezipour A, Fowler JA, Russell TG, Sterling M. Psychological therapy using virtual reality for treatment of driving phobia: a systematic review. *Disabil Rehabil*. 2023;45(10):1582–1594. doi:10.1080/09638288.2022.2069293
19. Rizzo A, Shilling R. Clinical virtual reality tools to advance the prevention, assessment, and treatment of PTSD. *Eur J Psychotraumatol*. 2017;8(sup5):1414560. doi:10.1080/20008198.2017.1414560
20. Rothbaum BO, Price M, Jovanovic T, et al. A randomized, double-blind evaluation of D-cycloserine or alprazolam combined with virtual reality exposure therapy for posttraumatic stress disorder in iraq and afghanistan war veterans. Article. *Am J Psychiatry*. 2014;171(6):640–648. doi:10.1176/appi.ajp.2014.13121625
21. Norr AM, Smolenski DJ, Reger GM. Effects of prolonged exposure and virtual reality exposure on suicidal ideation in active duty soldiers: an examination of potential mechanisms. Article. *J Psychiatr Res*. 2018;103:69–74. doi:10.1016/j.jpsychires.2018.05.009
22. Sheaves B, Holmes EA, Rek S, et al. Cognitive behavioural therapy for nightmares for patients with persecutory delusions (nites): an assessor-blind, pilot randomized controlled trial. *Can J Psychiatry*. 2019;64(10):686–696. doi:10.1177/0706743719847422
23. Freeman D, Lister R, Waite F, et al. Automated psychological therapy using virtual reality (VR) for patients with persecutory delusions: study protocol for a single-blind parallel-group randomised controlled trial (THRIVE). *Trials*. 2019;20(1):87. doi:10.1186/s13063-019-3198-6
24. Jeppesen UN, Due AS, Mariegaard L, et al. Face your fears: virtual reality-based cognitive behavioral therapy (VR-CBT) versus standard CBT for paranoid ideations in patients with schizophrenia spectrum disorders: a randomized clinical trial. *Trials*. 2022;23(1):658. doi:10.1186/s13063-022-06614-0
25. Berkhof M, van der Stouwe ECD, Lestestuiver B, et al. Virtual reality cognitive-behavioural therapy versus cognitive-behavioural therapy for paranoid delusions: a study protocol for a single-blind multi-Centre randomised controlled superiority trial. *BMC Psychiatry*. 2021;21(1):496. doi:10.1186/s12888-021-03473-y
26. Samora J, Jeong H, Conway FN, Claborn KR. Applications of immersive virtual reality for illicit substance use: a systematic review. *J Stud Alcohol Drugs*. 2024;85(2):158–167. doi:10.15288/jsad.23-00189
27. Sohn BK, Hwang JY, Park SM, et al. Developing a virtual reality-based vocational rehabilitation training program for patients with schizophrenia. Article. *Cyberpsychol Behav Soc Netw*. 2016;19(11):686–691. doi:10.1089/cyber.2016.0215
28. du Sert OP, Potvin S, Lipp O, et al. Virtual reality therapy for refractory auditory verbal hallucinations in schizophrenia: a pilot clinical trial. Article. *Schizophr Res*. 2018;197:176–181. doi:10.1016/j.schres.2018.02.031
29. Hone-Blanchet A, Wensing T, Fecteau S. The use of virtual reality in craving assessment and cue-exposure therapy in substance use disorders. *Front Hum Neurosci*. 2014;8:844. doi:10.3389/fnhum.2014.00844
30. Taubin D, Berger A, Greenwald D, et al. A systematic review of virtual reality therapies for substance use disorders: impact on secondary treatment outcomes. *Am J Addict*. 2023;32(1):13–23. doi:10.1111/ajad.13342
31. Gutierrez-Maldonado J, Pla-Sanjuanelo J, Ferrer-Garcia M. Cue-exposure software for the treatment of bulimia nervosa and binge eating disorder. Article. *Psicothema*. 2016;28(4):363–369. doi:10.7334/psicothema2014.274
32. Gemesi K, Doellinger N, Weinberger N-A, et al. Virtual body image exercises for people with obesity - results on eating behavior and body perception of the ViTraS pilot study. Article. *BMC Med. Inf. Decis. Making*. 2025;25(1):176. doi:10.1186/s12911-025-02993-x
