

Exploring Therapeutic Horizons: A Bibliometric Analysis of the Use of Virtual Reality in the Treatment of Schizophrenia

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Abstract— *The present study explores the application of virtual reality (VR) as an innovative therapy in treating schizophrenia, a condition that presents significant challenges with existing therapeutic approaches. Through a comprehensive bibliometric review using Web of Science, Scopus, and the Bibliometrix package, this work analyzes 252 articles, highlighting the growing prominence of VR in research. The results indicate growing international collaboration, with the UK, US, and Canada leading in contributions. Keyword analysis underscores a focus on “virtual reality exposure therapy,” suggesting growing interest in this modality. The findings support the potential of VR to improve the quality of life of patients, alleviating symptoms and improving social and cognitive functions. This analysis highlights the need for more research to optimize and validate VR as a therapeutic tool, pointing towards a promising future in the personalized treatment of schizophrenia.*

Keywords— *Schizophrenia, Virtual Reality, Cognitive Therapy, Bibliometric review.*

I. INTRODUCTION

Schizophrenia is a chronic and highly complex mental disorder characterized by psychotic symptoms and difficulties in social and cognitive function [1]. The constant search for innovative treatments that improve the quality of life of those affected is crucial in the medical field despite significant advances in psychopharmacology and psychological therapies. Although effective in managing symptoms, current treatments can lead to adverse side effects, highlighting the need for new, safer, and more efficient therapeutic options [2-4]. According to the World Health Organization (WHO), schizophrenia affects approximately 24 million people worldwide, representing a major public health challenge and underscoring the urgency of developing innovative and accessible therapeutic strategies [5,6]. Likewise, over the years, there have been significant advances in the early detection and accurate diagnosis of schizophrenia, as well as in the evolution of treatments, which have moved from the exclusive use of antipsychotics to more holistic therapeutic approaches. However, significant challenges remain, such as the need to personalize treatments due to variability in patient symptoms [7].

In this context, virtual reality has been presented as an emerging and promising therapeutic option, generating great interest due to its potential to offer immersive and personalized interventions [8,9]. Likewise, virtual reality introduces an innovative dimension to psychological therapy, creating controlled and adaptive environments that allow patients to face anxiety-provoking situations, with promising results in reducing symptoms such as paranoia and auditory hallucinations. Additionally, this technology has been used for social and cognitive skills training, allowing patients to practice interactions in realistic virtual environments and improve their performance in real social situations [10,11]. The flexibility of virtual reality allows treatments to be adapted to individual needs, offering a more precise and effective therapeutic approach. Therapists can adjust virtual environments and activities according to the progression of each patient, which is complemented by the possibility of continuous evaluation through the immediate feedback offered by technology. Therefore, given the heterogeneity of schizophrenia, virtual reality emerges as a promising tool due to its ability to provide immersive and personalized experiences [12-21].

The need to explore in depth the impact and scope of these innovations justifies a bibliometric review focused on the application of virtual reality in managing schizophrenia. This study will recapitulate the most recent discoveries and evaluate the effectiveness and safety of these interventions. However, it will also highlight research trends, identify gaps in current knowledge, and promote cooperation between different disciplines.

Specialized databases such as Scopus and Web of Science have been selected for this review, and analytical tools such as Rstudio and VosViewer have been used. Preliminary results indicate that virtual reality not only contributes to the reduction of specific symptoms of schizophrenia but also facilitates the development of social and cognitive skills. This represents a significant advance towards more precise and effective treatments.

