

A Review of Virtual Reality and Serious Games within Cognitive Behavioral Therapy for Social Anxiety Disorder

Tinjauan Realitas Virtual dan Game Serius dalam Terapi Perilaku Kognitif untuk Gangguan Kecemasan Sosial

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Abstract – This literature review discusses efforts to enhance cognitive behavioral therapy in addressing social phobia, such as social anxiety disorder, by utilizing serious games and virtual reality exposure therapy. In the worldwide context of the COVID-19 outbreak, conventional cognitive behavioral therapy faces significant challenges, prompting practitioners and researchers to seek innovative solutions. During the conducted literature review, several research articles were identified that explore the utilization of virtual reality exposure therapy and serious games within the stages of cognitive behavioral therapy. Using the PICOC method and software such as Publish or Perish, Zotero, and VOSViewer, 30 journal articles have been obtained, indicating that virtual reality exposure therapy and serious games can enhance the effectiveness of cognitive behavioral therapy. However, there are clear signs suggesting that integrating virtual reality (VR) technology and serious games on smartphones into the cognitive behavioral therapy process could offer a promising avenue for new research. This approach may help address the challenges brought about by the effects of the COVID-19 pandemic on people with social anxiety disorder, particularly in Indonesia. Although further research and therapy adaptation according to the cultural context in Indonesia are needed, this development offers new research opportunities as an alternative therapeutic approach with significant advancements in addressing social anxiety disorder.

Keywords: Literature Review, Social Phobia, Cognitive Behavioral Therapy, Serious Games, Social Anxiety Disorder, Virtual Reality Exposure Therapy

Abstrak – *Tinjauan literatur ini membahas upaya untuk meningkatkan terapi perilaku kognitif dalam menangani fobia sosial, seperti gangguan kecemasan sosial, dengan memanfaatkan permainan serius dan terapi paparan realitas virtual. Dalam konteks global wabah COVID-19, terapi perilaku kognitif konvensional menghadapi tantangan yang signifikan, mendorong para praktisi dan peneliti untuk mencari solusi inovatif. Selama tinjauan literatur yang dilakukan, beberapa artikel penelitian telah teridentifikasi meneliti pemanfaatan terapi paparan realitas virtual dan permainan serius dalam tahapan terapi perilaku kognitif. Dengan menggunakan metode PICOC dan perangkat lunak seperti Publish or Perish, Zotero, dan VOSViewer, telah diperoleh 30 artikel jurnal yang menunjukkan bahwa terapi paparan realitas virtual dan permainan serius dapat meningkatkan efektivitas terapi perilaku kognitif. Namun, terdapat bukti yang signifikan yang menyarankan bahwa mengintegrasikan teknologi realitas virtual dan permainan serius di smartphone ke dalam proses terapi perilaku kognitif dapat menjadi peluang penelitian yang menjanjikan. Pendekatan ini dapat membantu mengatasi tantangan yang ditimbulkan oleh dampak pandemi COVID-19 terhadap orang dengan gangguan kecemasan sosial, khususnya di Indonesia. Meskipun penelitian lebih lanjut dan adaptasi terapi sesuai dengan konteks budaya di Indonesia diperlukan, pengembangan ini menawarkan peluang penelitian baru sebagai pendekatan terapeutik alternatif dengan kemajuan signifikan dalam menangani gangguan kecemasan sosial.*

Kata Kunci: *Tinjauan Literatur, Fobia Sosial, Terapi Perilaku Kognitif, Permainan Serius, Gangguan Kecemasan Sosial, terapi paparan realitas virtual*

INTRODUCTION

The COVID-19 pandemic on a global scale has heightened awareness regarding mental health issues (Heinen et al., 2022), including in Indonesia. The impact of this pandemic has significantly increased the levels of anxiety. The following have contributed to the rise in anxiety worldwide as a result of Covid-19 factors (Kindred, R., & Bates, G. W., 2023):

1. **Social Isolation:** Social distancing measures and isolation to curb the virus' spread have led to loneliness and social isolation, which can exacerbate anxiety.
2. **Uncertainty:** This pandemic has created uncertainty about health, employment, education, and the economy, all of which can act as triggers for anxiety.
3. **Health Concerns:** Uncertainty about infection risks and the long-term health effects of Covid-19 has sparked significant health-related anxiety.
4. **Economic Crisis:** Economic downturns and job losses have created financial pressures, leading to financial anxiety.
5. **Social Media Usage:** Inaccurate and excessive information about Covid-19 on social media can also trigger anxiety and confusion.

Therefore, as indicated by research conducted by Sanderson et al., (2020), psychotherapy strategies are needed to help individuals to alleviate anxiety resulting from the Covid-19 pandemic.

One of the increasingly concerning mental health disorders is Social Anxiety Disorder (SAD). SAD Disorder ranks among the prevalent mental health conditions globally, impacting a vast number of individuals. Those suffering from SAD typically endure extreme anxiety and dread in social contexts, which results in them steering clear of various events, becoming isolated, and experiencing deteriorating social connections. Without proper treatment, their personal suffering can be profound, affecting their overall quality of life. SAD involves persistent fear that drives individuals to avoid social events due to the fear of negative judgment from others (Emmelkamp et al, 2020). More severe symptoms of social anxiety include a racing heart, trembling, blushing, and excessive sweating. Proper treatment not only enhances the individual's quality of life but also has far-reaching effects on their personal, professional, and economic well-being, making it an essential area for research to understand and promote effective interventions.

Cognitive behavioral therapy (CBT) explores the interplay between one's thoughts, emotions, and behaviors (Chand et al, 2023). It is a goal-oriented, time-bound, structured method employed to address numerous mental health conditions, such as SAD. A key component of CBT involves exposure, which includes confronting the triggers of fear directly and eliminating safety behaviors, aiding individuals in understanding that the outcomes they fear are unlikely to occur. Nevertheless, due to the disorder's characteristics, finding suitable situations for CBT practice can be scarce and challenging to replicate.