33. Matamala-Gomez M, Maselli A, Malighetti C, Realdon O, Mantovani F, Riva G. Virtual body ownership illusions for mental health: a narrative review. *J Clin Med*. 2021;10(1):139. doi:10.3390/jcm10010139
34. Wieczorek A, Schrank F, Renner KH, Wagner M. Psychological and physiological health outcomes of virtual reality-based mindfulness interventions: a systematic review and evidence mapping of empirical studies. *Digit Health*. 2024;10:20552076241272604. doi:10.1177/20552076241272604
35. Li HS, Zhang X, Wang HY, et al. Access to nature via virtual reality: a mini-review. *Frontiers in Psychology*. 2021:12725288. doi:10.3389/fpsyg.2021.725288
36. Ma J, Zhao D, Xu N, Yang J. The effectiveness of immersive virtual reality (VR) based mindfulness training on improvement mental-health in adults: a narrative systematic review. *Explore*. 2023;19(3):310–318. doi:10.1016/j.explore.2022.08.001
37. Waller M, Mistry D, Jetly R, Frewen P. Meditating in virtual reality 3: 360° video of perceptual presence of instructor. *Mindfulness*. 2021;12(6):1424–1437. doi:10.1007/s12671-021-01612-w
38. Capobianco M, Puzzo C, Di Matteo C, Costa A, Adriani W. Current virtual reality-based rehabilitation interventions in neuro-developmental disorders at developmental ages. *Front Behav Neurosci*. 2024;18:1441615. doi:10.3389/fnbeh.2024.1441615

39. Hamada T, Seki M, Nango E, Shibata T, Imai S, Miyata T. Enhancing effects of exercise and neurofeedback: a systematic review and meta-analysis of computer game-based interventions for pediatric ADHD. *Psychiatry Res*. 2025;348:116447. doi:10.1016/j.psychres.2025.116447
40. Chu L, Shen L, Ma C, et al. Effects of a nonwearable digital therapeutic intervention on preschoolers with autism spectrum disorder in China: open-label randomized controlled trial. *J Med Internet Res*. 2023;25:e45836. doi:10.2196/45836
41. Astafeva D, Syunyakov T, Shapievskii D, et al. Virtual Reality / Augmented Reality (VR/AR) approach to develop social and communication skills in children and adolescents with autism spectrum disorders without intellectual impairment. *Psychiatry Danub*. 2024;36(Suppl 2):361–370.
42. Mittal P, Bhadania M, Tondak N, et al. Effect of immersive virtual reality-based training on cognitive, social, and emotional skills in children and adolescents with autism spectrum disorder: a meta-analysis of randomized controlled trials. *Res Dev Disabil*. 2024;151:104771. doi:10.1016/j.ridd.2024.104771
43. Domenicucci R, Ferrandes F, Sarlo M, Borella E, Belacchi C. Efficacy of ICT-based interventions in improving psychological outcomes among older adults with MCI and dementia: a systematic review and meta-analysis. *Ageing Res Rev*. 2022;82:101781. doi:10.1016/j.arr.2022.101781
44. Pazzaglia C, Imbimbo I, Tranchita E, et al. Comparison of virtual reality rehabilitation and conventional rehabilitation in Parkinson's disease: a randomised controlled trial. *Physiotherapy*. 2020;106:36–42. doi:10.1016/j.physio.2019.12.007
45. Tobar A, Jaramillo AP, Costa SC, Costa KT, Garcia SS. A physical rehabilitation approach for parkinson's disease: a systematic literature review. *Cureus*. 2023;15(9):e44739. doi:10.7759/cureus.44739
46. Gurz D, Coimbatore Dada K, Naga Nyshita V, et al. The Impact of Virtual Reality (VR) gaming and casual/social gaming on the quality of life, depression, and dialysis tolerance in patients with chronic kidney disease: a narrative review. *Cureus*. 2023;15(9):e44904. doi:10.7759/cureus.44904
47. Yen HY, Chiu HL. Virtual reality exergames for improving older adults' cognition and depression: a systematic review and meta-analysis of randomized control trials. *J Am Med Dir Assoc*. 2021;22(5):995–1002. doi:10.1016/j.jamda.2021.03.009