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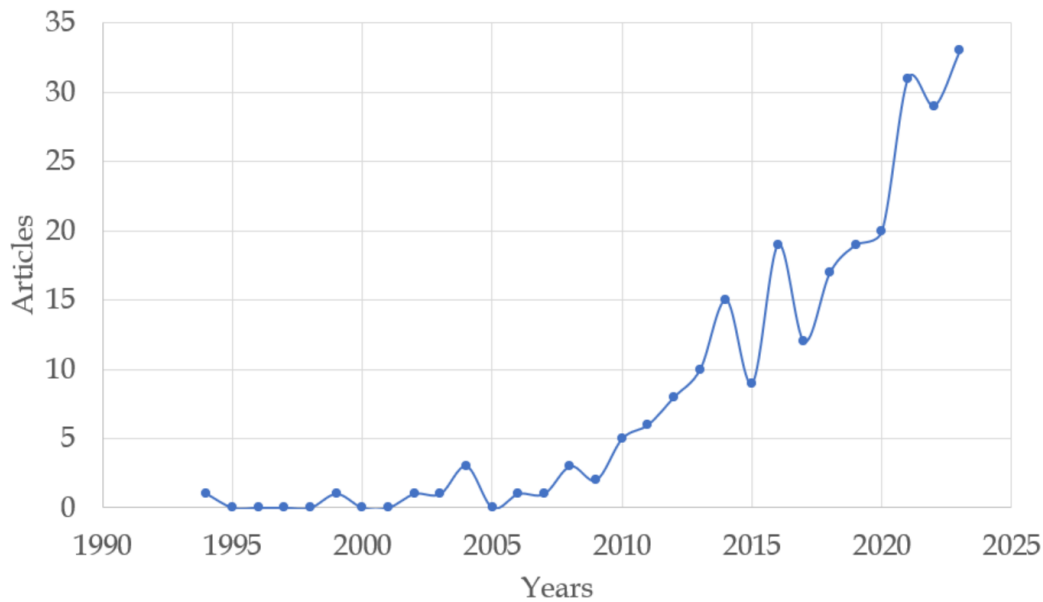


Figure 1: *Annual Scientific Production*

This review aims to guide future research and encourage the development of innovative therapeutic approaches, highlighting the value of virtual reality as a therapeutic resource and its positive influence on clinical practice for treating schizophrenia. Additionally, it seeks to inform and guide clinical practice, health policies, and technological innovation, highlighting its importance in the evolution of treatments for schizophrenia and its significant contribution to the academic literature in this field.

II. MATERIALS AND METHODS

This analysis was based on data collection from Scopus and Web of Science, two of the main academic databases worldwide, recognized for their extensive collection of academic documents and the rigor of their selection criteria, to identify a representative sample of relevant research on the topic of interest.

Four inclusion criteria were defined for the selection of studies: Type of document: original articles; Publication languages: English, French, Hungarian, Italian, Korean, Polish, and Spanish; Content on the use of virtual reality in schizophrenia; Publication period: from 1994 to 2023. The exclusion criteria applied were: Types of documents such as proceedings, editorials, summaries, and book chapters; Publications in languages other than those specified; Contents not related to the topic of study; Studies not indexed in the databases above; Duplicate posts. The emerging nature and progressive evolution of research in this field justify the choice of the time interval from 1994 to 2023. The year 1994

marks the beginning of interest in the application of virtual reality in schizophrenia, reflecting the first efforts to integrate this technology in treating the condition. Extending the analysis until 2023 allows us to capture the most recent evolution and trends in research, offering a broad and updated perspective on the therapeutic use of virtual reality in schizophrenia [22-24].

The search in both databases was carried out using the equation (“Virtual reality” OR “VR”) AND (“Therapy” OR “Treatment”) AND (“Schizophrenia”), resulting in a total of 252 documents. These were subjected to a bibliometric analysis using the VOSviewer software and the Bibliometric package in R to scientifically map the connections between authors and the most recurrent keywords. This approach allowed visualization of collaboration networks and predominant themes, providing a detailed understanding of the dynamics and research foci in using virtual reality to treat schizophrenia.

III. RESULTS AND DISCUSSION

During examining the Scopus and Web of Science databases, 174 and 152 publications were identified, respectively, adding 326 documents with a high relevance potential between 1994 and 2023 after eliminating 74 duplicate articles, consolidating a collection of 252 works suitable for study. These were subsequently analyzed through bibliometric techniques using specialized tools such as the VOSviewer 1.6.1 and Rstudio software, complemented by the Bibliometrix package [22,23].

