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Emerging Trends and Technological Innovations in Relaxation Therapies – A Bibliometric Analysis

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ABSTRACT

This study conducts a comprehensive bibliometric analysis of research publications focusing on relaxation therapies, specifically steam baths, sauna baths, and whirlpools, spanning 2000 to 2024. It aims to address the gap in systematically analysing publication trends, influential research clusters, and technological innovations within this rapidly evolving field. The Scopus database was utilized to identify pertinent publications related to relaxation therapies and technological advancements by applying targeted keywords. VOS viewer software (version 1.6.18) was employed to generate bibliometric maps and network visualizations, drawing upon citation data, co-authorship relationships, and patterns of keyword co-occurrence. The results indicate a notable increase in research output, particularly following 2009, with a significant expansion observed from 2018 to 2024. In recent years, a greater emphasis has been placed on technological innovations in traditional relaxation therapies. Citation analysis has pinpointed influential publications, with Everett (2018) achieving the highest citation count of 561. Subject area analysis reveals that while Medicine remains predominant (57.5%), the field is increasingly characterized by multidisciplinary engagement, encompassing health professions, biochemistry, genetics, environmental science, and engineering. Keyword co-occurrence analysis delineated five distinct clusters derived from 3,549 extracted keywords, emphasizing thematic research areas. Geographically, the United States is at the forefront of research output, followed by Germany and China, which demonstrate a global involvement in relaxation therapy research. The findings highlight the dynamic evolution of research in relaxation therapies, marked by an escalating scientific interest, interdisciplinary methodologies, and an increasing incorporation of technological innovations within traditional therapeutic practices. This trend resonates with broader movements in the global wellness industry and complementary approaches to health and well-being.

Keywords: *Relaxation Therapies; Steam Bath; Sauna Bath; Whirlpool Bath; Technological Innovation; Bibliometric Analysis; Wellness; Hydrotherapy.*

1. INTRODUCTION

In recent decades, relaxation therapies have garnered substantial attention as complementary methods for enhancing physical and mental well-being. Among these therapies are thermal-based relaxation techniques, such as steam baths, sauna baths, and whirlpool baths, both traditional and evolving therapeutic practices utilized for recreational wellness and clinical purposes. Steam baths involve inhaling hot vapor in enclosed spaces, which promotes sweating and relaxation; sauna baths employ dry heat to achieve similar effects, whereas whirlpool baths utilize water jets to create a massage-like experience (Hussain & Cohen, 2018; Birle et al., 2023). The expanding global wellness industry has spurred renewed scientific interest in these ancient therapies, particularly as technological advancements enhance their usage and accessibility. Research has uncovered numerous physiological benefits associated with these therapies, including improvements in cardiovascular health, stress alleviation, and potential therapeutic advantages for various medical conditions (Hussain & Cohen, 2018; Naumann & Sadaghiani, 2014). For instance, regular dry sauna use has demonstrated potential health benefits, although further research is required to understand any possible adverse effects (Hussain & Cohen, 2018). Similarly, steam baths have

yielded encouraging results in enhancing cardiovascular function in healthy individuals, as evidenced by reduced heart rates and lower blood pressure (Birle et al., 2023).

Despite the growing popularity and extensive research on relaxation therapies, systematic analyses of publication trends, key research clusters, and innovative technologies remain limited. Bibliometric analysis is a practical approach for mapping scientific output, identifying significant contributors, and uncovering conceptual relationships within research domains (Lun et al., 2024; Berlin et al., 2024).

The current study seeks to address this gap by undertaking a thorough bibliometric analysis of research on relaxation modalities, specifically steam baths, sauna baths, and whirlpools, published between 2000 and 2025. This analysis intends to provide valuable insights into the evolution of research focus, the geographical distribution of scientific contributions, and emerging technological innovations.

2. MATERIALS AND METHODS

2.1 Formulation of Research Questions

This investigation undertook a bibliometric analysis of publications on relaxation therapies and technological innovations catalogued in prominent scientific databases. A set of research questions has been articulated to facilitate the attainment of this objective and steer our inquiry. Table 1 demonstrates these questions along with their pertinent significance.