48. Bargeri S, Scalea S, Agosta F, et al. Effectiveness and safety of virtual reality rehabilitation after stroke: an overview of systematic reviews. *EClinicalMedicine*. 2023;64:102220. doi:10.1016/j.eclinm.2023.102220
49. Lin C, Ren Y, Lu A. The effectiveness of virtual reality games in improving cognition, mobility, and emotion in elderly post-stroke patients: a systematic review and meta-analysis. *Neurosurg Rev*. 2023;46(1):167. doi:10.1007/s10143-023-02061-w
50. Thomann H, Zimmermann J, Deutscher V. How effective is immersive VR for vocational education? Analyzing knowledge gains and motivational effects. *Comput Educ*. 2024;220105127. doi:10.1016/j.compedu.2024.105127
51. Tay JL, Xie H, Sim K. Effectiveness of augmented and virtual reality-based interventions in improving knowledge, attitudes, empathy and stigma regarding people with mental illnesses-a scoping review. *J Pers Med*. 2023;13(1). doi:10.3390/jpm13010112
52. Dhar E, Upadhyay U, Huang Y, et al. A scoping review to assess the effects of virtual reality in medical education and clinical care. *Digit Health*. 2023;9:20552076231158022. doi:10.1177/20552076231158022
53. Ioannou A, Papastavrou E, Avraamides MN, Charalambous A. Virtual reality and symptoms management of anxiety, depression, fatigue, and pain: a systematic review. *Sage Open Nurs*. 2020;62377960820936163. doi:10.1177/2377960820936163
54. Park MJ, Kim DJ, Lees U, Na EJ, Jeon HJ. A literature overview of Virtual Reality (VR) in treatment of psychiatric disorders: recent advances and limitations. Review. *Frontiers in Psychiatry*. 2019;10505. doi:10.3389/fpsyt.2019.00505
55. Kuang W, Yang EJ, Truong R, Woo BKP. Bringing virtual reality to mainstream pediatric care. Article. *J Patient Cent Res Rev*. 2024;11(2). doi:10.17294/2330-0698.2063
56. Carlson CG. Virtual and augmented simulations in mental health. Review. *Current Psychiatry Reports*. 2023;25(9):365–371. doi:10.1007/s11920-023-01438-4
57. Spiegel BMR, Liran O, Clark A, et al. Feasibility of combining spatial computing and AI for mental health support in anxiety and depression. Article. *Npj Digital Med*. 2024;7(1):22. doi:10.1038/s41746-024-01011-0
58. Omisore OM, Odenigbo I, Orji J, et al. Extended reality for mental health evaluation: scoping review. Review. *Jmir Serious Games*. 2024;2024:12e38413. doi:10.2196/38413
59. GomezRomero-Borquez J, Del-Valle-Soto C, Del-Puerto-Flores JA, Briseno RA, Varela-Aldas J. Neurogaming in virtual reality: a review of video game genres and cognitive impact. Review. *Electronics*. 2024;13(9):1683. doi:10.3390/electronics13091683
60. Riva G, Riva E. COVID feel good: a Free VR self-help solution for providing stress management and social support during the COVID-19 pandemic. editorial material. *Cyberpsychol Behav Soc Netw*. 2020;23(9):652–653. doi:10.1089/cyber.2020.29195.ceu
61. Malighetti C, Bernardelli L, Pancini E, Riva G, Villani D. Promoting emotional and psychological well-being during COVID-19 pandemic: a self-help virtual reality intervention for university students. Article. *Cyberpsychol Behav Soc Netw*. 2023;26(4):309–317. doi:10.1089/cyber.2022.0246
62. Falagas ME, Pitsouni EI, Malietzis GA, Pappas G. Comparison of PubMed, scopus, web of science, and google scholar: strengths and weaknesses. *FASEB J*. 2008;22(2):338–342. doi:10.1096/fj.07-9492LSF
63. Martin-Martin AE, Orduna-Malea E, Thelwall M, Delgado López-Cózar E. Google scholar, web of science, and scopus: a systematic comparison of citations in 252 subject categories. *J Informetrics*. 2018;12(4):1160–1177. doi:10.1016/j.joi.2018.09.002