A. Annual Production

Figure 1 reflects a clear evolution in the frequency of publications from 1994 to 2023. At the beginning of the period examined, incipient research activity is perceived, characterized by a low generation of articles, evident in the absence of publications, for several consecutive years in the 1990s and early 2000s. This initial trend could suggest that the field was in its early stages of development or did not have widespread recognition in the scientific community. As time passes, a gradual and sustained increase in the production of articles is observed, with notable growth starting in 2004. The following decade marks a period of significant expansion in the volume of published research, highlighting a quantitative leap from 3 publications in 2004 to 15 in 2014. However, the data analysis reveals certain annual fluctuations that could be attributed to external contextual variables, such as changes in research funding policies, modifications in the editorial agendas of scientific journals, or the influence of global events. An example of this variability is evident in 2015 when production dropped to 9 items after a year of prominent growth.

The time interval between 2014 and 2023 stands out for a substantial increase in the volume of publications, with 2021 recording the highest peak with 31 articles. The following two years show a slight decrease and subsequent recovery, with 29 articles in 2022 and a new increase to 33 articles in 2023, indicating that the field of study continues to be relevant and that scientific production remains robust.

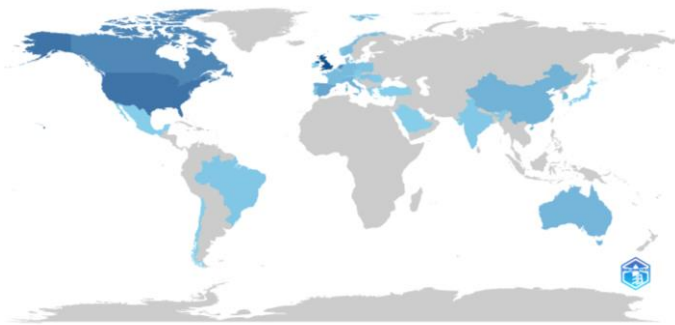


Figure 2: Country scientific production

B. Production by country and collaborations

Figure 2 shows the geographical distribution of scientific production; the color coding also varies in intensity to represent the volume of scientific contributions per country. The United States leads in research production in this domain, evidenced by a deep blue hue. A more saturated blue also distinguishes Australia and Canada; this prominence may indicate advanced research infrastructure and significant

investment in exploring emerging therapeutic modalities. An intermediate production level is shown on the European continent, as reflected in a lighter blue hue. The paler representation of blue in vast regions of Africa, Latin America, and Asia can be interpreted as limited scientific production in this field. This limitation could be attributed to a variety of factors, including, but not limited to, the availability of financial and technological resources, prioritization of research in other health settings, or differences in the prevalence or therapeutic approaches to schizophrenia.

Figure 3 shows publications classified by the country of the corresponding author, differentiating between publications from a single country (SCP) and publications resulting from international collaborations (MCP). It is identified that the United States leads in the production of documents with a notable preponderance of SCP, which could indicate a robust intranational research capacity. The United Kingdom is in a prominent position, manifesting a more homogeneous balance between SCP and MCP, reflecting a comparatively equal propensity towards domestic and international collaborations. Canada, with a significant presence of SCP and a minor participation of MCP, together with Spain, which presents a considerable number of MCP, suggests different approaches or collaboration strategies. Countries like Italy, the Netherlands, Australia, China, and Germany exhibit comparable publication volumes. However, they are distinguished by the relative distribution of SCP versus MCP. Nations with a smaller corpus of publications, such as Korea, France, Denmark, Switzerland, Norway, Poland, Portugal, Brazil, the Czech Republic, and Hungary, contribute to the SCP and MCP areas. This participation underlines the presence of cross-border collaborations regardless of production volume.

C. Production by authors and collaborations

In the bibliometric analysis, a distinctive hierarchy in the contribution of the authors is also denoted. It was found that researchers DUMAIS A and VELING W distinguish themselves as leaders in academic production, with 16 publications each, which positions them as possible preeminent figures in this sphere of study. Following closely, authors FREEMAN D, PHRAXAYAVONG K, and POTVIN S, each with 15 contributions, exhibit significant research activity and could exert considerable influence within the community interested in this therapeutic approach. Likewise, DELLAZIZZO L contributes with 13 articles; likewise, a stratum of authors is identified who show a moderate number of publications, such as WAITE F with nine and RUS-CALAFELL M with 8, followed by a group of researchers who have contributed with seven or fewer items.