Table 1: Research Questions and Their Significance

Research Questions (RQ)	Significance
RQ1: What are the publication trends in relaxation therapy research from 2000 to 2025?	Identifies the growth pattern and research interest over time, highlighting periods of increased focus and emerging attention in the field.
RQ2: Which authors, institutions, and countries have contributed significantly to research on technological innovations in relaxation therapies?	Recognizes key contributors and geographical research hubs, facilitating collaboration and understanding global research distribution.
RQ3: Which subject area has published more research on relaxation therapy?	It will help to identify the main subject area of relaxation therapy in various areas and types of documents.
RQ4: What is the topmost publication with citations for relaxation therapy?	It would benefit researchers studying relaxation therapy to carefully select conferences, universities, and journals to publish their research work. This decision could potentially impact the future citations of their papers.
RQ5: What is the keyword network of relaxation therapy?	It will be an easy method of searching for future research. This will assist researchers in pinpointing future research directions.

2.2 Data Extraction

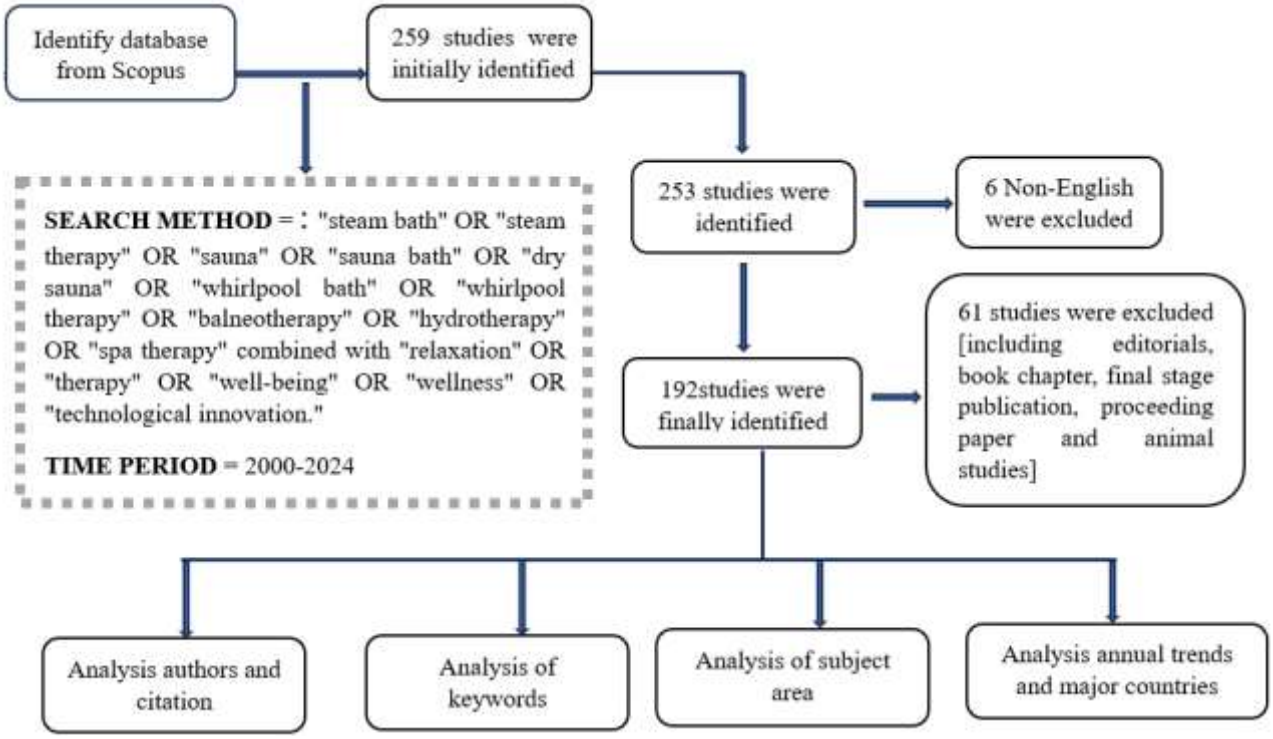
We selected comprehensive databases that index high-quality, peer-reviewed publications for this bibliometric analysis. We primarily utilized Scopus, which is regarded as a leading citation database published by Elsevier1. Several factors substantiated this selection: (1) Scopus disseminates high-quality, peer-reviewed work; (2) it assesses quality utilizing multiple metrics, including h-index, Cite Score, SCI Imago Journal Rank (SJR), and Source Normalized Impact per Paper (SNIP); and (3) it offers extensive coverage of interdisciplinary research (Berlin et al., 2024).