Virtual Reality Exposure Therapy (VRET) utilizes virtual reality technology to generate simulated environments or situations that trigger anxiety responses in individuals as part of a therapeutic approach (Boeldt et al, 2019). VRET allows individuals to face their fears in a controlled and secure manner, aiding them in conquering anxiety and fear. In several studies, like those undertaken by Zhang et al., (2020), Krzystanek et al., (2021), and Hawajri et al., (2023), VRET has demonstrated success in reducing anxiety and depression symptoms, particularly in individuals with specific fears. Additionally, VR is not only used for therapy but also for assessment purposes. VR technology allows researchers to design situations for assessing immediate behavioral, emotional, cognitive, and physiological reactions within simulated settings (Emmelkamp & Meyerbröker, 2021).

The proliferation of game genres (Rosyid et al., 2019), including both entertainment (Rosyid et al., 2018) and serious games, is swiftly advancing in tandem with technological progress. Serious Games (SG) represent a rapidly advancing therapeutic approach in recent years (Damaševičius et al, 2023). SG is interactive software specifically designed for therapeutic purposes (Caserman et al, 2020). These serious games take the form of simulation environments that support the therapeutic process by integrating educational gaming elements (Rosyid et al., 2021). SG has become a valuable tool in addressing anxiety, combining controlled exposure and relaxation exercises in an enjoyable and interactive setting (Abd-Alrazaq et al., 2022).

While research has demonstrated the utility of CBT, VRET, and Serious Games for addressing Social Anxiety Disorder, mental health issues, and phobias—both as standalone treatments and in combination—there remains a scarcity of studies that specifically examine the efficacy of integrating these three

treatment strategies into a singular comprehensive therapeutic framework. This notable gap in research is particularly evident in Indonesia. The combination of SG, VRET, and CBT within a single therapy platform is expected to offer greater benefits in reducing anxiety symptoms and enhancing psychological well-being compared to using each therapeutic approach separately.

Lately, there has been a marked surge in studies investigating the incorporation of virtual reality exposure therapy and serious games into cognitive behavioral therapy. This is evident in various journal indexing databases. In this study, three closely related journal indexing databases were employed, including Google Scholar, PubMed, and Semantic Scholar, using four keywords: virtual reality, serious games, social anxiety disorder, and cognitive behavioral therapy. From the search results in these databases, several literature reviews were found on topics related to the four search keywords. However, most of these literature reviews primarily addressed the combination of VRET and CBT or the combination of SG and CBT to address anxiety disorders, without a specific focus on social anxiety disorders (SAD).

In order to tackle this concern, it is necessary to conduct a literature review to identify and to assess research published between 2019 and 2023, as a part of this study. This literature review will describe the research focus, analyze research findings, highlight weaknesses in previous research, and provide a theoretical foundation for future research. Consequently, this research spans from the embryonic phase of utilizing VRET and SG technologies within cognitive behavioral therapy (CBT) to explore the potential combination of these three approaches for individuals with social anxiety disorder (SAD). The combination of all these elements serves as a novelty for this study, potentially offering an alternative avenue for future research.

RESEARCH METHOD

This paper extensively investigates published studies concerning the treatment of SAD through the utilization of VRET, CBT, and Serious Games. The Systematic Literature Review (SLR) method is well-established in psychological and mental health research and even more so in information technology. The SLR approach utilized in this study follows the methodology outlined by Kitchenham and Charters, with the goal of

identifying, assessing, and interpreting findings related to specific research questions (Kitchenham et al, 2010).

The initial steps in this research involve the use of bibliometric analysis to examine the acquired data. This analysis consists of two primary steps: data collection and data cleansing. Subsequently, after data collection and cleansing, the next step is to address the research questions, following the SLR methodology.

Search Strategy

The search strategy involved formulating the search string in English and combining search terms for four keywords: virtual reality, serious games, cognitive behavioral therapy, and social anxiety disorder, using simple keywords search without the use of Boolean operators (AND, OR) in specific ways to broaden or narrow the results. This process included exploring journal indexing databases for data sources and establishing criteria for inclusion and exclusion, as illustrated in Table 1. The criteria for inclusion serve as prerequisites for relevant research, while exclusion is employed to eliminate studies or research that are not relevant.

Table 1 Criteria for Inclusion and Exclusion

Inclusion	Exclusion
Articles published in English.	Articles published in languages other than English.
Published from January 1, 2019, to August 31, 2023.	Published prior to January 1, 2019, and beyond the inclusion period.
Accessible and relevant articles contain four predefined keywords.	Duplicated articles. Articles without accessible or locatable full content.
Included in international journals.	Not included in international journals.

Data Collection and Data Cleansing

The data source was obtained from three journal indexing databases: PubMed, Semantic Scholar, and Google Scholar. The choice of the three databases was determined by their thorough coverage, dependability, ease of access, advanced search features, and facilitation of inclusion criteria. The process of extracting data from these three databases was carried out using the Publish or Perish (PoP) application, as shown in Figure 1. PoP was chosen due to its filtering feature, which allows displaying results only from journal articles. Furthermore, keywords were used in the journal search, and double quotation marks were used to enhance the accuracy of the search results (Harzing & Adler, 2016).