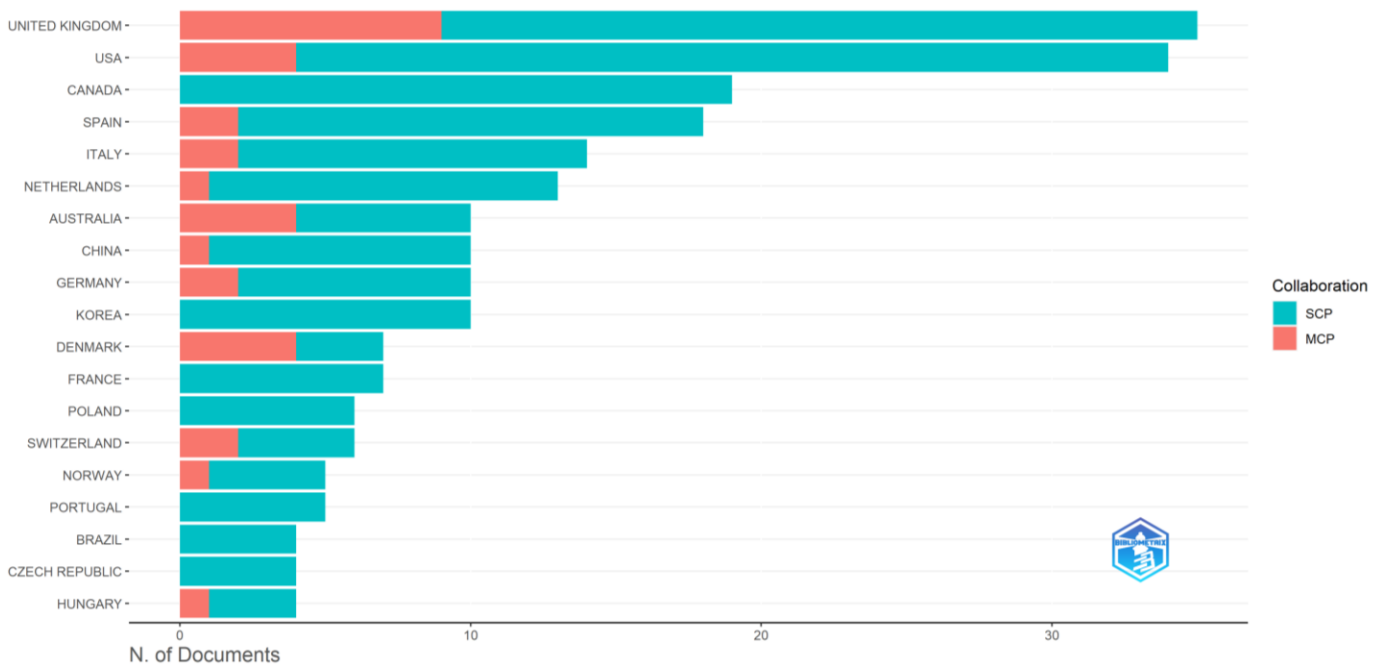


Figure 3: Countries of the corresponding authors

Therefore, the plurality of authors (1040) with multiple articles indicates the existence of specialized subdomains within the central topic and suggests interdisciplinary collaborations that could enrich the progress of this innovative therapy.

the magnitude of the nodes suggests a voluminous academic production with a strong impact on the field. The blue cluster is organized around FREEMAN D. It is made up of authors such as WAITE F, CLARK D, and LAMBE S. This group has FREEMAN D in a central position of interaction, which implies a significant role in the integration of the community researcher and mentoring in collaborative projects. The smaller red cluster centered on VELING W suggests a more focused collaboration with fewer authors involved, as seen in the fewer connections.