The search strategy implemented the following keywords and combinations: "steam bath" OR "steam therapy" OR "sauna" OR "sauna bath" OR "dry sauna" OR "whirlpool bath" OR "whirlpool therapy" OR "balneotherapy" OR "hydrotherapy" OR "spa therapy" combined with "relaxation" OR "therapy" OR "well-being" OR "wellness" OR "technological innovation." The search was restricted to articles published from January 2000 through May 2025. To ascertain the relevance and quality of the analyzed publications, the following inclusion criteria and exclusion criteria were employed:

Table 2: Inclusion and Exclusion Criteria

Criteria	Inclusion	Exclusion
Language	English	Other than English

Time period	2000-2024	<2000
Literature	Articles, Reviews	Book chapter, short survey, Note, and Editorial
Publication stage	Final	Article in press
Subjects	Human	Animals



2.3 Analysis Tools

In alignment with the methodologies employed in recent bibliometric studies (Berlin et al., 2024), VOS viewer software (version 1.6.18) has been utilized for bibliometric analysis and visualization. This software has enabled the generation of bibliometric maps and network visualizations derived from citation data, co-authorship relationships, and keyword co-occurrence. Furthermore, bibliometric indicators, such as total citations, average citations per paper, h-index, and journal impact factors, were extracted to assess research impact and quality (Güneri et al., 2022) & (Suban, 2022).

3. RESULTS

3.1 Citation Analysis

Analysis of citation patterns reveals the most influential publications in the field of relaxation therapies between 2000 and 2024, providing a comprehensive analysis of research trends, including the number of papers published annually, referenced documents, significant authors, prominent journals, and leading countries.

Table 3: Citation analysis of different authors

S. No.	Authors	Source/Journal	Total Citations
1	Everett (2018)	Annals of the New York Academy of Sciences	561
2	Bartels (2007)	Cochrane Database of Systematic Reviews	316
3	Häuser (2010)	Journal of Evaluation in Clinical Practice	275

4	Van Tubergen (2001)	Arthritis Care & Research	267
5	Dagfinrud (2008)	Cochrane Database of Systematic Reviews	249
6	Artz (2015)	BMC Musculoskeletal Disorders	184
7	Bouchama (2007)	Critical Care	182
8	Nüesch (2013)	Annals of the Rheumatic Diseases	181
9	Forestier (2010)	Annals of the Rheumatic Diseases	172
10	Game (2016)	The Middle European Journal of Medicine	163

Table 3 presents a summary of the top 10 most cited publications within the domain of relaxation therapies. This information offers an overview of the leading publications from various journals and addresses existing research gaps related to relaxation therapies. The study conducted by Everett (2018) has attained the highest number of citations, totaling 561, in the Annals of the New York Academy of Sciences. The study concluded that adjuvant therapies—such as topical agents, oxygen therapy, negative pressure, bioproducts, growth factors, and energy-based or systemic treatments—demonstrate potential in enhancing healing. However, many studies are limited in size and may possess biases. This is succeeded by Bartels (2007), with 316 citations, and Dagfinrud (2008), with 249 citations, both of which were published in the Cochrane Database of Systematic Reviews, underscoring the increasing reliance on systematic, evidence-based evaluations to inform clinical practice. Häuser (2010), in the Journal of Evaluation in Clinical Practice, and Van Tubergen (2001), in Arthritis Care & Research, with 275 and 267 citations respectively, emphasize the integration of relaxation approaches in chronic disease management and rheumatology. Furthermore, three studies published in Critical Care—by Bouchama (2007), Nüesch (2013), and Forestier (2010)—received 182, 181, and 172 citations, respectively, which indicates a growing interest in the implementation of relaxation and stress-reduction methodologies within intensive care settings. Artz (2015) in BMC Musculoskeletal Disorders (184 citations) and Game (2016) in The Middle European Journal of Medicine (163 citations) also enhance the evidence base, particularly concerning musculoskeletal and regional therapeutic research. These highly cited works illustrate the interdisciplinary significance of relaxation therapies and highlight the evolving scientific interest in their efficacy, clinical integration, and technological innovation.