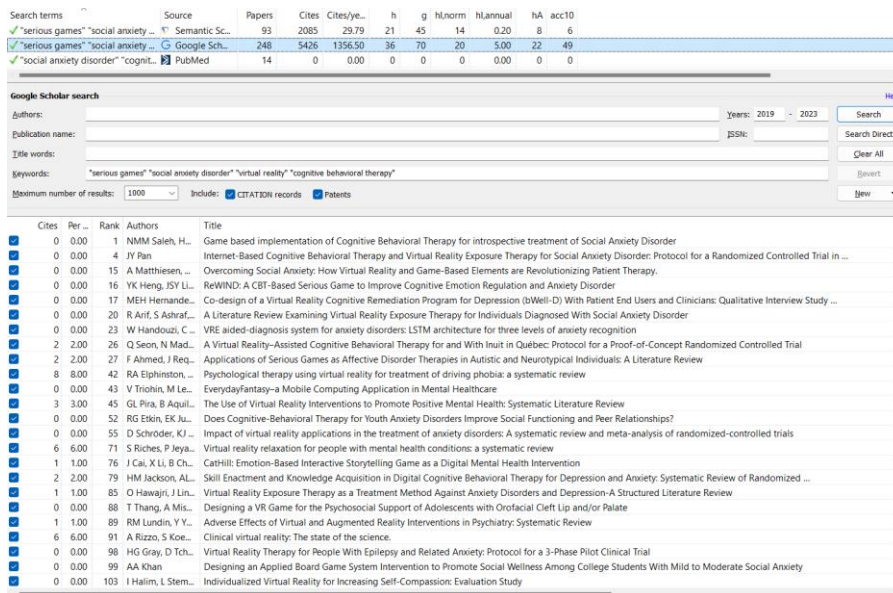


Figure 1 Search Results of Metadata Using Publish or Perish

Based on the results of collecting data from the articles obtained from each journal database, a total of 355 articles were identified, as shown in Table 2. Following the established inclusion and exclusion criteria, a selection process was conducted to choose relevant studies.

Table 2 The Results of Article Search

Source	Number of Papers
Google Scholar	248
PubMed	14
Semantic Scholar	93

The selection was performed using the Zotero application by grouping data that met the established criteria. Duplicate journals and journals classified as literature reviews have been removed. The next step

involved data cleansing and sorting. Thirty journal articles that met the criteria in Table 1 were obtained.

The outcomes of the process of selecting articles have been visually represented in a PRISMA flow diagram, which is shown in Figure 2. This diagram provides a clear and structured overview of how articles were screened, assessed, and included or excluded in the study, which are recognized standards for conducting systematic reviews. Within the diagram, each step of the selection process is delineated, from the initial identification of potential articles through to their final based on predetermined criteria. This structured approach ensures transparency and rigor in the review process, allowing for a reliable synthesis of the available evidence.

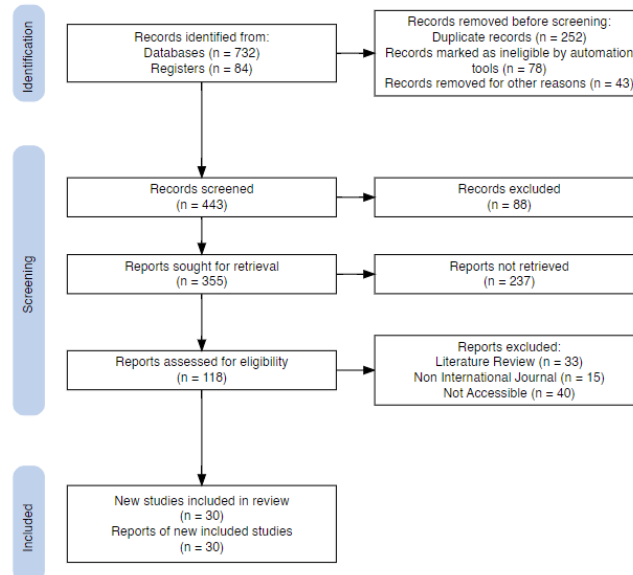


Figure 2 A flow diagram using PRISMA (Haddaway et al., 2022)

Furthermore, using the VOSViewer application, mapping will be conducted. This process involves creating visual representations in multiple formats, such as network visualization, overlay visualization, and density visualization. Network visualization illustrates the connections and relationships between different research items, overlay visualization allows for the simultaneous display of multiple data layers, and density visualization provides insights into the concentration and distribution of research topics. In addition to generate visualizations, VOSViewer also offers valuable information on clusters, which are groups of closely related research items based on shared characteristics such as keywords or citations. Its ability to generate visually appealing and informative representations, coupled with its functionality in identifying and exploring research clusters, makes it a valuable asset in the pursuit of research innovation (Nandiyanto & Al Husaeni, 2022).

Research Question

Research inquiries stem from the PICOC (Population, Intervention, Comparison, Outcomes, Context) framework. PICOC, outlined by Cumpston et al. (2021), functions as a structured approach to define the criteria and scope of the papers included in the literature review, as depicted in Table 3.

Table 3 Criteria for Formulating Research Questions

Criteria	Scope
P Population	SAD, CBT, VRET and SG Limited to research that addresses the connection between VRET, serious games, and CBT in the context of social anxiety disorder.
I Intervention	
C Comparison	n/a
O Outcomes	The application of VRET technology and serious games CBT for treating SAD is a topic of research interest.
C Context	A review of all research involving VRET and Serious Games within CBT for SAD

The PICOC approach is instrumental in formulating well-structured and practical questions. By clearly defining each component - Population, Intervention, Comparison, Outcomes, and Context - questions become focused and comprehensive, this aids in narrowing down the scope of the study and contributes to the development of evidence-based practice.

Through the PICOC framework, key aspects related to the research topic can be systematically addressed, including the characteristics of the target population, the interventions being studied, any comparisons made, the desired outcomes, and the contextual factors that may influence the results. Considering these elements enables the design of studies that are relevant and meaningful in informing decision-making and guiding practice across various fields.

Based on the criteria and scope mentioned in Table 3, they were formulated into seven questions as seen in Table 4.

Table 4 Research Questions

Code	Question
Q1	Does the paper discuss social anxiety disorder?
Q2	Does the paper discuss cognitive behavioral therapy?
Q3	Does the paper discuss virtual reality technology?
Q4	Does the paper discuss serious games?
Q5	What is the primary emphasis of the study?
Q6	What is the result of the research?
Q7	Who has researched the most in this field?

RESULT AND DISCUSSION

The search for papers involves executing the subsequent actions:

1. Utilize Publish or Perish (PoP) to input four keywords into the search field for each journal index database (Google Scholar, PubMed, Semantic Scholar).
2. Restrict the search to the years 2019 through 2023.
3. Carry out downloads for articles that are accessible.
4. Conduct screening and eligibility assessment of downloaded articles.
5. Create and maintain a flow diagram using PRISMA to document various phases of the literature search process, including identification, screening, eligibility, and inclusion of studies.