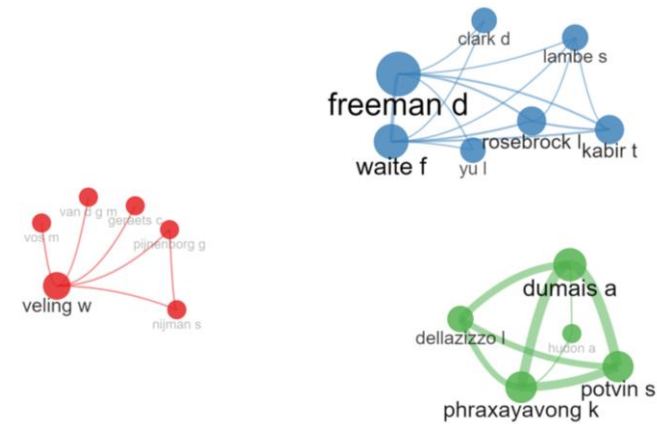


Figure 4: Authors and the collaboration networks.

The collaboration network in Figure 4 shows the collaborations between researchers in this field. Thus, three main clusters are identified, each denoting different dynamics and levels of collaboration. The green cluster, with DUMAIS A as the featured author, is characterized by a high density of connections, indicating close collaboration and a series of joint publications. The authors DELLAZZO L, PHRAXAYAVONG K, and POTVIN S also stand out within this group, suggesting their relevance in production. Likewise,

Figure 5 illustrates the research trajectory of various authors in the area, revealing publication patterns and the accumulation of citations over time. The authors DUMAIS A and VELING W exhibit constant and prolonged research activity, with publications distributed over 5 and 9 years. Furthermore, FREEMAN D, the author with the longest career, emerges as a reference in the area, showing an upward trajectory in terms of citations, suggesting a growing recognition of his contributions. On the other hand, PHRAXAYAVONG K, POTVIN S, and DELLAZZO L present intermittent production with high-density points in specific years. In contrast, WAITE F, RUS-CALAFELL M, and KIM J demonstrate a lower frequency of publications. Finally, KABIR T has a short history in terms of production and citations; this suggests that the author is in the initial stages of his research career or that his approaches are more specialized or recent in the field of study.

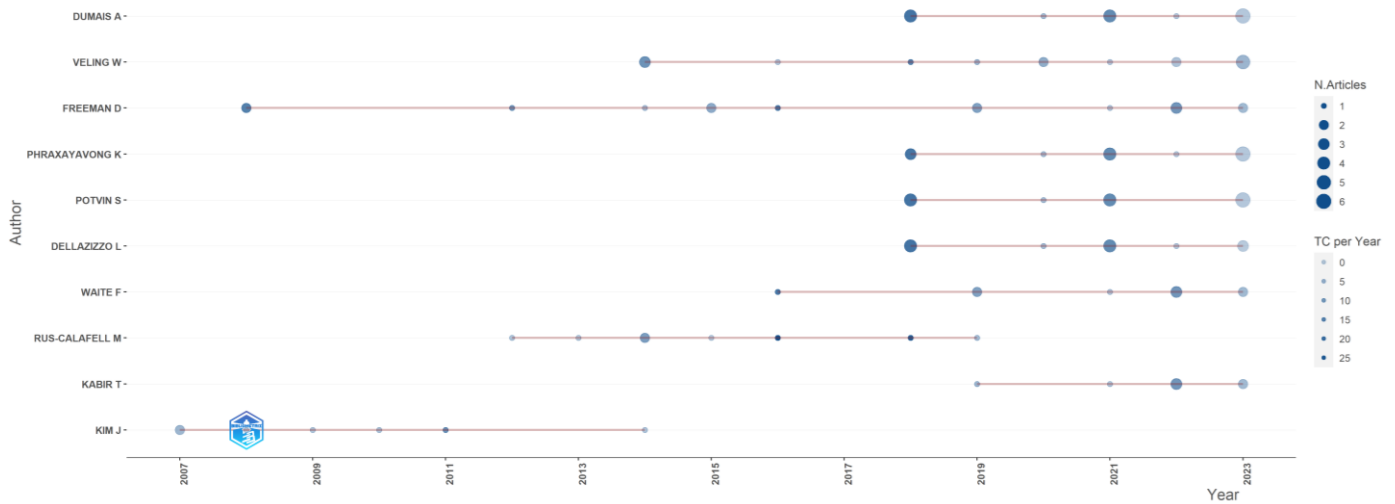


Figure 5: Authors Production Over Time

D. Keywords

Figure 6 shows a word cloud to synthesize and emphasize the predominant terms in the study. The terms "schizophrenia" and "virtual reality" stand out for their size, confirming their predominant frequency and central role in research. Concepts such as "social functioning", "cognitive remediation", and "psychosis" are also notable, implying that they are recurring topics. The relevance of these terms underscores a focus on improving social functionality and cognition. Furthermore, the emergence of "auditory hallucinations", "paranoia", and "delusions" suggests particular attention to these specific psychopathological symptoms and how virtual reality could be instrumental in their treatment. The inclusion of "avatar therapy" and "mental health" indicates that the review encompasses explorations of innovative approaches and the overall impact of virtual reality on mental health.