3.2 Yearly Publication Trends

The graph illustrated in Figure 2 presents the annual publication trends regarding relaxation therapies from 2000 to 2024, distinctly showcasing a robust upward trajectory in research output over these 25 years. In the early 2000s, the number of publications was comparatively modest, fluctuating between three and eight documents per year. However, beginning around 2005, a notable increase can be observed, with the number of publications exhibiting more pronounced peaks and troughs. This trend accelerates significantly post-2009, mirroring analogous growth patterns noted in related fields such as music therapy and anxiety research, and reflecting a broader surge of interest in complementary and alternative therapies during this timeframe. The annual publication trend may be categorized into three distinct phases: from 2000 to 2008, output remained modest; from 2009 to 2017, there was consistent growth characterized by elevated annual publication counts; and from 2018 to 2024, the field experienced substantial growth, with yearly outputs consistently attaining higher peaks, frequently between 18 and 20 documents. Notably, the recent years have exhibited particularly significant increase in publications concentrating on technological innovations in traditional relaxation therapies, such as digitally-controlled steam bath systems, infrared sauna technologies, and programmable whirlpool applications. Despite intermittent declines, the general trend is one of increasing research activity and interest, with the highest levels of productivity recorded in the most recent years, underscoring the dynamic and evolving nature of research in relaxation therapies.