After utilizing PoP for browsing and searching for sources and employing the PRISMA flow diagram to enhance the transparency, rigor, and reproducibility of meta-analyses and systematic reviews, thereby ultimately enhancing the quality of evidence synthesis in research literature based on inclusion and exclusion criteria, the process proceeded to utilize Zotero for

extracting papers. Consequently, a total of 30 articles were identified. The titles, publication years, and repository sources of these articles can be found in Table 5.

Table 5 The List of Article

Code	Year	Focus Topics	Cite Paper	Source
A1	2020	VRET, SG	(Bossenbroek et al., 2020)	jmir.org
A2	2021	CBT, SG	(Thabrew et al., 2021)	jmir.org
A3	2022	SG	(Almeqbaali et al., 2022)	jmir.org
A4	2023	SG, CBT	(Sriwatanathamma et al., 2023)	jmir.org
A5	2023	VRET, CBT	(Hernandez et al, 2023)	jmir.org
A6	2021	VRET, CBT	(Shin et al, 2021)	jmir.org
A7	2021	VRET	(Hur, J. et al., 2021)	jmir.org
A8	2023	VRET, CBT	(Pan, 2023)	jmir.org
A9	2020	CBT, SG	(Silk et al., 2020)	linkinghub.elsevier.com
A10	2021	VRET, SG	(Beidel et al., 2021)	linkinghub.elsevier.com
A11	2021	VRET	(Zainal et al., 2021)	linkinghub.elsevier.com
A12	2019	VRET	(Farrer et al., 2021)	linkinghub.elsevier.com
A13	2019	SG, CBT	(Christie et al., 2019)	linkinghub.elsevier.com
A14	2022	CBT	(Thew et al., 2022)	linkinghub.elsevier.com
A15	2023	SG, CBT	(Gómez-Cambronero et al., 2023)	linkinghub.elsevier.com
A16	2021	SG, CBT	(Báldy et al., 2021)	link.springer.com
A17	2023	VRET	(Chard et al., 2023)	frontiersin.org
A18	2022	VRET, CBT	(Ørskov et al, 2022)	frontiersin.org
A19	2023	VRET	(Valls-Ratés et al., 2023)	frontiersin.org
A20	2023	VRET, SG	(Kahlon & Nordgreen, 2023)	frontiersin.org
A21	2020	SG, CBT	(Carlier et al., 2020)	mdpi.com
A22	2022	VRET, CBT	(Stefaniak et al., 2022)	mdpi.com
A23	2021	VRET, CBT	(Jeong et al., 2021)	mdpi.com
A24	2020	VRET, CBT	(Clemmensen et al., 2020)	biomedcentral.com
A25	2022	VRET, CBT	(Arnfred et al., 2022)	bmj.com
A26	2023	SG, CBT	(Saleh et al., 2023)	ejournal.ukm.my
A27	2023	SG, CBT	(Heng et al., 2023)	seriousgamessociety.org
A28	2021	CBT	(Curtiss et al., 2021)	psychiatryonline.org
A29	2023	CBT	(Schittenhelm et al., 2023)	biomedcentral.com
A30	2019	VRET, CBT	(Geraets et al., 2019)	cambridge.org

Keyword Mapping Analysis

The research development mapping results, based on four keywords (SG, VRET, SAD, CBT), were generated using VOSViewer by selecting 'create a map from text data.' Subsequently, data extraction from titles and abstracts was executed, utilizing the binary counting method.

The minimum term occurrence threshold was set at 4, resulting in the selection of 30 terms. This number was determined by the highest item count of 31, surpassing the default threshold of 60% (19 items). Before mapping, the data underwent a cleaning process, excluding proper names such as geographic locations, individuals, journal titles, and institutions, as illustrated in Figure 3.

Create Map ✕

Verify selected terms

Selected	Term	Occurrences	Relevance
<input checked="" type="checkbox"/>	anxiety	9	2.52
<input checked="" type="checkbox"/>	cbt	11	0.24
<input checked="" type="checkbox"/>	depression	5	1.80
<input checked="" type="checkbox"/>	effect	7	0.55
<input checked="" type="checkbox"/>	efficacy	7	0.27
<input checked="" type="checkbox"/>	game	6	4.52
<input checked="" type="checkbox"/>	intervention	11	0.42
<input checked="" type="checkbox"/>	randomized controlled trial	8	1.39
<input checked="" type="checkbox"/>	sad	9	0.27
<input checked="" type="checkbox"/>	serious game	8	2.72
<input checked="" type="checkbox"/>	social anxiety	5	0.56
<input checked="" type="checkbox"/>	social anxiety disorder	15	0.31
<input checked="" type="checkbox"/>	therapy	19	0.23
<input checked="" type="checkbox"/>	treatment	17	0.59
<input checked="" type="checkbox"/>	virtual reality	7	0.99
<input checked="" type="checkbox"/>	virtual reality exposure therapy	4	2.62
<input checked="" type="checkbox"/>	vivo exposure	5	1.38
<input type="checkbox"/>	change	4	0.67
<input type="checkbox"/>	evidence	5	0.68
<input type="checkbox"/>	feasibility	4	0.41

Figure 3 Data Cleaning Process

Next, from the network visualization of the mapping results obtained, when observed in Figure 4, the most prominent word is ‘therapy.’ This is because of two factors. The first factor is that the word ‘therapy’ is associated with therapeutic methods used for individuals with social anxiety disorders, such as virtual reality exposure therapy and cognitive behavioral therapy. The second factor that influences

this is that the word ‘therapy’ also pertains to the media utilized for therapy in patients, such as games and serious games. This broad understanding encompasses not only traditional therapeutic methods but also innovative digital interventions, which are increasingly prevalent in contemporary healthcare settings. Both of these factors can be observed in the titles and abstracts of the collected research.