Figure 6: Keywords

Figure 7 allows us to visualize the interrelationships between key concepts in the literature relevant to the use of virtual reality in therapeutic contexts for schizophrenia. The central core of the graph, denoted by red nodes, highlights "schizophrenia" and "virtual reality" as the predominant thematic axes, around which other terms related to psychotic treatment, mental health, and cognitive behavioral interventions are articulated. This grouping suggests a

concentration intersection of virtual reality with intervention strategies for schizophrenia, focusing on the improvement of cognition and the modulation of psychopathological symptoms. On the other hand, the blue nodes reveal a specific focus on the symptoms of schizophrenia and schizophrenia spectrum disorders, with special mention of "delusions" and "activities of daily living", which are interpreted as an interest in the application of exposure therapies through virtual reality to improve functionality in the daily lives of those affected. On a third level, the green nodes concentrate on particular symptoms such as auditory verbal hallucinations and avatar therapy, showing an orientation towards the application of new technologies, such as machine learning, in psychotherapy and in the simulation of social interactions through virtual avatars. Finally, the purple nodes address more abstract conceptual elements such as the "theory of mind" and "social cognition training", manifesting an area focused on developing and strengthening social cognitive skills through training assisted by virtual reality.

E. Source Impact

The study analyzed the local impact of various academic journals through quantification through the H index. The magazine "Schizophrenia Research" is presented as the most preeminent source with an H index of 11, being a significant influence in the study of schizophrenia. In addition, "Schizophrenia Bulletin" has an H index of 9 and is consolidating itself as another important source in disseminating high-impact research. Publications such as "Annual Review of Cybertherapy and Telemedicine", "Frontiers in Psychiatry", "Cyberpsychology and Behavior", and "Cyberpsychology Behavior and Social Networking" present important H indices that range between 4 and 5. Additionally, "Frontiers in Psychology", "JMIR Mental Health" and "Psychiatry Research" have a uniform H index of 4. The other academic sources have an H index of less than 4.