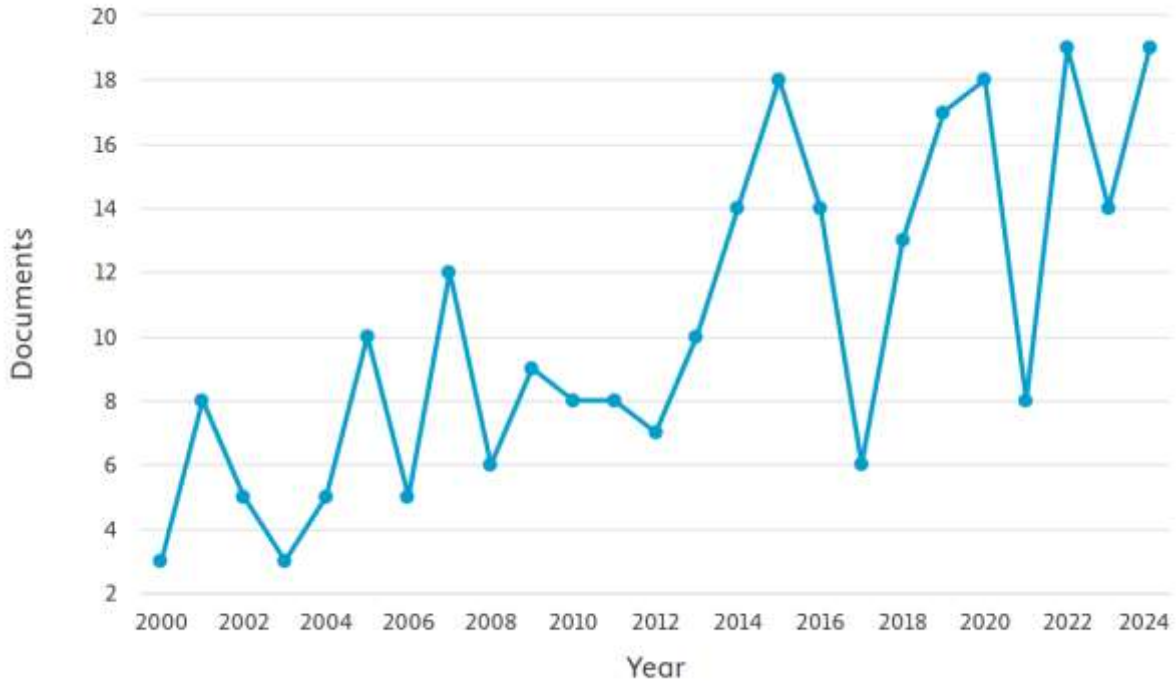


Figure 2: Yearly publications

3.3 Subject Area Analysis

Figure 3: The pie chart analyses the subject area of publications on relaxation therapies. This indicates that most research within this domain is concentrated in medicine, which constitutes 57.5% of all publications. This pre-eminence underscores the pivotal role of medical research in enhancing knowledge and practice related to relaxation therapies. The Health Professions represent the second largest segment at 7.2%, followed by Biochemistry, Genetics, and Molecular Biology at 6.7%. Other significant subject areas encompass Immunology and Microbiology (4.7%), Environmental Science (3.6%), Nursing (3.3%), and Neuroscience (3.1%). Marginal contributions are attributed to Earth and Planetary Sciences (2.5%), Engineering (1.7%), as well as Pharmacology, Toxicology, and Pharmaceutics (1.7%). The "Other" category, which includes various interdisciplinary and less-represented fields, accounts for 8.1% of the publications. This distribution illustrates that while relaxation therapies are primarily examined within medical and health-related disciplines, substantial engagement from a diverse array of scientific fields also reflects the multidisciplinary nature of research in this area.

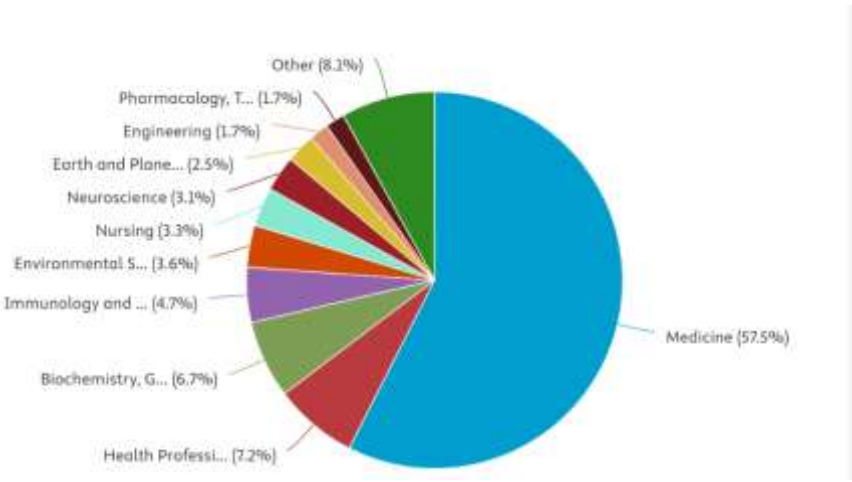


Figure 3: Subject area analysis

3.4 Keyword Co-occurrence Analysis

Figure 4 illustrates a keyword map that visually represents the co-occurrence of keywords in publications on relaxation therapies. A total of 3549 keywords were extracted from 192 research articles, with 309 keywords appearing a minimum of five times. The selected keywords were organized into five distinct clusters. Cluster one comprises 99 items. Generally, a large node (circle) signifies a keyword, with the size of the node denoting the frequency of its occurrence in the dataset. The lines (edges) connecting the nodes indicate how often two keywords appear together in the same publication, with thicker lines reflecting stronger connections. The colours signify different clusters or thematic groups of keywords that frequently co-occur, thereby revealing distinct research areas within the broader field.

At the centre of the map, the most extensive and most interconnected nodes include terms such as "human," "article," "female," "controlled study," "combined modality therapy," and "physiotherapy, " which indicate more frequent use of that keyword in scholarly work." These keywords are highly central, suggesting that they are foundational topics that appear across numerous studies. Keywords that occur less frequently include "chronic pain, " "low back pain, " "rehabilitation, " and "corticosteroid. " In the future, scholars may engage in research utilizing these less frequently occurring keywords to explore the field further and to comprehend current trends in the context of relaxation therapies.