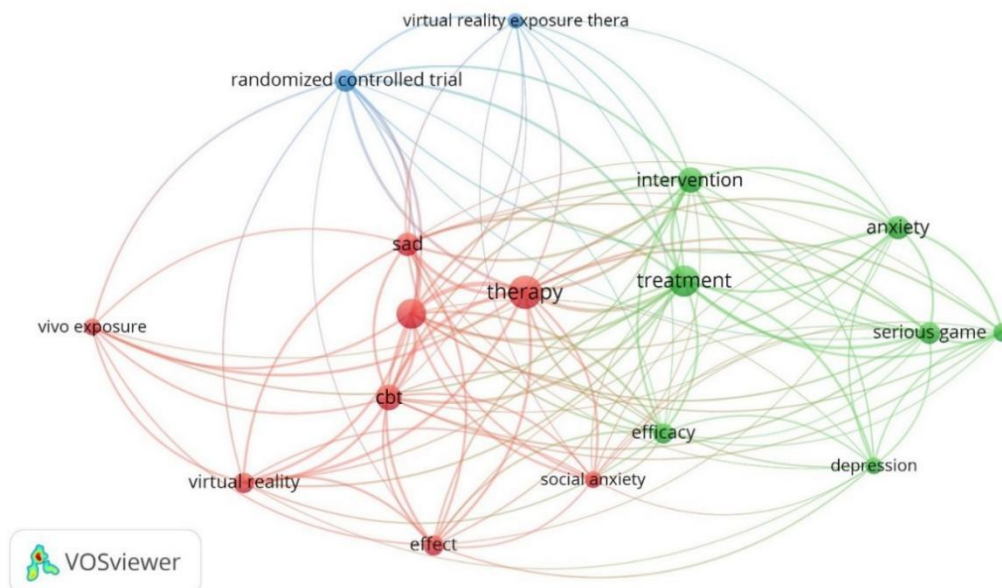


Figure 4 Network Visualization

The results of mapping the development of SAD therapy research using VOSViewer, when associated with CBT, VRET, and serious games—the keywords within this literature review, along with other identified terms—can be categorized into 3 clusters. In cluster 1,

with the central term being ‘therapy,’ it is associated with 16 other terms, including all three keywords. In cluster 2, with the cluster center at ‘treatment,’ it is also associated with 16 other terms. Finally, in cluster 3,

centered around the term 'randomized control trial,' it is associated with 13 other terms.

Through this network visualization, correlations between each keyword can be observed. For the term 'social anxiety disorder', it is in the same cluster as 'cbt', namely in cluster 1. However, the terms 'virtual reality exposure therapy' and 'serious games' are not found within the same cluster. Additionally, these two terms are not connected to each other unless through terms located in other clusters. This suggests the

possibility of conducting research that could relate the two so they can be in the same cluster.

The next mapping result is an overlay visualization that displays the history of research conducted in previous years. Analyzing the evolution of research through time illuminates the gradual development of knowledge and insights within the field. This visualization allows us to trace the progression of research trends, and to highlight the historical context that informed current studies and innovations. This display can be seen in Figure 5.

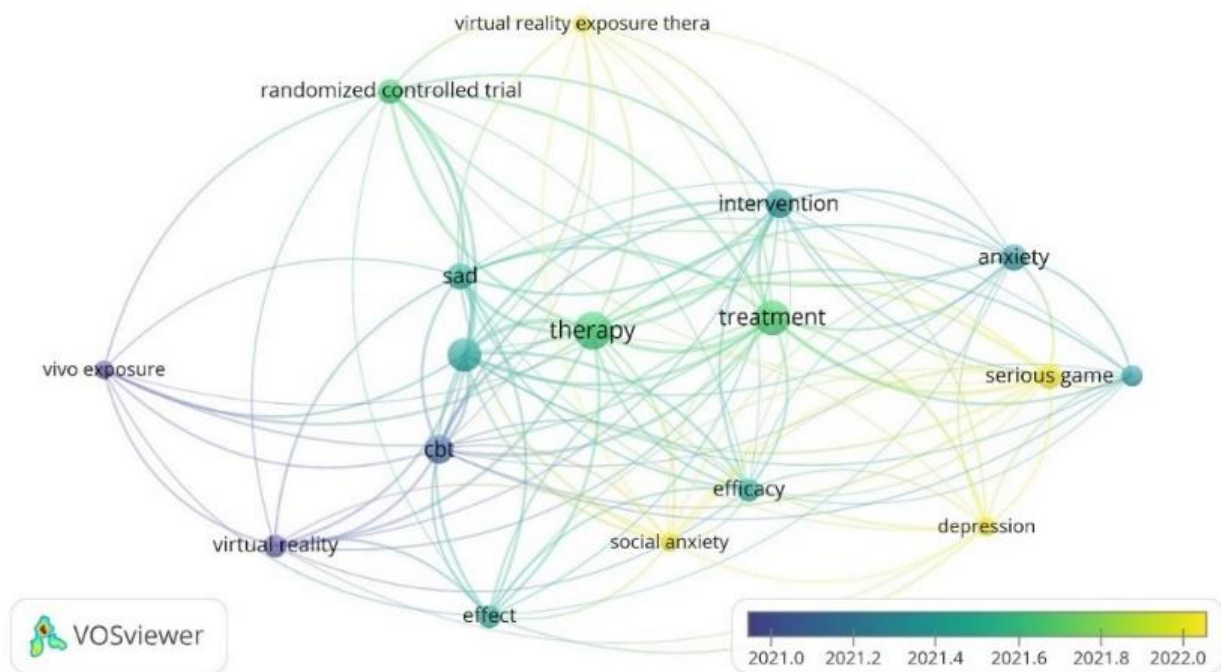


Figure 5 Overlay Visualization

From the visualization, information regarding recent research conducted in connection with social anxiety disorder, cognitive behavioral therapy, virtual reality, and serious games can be obtained. This research covers the years from 2019 to 2023 and is related to the existing terms.