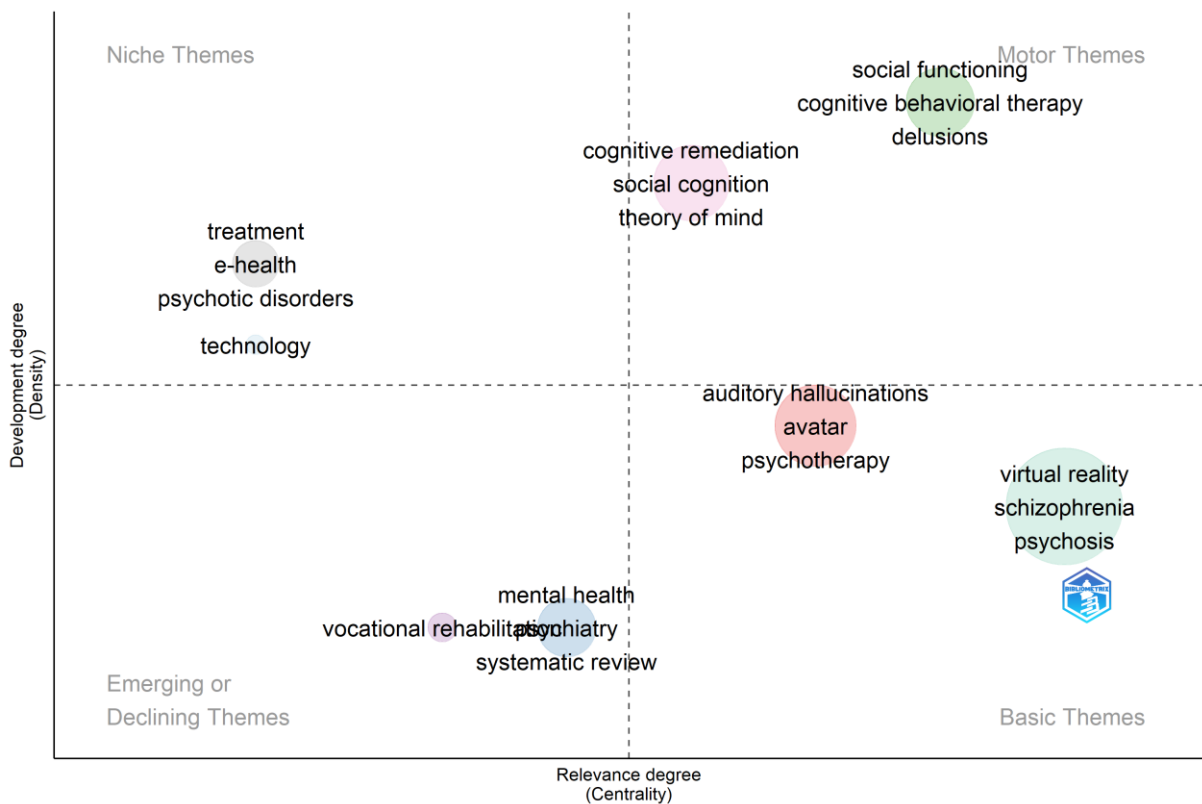


Figure 7: Thematic map

Figure 7 shows four quadrants that classify research topics according to their density, reflecting their degree of development and centrality. The topics in the "Driver Themes" quadrant have a high density and centrality, indicating that they are consolidated and fundamental research areas within the discipline. Terms such as "social functioning", "cognitive behavioral therapy", and "delusions" stand out as thematic axes. These themes act as pillars on which subsequent research is structured, marking the contours of the discipline. In contrast, the "Niche Topics" quadrant contains topics that have a relatively low centrality; here, "treatment", "e-health", "psychotic disorders" and "technology" represent specialized research areas that, although they are important, they do not constitute the main core of the research in the context of the study. The "Basic Themes" quadrant groups together themes that present a less dense development level than motor themes. This is evident in terms such as "virtual reality", "schizophrenia", and "psychosis", which are fundamental to the understanding of the subject. Finally, "Emerging or Declining Topics" are located in the quadrant, which suggests low density and centrality, which could reflect areas of research that are gaining traction and emerging as focuses of interest or, conversely, declining topics. In prominence and may require re-evaluation or innovative approaches to revive their relevance. Terms such as "vocational rehabilitation", "psychiatry", and "mental health" are found in this segment

IV. CONCLUSIONS

The present bibliometric analysis focused on using virtual reality (VR) as an innovative treatment for schizophrenia. The study analyzed 252 articles and revealed increased international collaboration, with the United Kingdom, the United States, and Canada leading in contributions. Additionally, "virtual reality exposure therapy" was highlighted as an area of growing interest, underscoring its potential to improve patients' quality of life, alleviate symptoms, and improve social and cognitive functions. On the other hand, the analysis of scientific production and collaboration by country indicates that while some regions show a solid research infrastructure and a high volume of contributions, other areas, especially in Africa, Latin America, and parts of Asia, have a limited production, which could be due to factors such as the availability of resources and the prioritization of research in other health fields.

Authors DUMAIS A and VELING W were identified as leaders in academic production, each with 16 publications, closely followed by FREEMAN D, PHRAXAYAVONG K, and POTVIN S with 15 contributions each. These authors could have considerable influence on virtual reality applied to schizophrenia. Furthermore, a wide range of authors with multiple articles was observed, indicating the presence of specialized subdomains and interdisciplinary collaborations that enrich progress in this innovative therapy.

Finally, the present bibliometric review pointed out the growing importance of virtual reality in treating schizophrenia and underlined the need to continue exploring this therapeutic horizon. VR is presented as a valuable tool to improve the lives of patients with schizophrenia and represents a promising avenue for future research and clinical applications.

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