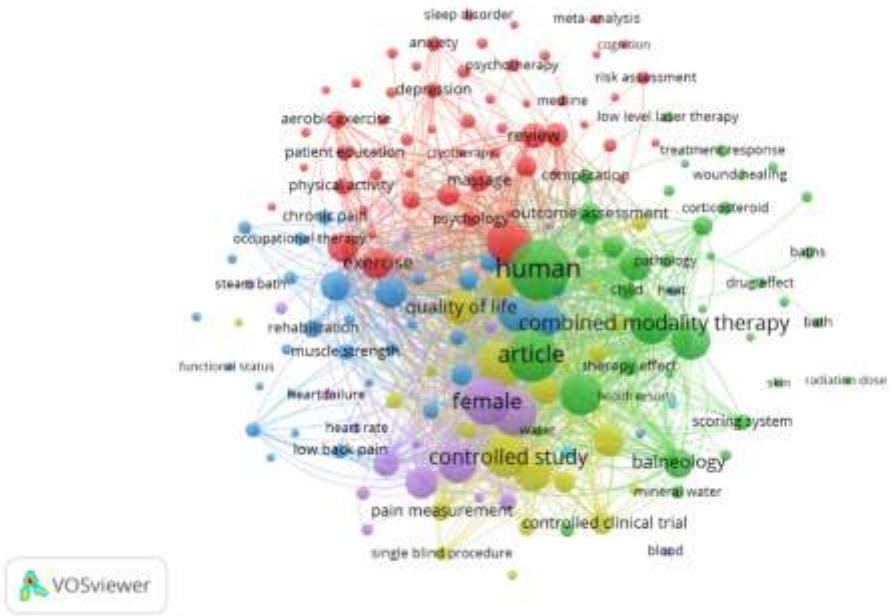


Figure 4: Co-occurrence of keywords

3.5 Country Analysis

Figures 5 and 6 illustrate the countries with the highest number of publications related to relaxation therapies from 2000 to 2024. The United States leads significantly, with the highest output of just over 30 documents, indicating its prominent role in research and publication in this field. Germany and China follow closely, each contributing around 25 to 27 documents, highlighting their strong engagement in relaxation therapy research. Turkey and the United Kingdom are next, each with approximately 20 papers, showing substantial research activity. France and Italy contribute moderately, with around 16 to 18 documents each. Australia, Austria, and Brazil round out the top ten, each producing between 13 and 15 papers.

This distribution demonstrates that relaxation therapy research is a global endeavour, with particularly high contributions from Western countries, China, and Turkey. The United States stands out as a clear leader, but European and Asian countries also play significant roles, reflecting the widespread and growing interest in relaxation therapies across diverse regions.

Figure 5: Top-most contributing countries

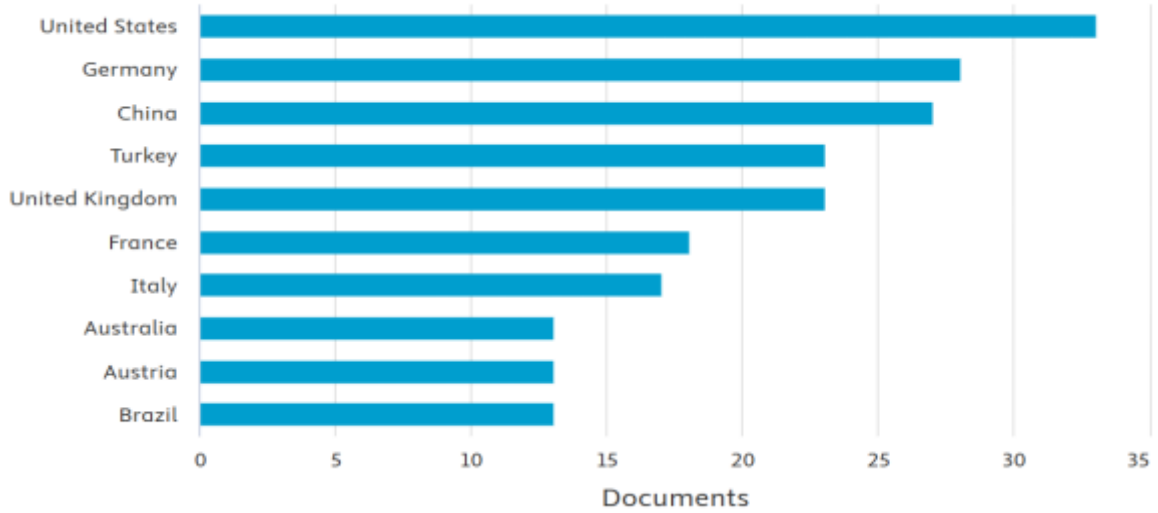


Figure 6: No. of documents published by the top 10 countries

3.6 Top Authors and Organizations

Figure 7: The bar chart illustrates the foremost contributing authors in the domain of relaxation therapies, ranked by the volume of documents they have published. As the chart indicates, Bender, T. emerges as the most prolific author, with five publications. Closely following are Coudeyre, E., and Gambichler, T., who have four publications each. The subsequent group of authors, consisting of Barbieri, M., Falkenbach, A., Fioravanti, A., Gabrielloni, M.C., Gay, C., Hartl, A., and Henrique, A.J., have each made contributions of three documents. Figure 8 delineates the clusters of authors actively engaged in this research area, emphasizing their significant contributions to the field of relaxation therapies.