The final analysis of keyword mapping takes the shape of density visualization, aimed at illustrating the

concentration of research topics. In this visual representation, areas with brighter colors indicate a more extensive study of those topics. Conversely, when the color fades, it signifies that research on the subject in that specific domain remains relatively limited. This visualization tool offers valuable insights into the research landscape. It provides a clear visual representation of the distribution of research focus.

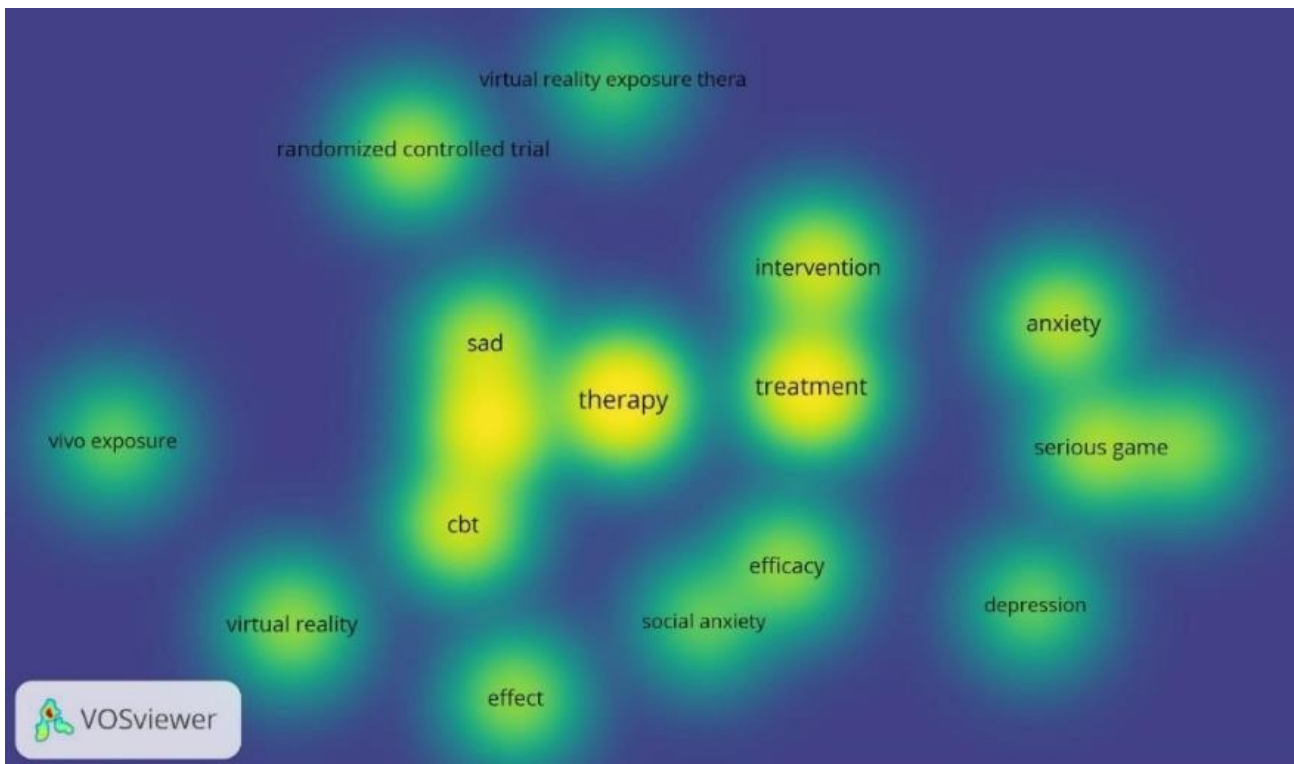


Figure 6 Density Visualization

In Figure 6, an analysis of research can be observed, which is still limited in the areas of serious games and virtual reality exposure therapy. This indicates an ongoing opportunity for various upcoming studies, with both terms as starting points.

PICOC Analysis

Following the outcomes of the keyword mapping analysis, the subsequent action involves responding to the seven questions derived from the PICOC framework. Here are the answers to the seven questions:

a. Does the paper discuss social anxiety disorder?

Out of the 30 papers reviewed, 22 papers implicitly address social anxiety disorder (SAD). These papers are A6 – A12, A14, A16 – A28, and A30. Additionally, there are 13 papers that explicitly mention SAD in their research titles, namely papers A8, A10, A11, A14, A16, A18, A22 – A26, A28, and A30.

b. Does the paper discuss cognitive behavioral therapy?

Out of the 30 papers reviewed, 22 take an implicit stance toward cognitive behavioral therapy (CBT). These papers, namely A2, A4 – A6, A8, A9, A11, A13 – A16, A18, and A21 – A30 discreetly engage with

CBT principles within their content. Furthermore, there are 17 papers that overtly cite CBT in their research titles: A2, A4, A6, A8, A9, A13, A14, A18, and A22 – A30.

c. Does the paper discuss virtual reality technology?

Out of the 30 papers under review, 17 indirectly delve into virtual reality (VR) as evidenced by their inclusion in the following papers: A1, A5 – A8, A10 – A12, A17 – A20, A22 – A25, and A30. Moreover, 15 papers explicitly mention virtual reality in their research titles: A1, A5 – A8, A11, A17 – A20, A22 – A25, and A30.

d. Does the paper discuss serious games?

Among the 30 papers under review, 13 subtly engage with the concept of serious games (SG), as made evident by their presence in the following papers: A27, A26, A21, A20, A16, A15, A13, A10, A9 and A1 – A4. On the other hand, only 3 papers explicitly reference serious games in their research titles: A3, A10, and A16. It's important to note that the rest of the papers primarily focus on the term 'games.'

e. What is the primary emphasis of the study?

Table 6 displays the alignment of the primary research emphases found in articles released between January 2019 and August 2023.

Table 6 Mapping of Research Focus

Method	Therapy Focus		
	CBT	VR	SG
Design (prototyping, agile, req-prototyping, GDLC etc)	A2, A4, A9, A13, A15, A16, A21, A26, A27	A10, A11, A12	A2, A3, A4, A9, A10, A13, A15, A16, A21, A26, A27
Experimental (Randomized Control Trial)	A4, A5, A8, A9, A14, A15, A18, A21, A22, A24, A25, A27, A29, A30	A1, A5, A7, A8, A10, A11, A12, A13, A17, A18, A19, A20, A22, A24, A25, A30	A1, A4, A9, A10, A13, A15, A20, A21, A27
Questionnaire	A6, A9, A14, A16, A18, A22, A25, A26, A27, A29, A30	A1, A5, A6, A17, A18, A22, A25, A26, A27, A30	A1, A9, A16
Descriptive Statistics	A2, A15, A18, A28, A29	A1, A11, A18, A19	A1, A2, A15
Interview	A8, A16, A21, A22, A23, A24, A25, A29	A5, A7, A8, A10, A11, A12, A20, A22, A23, A24, A25	A3, A10, A16, A20, A21
Ecological Momentary Assessment (EMA)	A2		A2
Usability Evaluation	A21, A26, A27		A3, A21, A26, A27
ABCDE Model	A4		A4
ANCOVA	A6	A6	
ANOVA	A8	A7, A8	
ER40, ASQ, SAM-C	A9		A9
Interaction log analysis		A10	A10
Mixed-Model Analysis	A30	A12, A20, A30	A20
RMSSD		A17	

In Table 6, the methods used in each study and the research focus can be seen. In broad terms, it can be stated that the 30 research papers focus on how Cognitive Behavioral Therapy (CBT), Virtual Reality (VR) technology, and Serious Games (SG) development can be utilized as a form of therapy for Social Anxiety Disorder (SAD), whether applied separately or in combinations. All research results indicate that the stages in CBT can generally be combined with Virtual Reality Exposure Therapy and Serious Games. The combination of Cognitive Behavioral Therapy (CBT) stages with Virtual Reality Exposure Therapy (VRET) and serious games represents a promising and innovative approach in the realm of therapy and mental health. The integration of these elements can present several potential benefits.

f. What is the result of the research?

Article A1 investigates the utilization of the DEEP game as a method to address disruptive behavior and anxiety within a specialized school setting. An analysis of individual profiles revealed that 6 participants experienced reduced anxiety, while 5 participants demonstrated decreased disruptive classroom behaviors after introducing DEEP.

In Article A2, preliminary findings support the

interactive game "Starship Rescue" serves as a successful digital health strategy to regulate anxiety among youth suffering from long-term medical issues. This game was collaboratively developed with a group of 15 minors and adolescents at a major hospital in New Zealand, was later evaluated by 24 participants aged 10-17 during an 8-week open trial.

Article A3 centered on developing and assessing a serious gaming application integrated with biofeedback technology aimed at mitigating anxiety in the young adult population of the UAE. The findings of this research have paved the way for future enhancements to optimize the app for broader testing among young adults experiencing anxiety.

Article A4 explored the development of gamified cognitive behavioral therapy methods, incorporating gaming elements within a serious game, BlueLine, designed specifically for the millennial demographic in Bangkok. Throughout the in-game scenarios, players acquire insights on diminishing the effects of depressive symptoms via gamified interactions on their smartphones.

Article A5 aimed to develop the first version of a virtual reality cognitive rehabilitation program for Major Depressive Disorder (MDD) named "bWell-D."

The authors also highlighted the significance of an immersive VR therapy incorporating lifelike, multisensory settings and tasks, as well as customizable components.

Article A6 sought to explore the viability of self-guided VR as a cost-effective alternative to traditional treatments. The outcome of the study aimed to offer insights into how effective a self-directed virtual reality cognitive behavioral therapy (VR CBT) delivered via a mobile application could be in managing panic disorder.

Article A7 aimed to explore changes in self-referential processing and the associated neural mechanisms following the VR treatment. The findings provided many insights into self-referential processing within the framework of social anxiety disorder, expanding on the existing body of evidence collected from brain imaging research.

Article A8 was dedicated to the development of "Ease Anxiety in Social Event Online" (Ease Online), an iCBT program featuring VRET. This program was designed for a randomized controlled trial involving Hong Kong adults who had previously experienced SAD.

The goal of Article A9 aimed to assess the usability, feasibility, acceptability, and initial effectiveness of SmartCAT 2.0 in an open trial. This trial sought to integrate brief (8 sessions) cognitive-behavioral therapy (CBT) with the SmartCAT mobile health program.

In Article A10, an AI-driven web-based application called Pegasys-VR™ was created with the aim of substituting peer generalization sessions and improving homework adherence. The findings indicated that both programs were equally successful in diminishing anxiety and improving social skills during social interactions.

The aim of Article A11 was to assess the effectiveness of a self-guided virtual reality exposure technique for people suffering from SAD. The results suggest that a streamlined, self-directed VRE regimen has the potential to reduce SAD symptoms and associated anxiety in adults ranging from young to middle age afflicted with the condition.

Article A12 discussed the results of a randomized controlled trial examining the effectiveness of the UVC as a comprehensive online intervention for addressing mental health issues and associated concerns among Australian university students. The trial indicated that the UVC had some value in

reducing social anxiety and enhancing students' academic self-efficacy, and it received positive ratings for satisfaction and usability.

Article A13 outlines the creation of Quest - Te Whitianga, a mobile app designed to promote CBT skill acquisition through a range of interactive activities and games. The outcome is a versatile mobile application that employs gamification to actively involve young individuals in online CBT.

In Article A14, the effectiveness of iCT-SAD, a UK-developed internet Cognitive Therapy program for Social Anxiety Disorder, was assessed when administered in Hong Kong by local therapists. The results demonstrated the robust efficacy of iCT-SAD in treating SAD in the Hong Kong context.

The objective of Article A15 was to offer an initial demonstration of the positive impact of a smartphone-based serious game intervention on depressive symptoms. The findings of the study could provide preliminary backing for the possible utilization of smartphone games as an innovative means for delivering interventions, potentially enhancing treatment accessibility and adherence, thus prompting further research in the field.