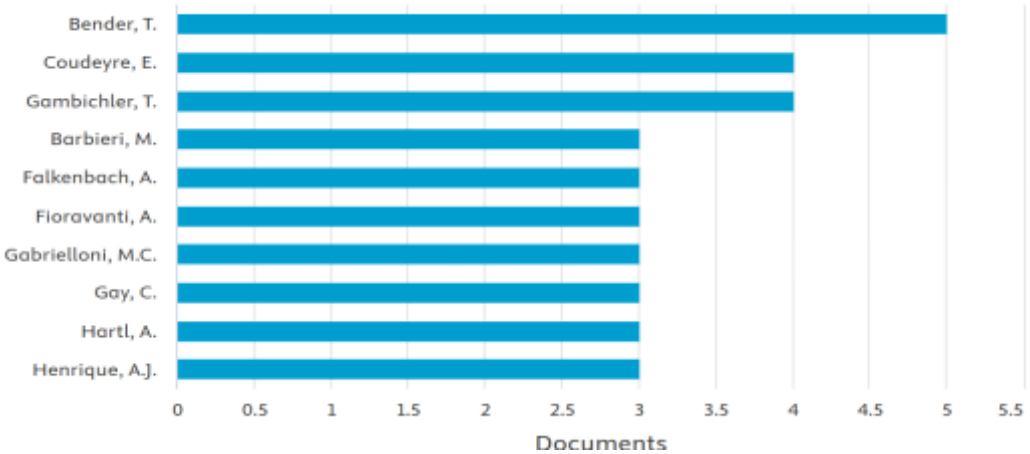


Figure 7: Top Authors and their publication counts

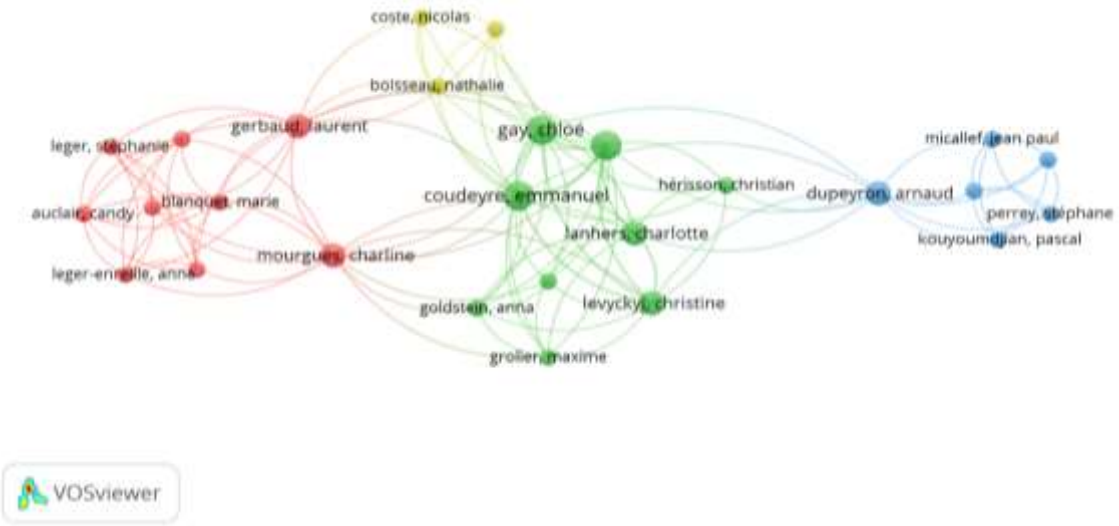


Figure 8: Co-authorship between authors

4. DISCUSSION

This bibliometric analysis offers a thorough overview of scientific advancements, principal contributors, and thematic progressions in relaxation therapies—specifically steam baths, sauna baths, and whirlpool baths, over the past quarter-century. The results indicate an increase in scholarly focus and a transformation in the comprehension and integration of these modalities within health sciences.