The objective of Article A16 was aimed at developing and evaluating a serious game promoting understanding of CBT skills associated with SAD. The results showed that the designed game effectively engaged users, was considered user-friendly, aesthetically pleasing, valuable, and improved comprehension of the narrative.

Article A17 explored the appeal of using VRET to enhance the integration of speech and anxiety treatments. The results offered initial indications of suitable methods.

Article A18 conducted a study to determine the effectiveness of integrating cognitive behavioral therapy with adjustable virtual reality exposure, which modified the exposure intensity based on live tracking of the participants' anxiety levels. This randomized controlled study, distinguished by its extensive sample size, subsequent data collection, and reliable metrics for evaluating social anxiety results, enriched the current knowledge base regarding the use of VR exposure in therapeutic practices.

Article A19 set out to investigate if instructing secondary school students on specific gesture use within a three-session training program aided by virtual reality could diminish their levels of Public Speaking Anxiety (PSA). The study's findings provide

additional insights into the optimal use of VR-simulated environments by secondary students to enhance their public speaking abilities.

Article A20 investigated the utilization of VRET as a standalone, gamified intervention to alleviate social anxiety in young individuals, demonstrating promising outcomes. The research investigated the potential for applying VRET as such and yielded favorable findings.

Article A21 aimed to evaluate the potential for improving stress and anxiety reduction in children with ASD and their parents through the use of a serious game. The game included two mini-games featuring relaxation techniques, and the findings emphasized the need for further research to effectively integrate existing patient empowerment guidelines into e-health applications.

Article A22's research endeavored to assess the safety and efficacy of self-managed virtual reality exposure in relation to Cognitive Behavioral Therapy, and CBT augmented with virtual exposure. Comparative analysis indicated that subjects in the VR group exhibited greater scores on the Liebowitz Social Anxiety Scale during assessments compared to those undergoing CBT alone.

Article A23 aimed to determine the effectiveness of brief Individual CBT utilizing virtual reality in addressing social anxiety disorder (SAD). The findings indicated that a nine to ten-session short-term VR-based individual CBT may be effective, with minimal additional benefit from extending the sessions if the therapeutic effect is insufficient within this time frame.

Article A24 detailed the design for a three-pronged Randomized Controlled Trial: 1) Cognitive Behavioral Therapy combined with 360-degree video-based VR exposure, 2) Traditional Cognitive Behavioral Therapy with real-life exposure, and 3) VR-based relaxation therapy. This study represented the first program in Denmark to integrate VR for managing SAD, capitalizing on its therapeutic benefits.

Article A25 detailed the SoREAL trial, which aimed to compare the impact of group Cognitive Behavioral Therapy that included exposure in real-life situations against group CBT featuring virtual reality exposure, on combined groups of individuals with social anxiety disorder and/or agoraphobia. Inclusion for this study began on February 4, 2019, but due to the COVID-19 pandemic, it was delayed by about

three months, and inclusion was anticipated to conclude on June 4, 2023.

Article A26 presented the Social Phobia Game as the core investigative tool for gaining insight, enhancing understanding, and supporting self-management of Social Anxiety Disorder. The analysis of its functionality and user experience suggested that the structure used in the serious game prototype could aid in recognizing, treating, and heightening awareness of SAD.

In Article A27, the research concentrated on a serious role-playing game, called ReWIND that incorporates elements of CBT into the game's anxiety-centric narratives and mechanics. The findings indicated that ReWIND was successful in diminishing the intensity of anxiety symptoms and persistent anxiety, while improving individuals' sense of control over their anxiety, demonstrating greater benefits than a non-game related task.

Article A28 analyzed both common and distinctive components of CBT interventions designed to address anxiety and related disorders, such as panic disorder, social anxiety disorder, generalized anxiety disorder, obsessive-compulsive disorder, post-traumatic stress disorder, and prolonged grief. The results confirmed that CBT remains an effective, standard treatment for anxiety and stress-related disorders.

In Article A29, the effectiveness of using the app alone (APP) was compared to therapist-guided app use through videos (TG-APP), and both were compared to a wait-list control group (WLC) in reducing symptoms and improving various secondary outcomes such as quality of life and psychological distress. The findings showed that incorporating therapist-guided sessions resulted in larger effect sizes compared to using the app alone.

Article A30 investigated the feasibility and potential impact of virtual reality-based cognitive behavioral therapy (VR-CBT) in patients with severe generalized SAD. This uncontrolled pilot study demonstrated the feasibility and therapeutic potential of VR-CBT in a challenging-to-treat group with generalized SAD, indicating its effectiveness in reducing anxiety and depression while enhancing the quality of life.

g. Who has researched the most in this field?

The observation made in Table 1 indicates that each researcher has only published one research article that aligns with the searched keywords. This suggests that there are future research opportunities in this area, as

the limited number of publications implies that there is still much more to explore and investigate.

CONCLUSION

In summary, the extensive literature review has revealed an intriguing direction for the progression of social anxiety disorder treatments. The assessments of serious games and VRET as part of CBT in the explored academic publications demonstrate the possibility of creating a powerful combined method. Combining VRET and serious games throughout various phases of CBT shows significant potential in offering a comprehensive and captivating therapeutic journey for individuals managing social anxiety. Leveraging the immersive and interactive nature of virtual reality, patients can confront anxiety-inducing scenarios in a controlled environment. Simultaneously, incorporating serious games makes therapy more enjoyable, motivating, and accessible.

Furthermore, the potential use of smartphones as a medium for this hybrid approach offers the advantages of portability and convenience, making therapy more accessible and adaptable to individuals' daily lives. While this hybrid approach shows immense potential, it is essential to emphasize the need for rigorous research and clinical trials to refine and validate these methods.

By exploring the possibilities of combining VRET, serious games, and smartphone technology within CBT for social anxiety, there exists the opportunity to revolutionize the field, offering individuals a more effective, engaging, and accessible path to conquer and enhance their quality of life. This research lays the foundation for exciting advancements in the treatment of SAD.

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