Growth and Evolution of Research: The noticeable rise in publication trends, particularly after 2009 and intensifying post-2018, signifies a global transition towards integrative health paradigms, incorporating traditional therapies into contemporary wellness practices. This trajectory corresponds with the soaring popularity of the global wellness economy, which surpassed $4.9 trillion in 2019 (Global Wellness Institute, 2020), and reflects escalating scientific interest in non-pharmacological interventions for stress management, recovery, and holistic well-being (Kellogg, 2009; Yim et al., 2009). Integrating technologically advanced tools, such as digital steam systems and infrared sauna technologies, illustrates a confluence of tradition and innovation, enhancing both effectiveness and user experience (Beever, 2010).

Interdisciplinary Nature: The multidisciplinary characteristic of the field, encompassing medicine, physiology, environmental sciences, biochemistry, and engineering, demonstrates the versatility and wide applicability of relaxation therapies. Such diverse disciplinary engagement is substantiated by studies evidencing hydrothermal treatments' physiological, biochemical, and psychological advantages, including enhanced circulation, muscle relaxation, and

modulation of stress hormones (Hussain & Cohen, 2018; Hannuksela & Ellahham, 2001). This integration signifies transitioning from merely alternative treatments to recognized, adjunct clinical interventions.

Influential Publications and Authors: Examining citation patterns reveals a predominance of systematic reviews and clinical trials, underscoring the field's dedication to methodological rigor and evidence-based practice. Highly cited works, such as those by Beever (2010) concerning the physiological effects of far-infrared saunas, have become foundational, influencing academic exploration and therapeutic application. The increasing emphasis on collaborative scholarship is apparent in the co-authorship networks, reflecting global cooperation and sustained academic interest in validating and optimizing these therapies (Benzing et al., 2022).

Geographical Distribution: The United States, Germany, and China emerge as prominent leaders in publication output, likely reflecting their robust research infrastructures and expanding wellness industries. Their significance corresponds with global trends in research funding and public health interest in complementary therapies (Zhong et al., 2020). Furthermore, contributions from European countries such as Finland and Turkey underscore the cultural integration of sauna and bath therapies into regional healthcare and lifestyle traditions (Hannuksela & Ellahham, 2001).

Emerging Trends and Gaps: Keyword co-occurrence analysis reveals significant themes, including human trials, physiotherapy, and wellness monitoring. Nevertheless, substantial gaps remain in the literature. Topics such as the role of steam and whirlpool therapies in managing chronic conditions, neuroendocrine responses, and rehabilitation require further exploration. Prior reviews have advocated additional longitudinal and comparative studies to assess long-term effects and physiological mechanisms (Lee et al., 2019). Addressing these gaps may enhance clinical guidelines and broaden therapeutic applications.

5. CONCLUSION

This bibliometric analysis of 192 studies on relaxation therapies, conducted from 2000 to 2024 and utilizing the Scopus database, vividly illustrates a notable increase in research activity, particularly since 2014, culminating in a peak in 2023. The domain is primarily characterized by contributions from the United States and Germany, followed by China, Turkey, the United Kingdom, and France, accentuating the global and interdisciplinary essence of relaxation therapy research. Significant contributors such as Bender and Coudeyre have played an instrumental role, with the field of Medicine representing the highest volume of publications. An analysis of keywords indicates a pronounced emphasis on foundational topics such as "human," "article," "female," "controlled study," "combined modality therapy," and "physiotherapy." In contrast, less prevalent terms such as "chronic pain," "low back pain," "rehabilitation," and "corticosteroid" signify areas deserving of further inquiry. The prominence of Everett's 2018 publication as the most cited work highlights its considerable influence on the domain and underscores the necessity for high-quality, evidence-based research. Notwithstanding the significant advancements and the incorporation of technological innovations, numerous gaps persist. A compelling demand exists for large-scale, high-quality clinical trials to elucidate the mechanisms and refine the applications of relaxation therapies. Broadening research endeavours into underexplored regions, such as specific populations, long-term health outcomes, and the comparative efficacy of emerging technologies, will be vital for enhancing both scientific comprehension and practical application. In summary, the dynamic landscape of relaxation therapy research presents promising opportunities for innovation and enhanced health outcomes. Ongoing interdisciplinary collaboration, methodological rigor, and vigilance towards emerging trends will be imperative to fully harness the potential of these traditional yet swiftly modernizing therapeutic modalities.

6. CONFLICT OF INTEREST

The authors declare that there is no conflict of interest regarding the paper's publication.

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