

# **Bibliometric Analysis of Past Yoga Research Trends to Shape Future Health and Sports Investigation**

**Short title:** Bibliometric Analysis of Yoga Trends

Sara Santos<sup>1,2,3\*</sup>, Alejandro Vega-Muñoz<sup>4,5</sup>, Miguel A. Garcia-Gordillo<sup>6</sup>, Ricardo H. Gonzalez<sup>7</sup>, Filipe Melo<sup>2,8</sup>, Orlando Fernandes<sup>1,2</sup>, José Carmelo Adsuar<sup>9,10</sup> and José Alberto Parraca<sup>1,2</sup>

<sup>1</sup> Departamento de Desporto e Saúde, Escola de Saúde e Desenvolvimento Humano, Universidade de Évora, Évora, Portugal.

<sup>2</sup> Comprehensive Health Research Centre, CHRC, Universidade de Évora, Évora, Portugal.

<sup>3</sup> Escola Superior de Saúde (ESS), Universidade do Algarve (UALG), Algarve, Portugal.

<sup>4</sup> Facultad de Medicina y Ciencias de la Salud, Universidad Central de Chile, Santiago 8330507, Chile.

<sup>5</sup> Facultad de Ciencias Empresariales, Universidad Arturo Prat, Iquique 1110939, Chile.

<sup>6</sup> Departamento de Administración y Economía, Universidad de La Frontera, Temuco 4811230, Chile.

<sup>7</sup> Institute of Physical Education and Sports-Post-Graduation Program in Public Health - Federal University of Ceará, Brasil.

<sup>8</sup> Universidade de Lisboa, Faculdade de Motricidade Humana (FMH), Cruz Quebrada, Lisboa, Portugal.

<sup>9</sup> Universidad de Extremadura, Facultad de Ciencias del Deporte, Cáceres, Spain.

<sup>10</sup> Faculty of Human Kinetics, CIPER, University of Lisbon. Lisbon, Portugal.

**\*Corresponding author:**

**E-mail:** sagsantos@ualg.pt

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Alejandro Vega-Muñoz:  
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José Carmelo Adsuar:  
José Alberto Parraca:

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ISCE DOURO- Higher Institute of Education Sciences of Douro, Penafiel, Portugal

## ABSTRACT

This study employs a bibliometric analysis to systematically identify and analyse systematic reviews related to yoga. The objectives include elucidating publication characteristics, exploring trends in its application in medicine, sports performance and occupational health, assessing methodology, and identifying gaps in research findings. Data were obtained from the Web of Science (WoS) Core Collection. A thematic search for "yoga" in review articles was conducted, and temporal evolution, contributors, and citation analysis were performed. A total of 1260 review articles from 76 countries were analysed. Prolific authors, journal concentration, and keyword usage were evaluated. Contributions span 76 countries and involve 5052 authors. 57 prolific authors were identified, with Holger Cramer standing out with 36 contributions. The h-index of the collective set of 1260 review articles was 93. Bibliometric indicators guided the analysis but did not ensure in-depth discussions. Yoga studies appeared in a range of Impact Factor journals. Consistent terminology is crucial for clarity and replication. Prominent research areas include yoga for mood disorders and low back pain. Despite the progression of time, the lack of information on yoga styles, professionals' qualifications, and the absence of sports physiology methodology persist across the analysed articles. Future studies should explore trends in yoga schools across countries, considering potential cultural differences in learning and application when evaluating outcomes.

**Keywords:** Integrative Medicine; Mind-Body Interventions; Holistic Health; Integrative Health Practices; Hatha Yoga; Vinyasa Yoga; Ashtanga Yoga; Iyengar Yoga; Kundalini Yoga; Bikram Yoga; Integrative Sports Practices.

# INTRODUCTION

Yoga, originating in India, integrates physical, mental, and spiritual practices that include ethical principles, postures, breathing techniques, and meditation (Park et al., 2015; Dybvik et al., 2021). Although yoga has been widely associated with improvements in physical and mental well-being across diverse populations (Cramer et al., 2016), the scientific literature remains highly heterogeneous in terms of intervention protocols, intensity, duration, outcome measures, and conceptual definitions of what constitutes a “yoga intervention”. This methodological and conceptual variability limits the comparability of findings and challenges the consolidation of evidence regarding the true magnitude and mechanisms of yoga’s effects. In Western countries, yoga has been increasingly adopted for both health promotion and performance-related purposes (Brinsley et al., 2021). It has also been framed as a form of physical conditioning that may enhance strength, flexibility, balance, and cognitive focus, thereby contributing to athletic performance (Sharma, 2015; Government of India, 2023). However, different yoga styles vary substantially in their combinations, intensities, and durations of postures, breathing, and meditative components (Mandlik et al., 2023; Forseth et al., 2020). This diversity, together with the growing volume of empirical studies, has resulted in a fragmented body of literature in which outcomes, populations, and methodological approaches are weakly standardised. Such fragmentation reinforces the need for structured approaches capable of mapping research trends, thematic concentration, and the methodological maturity of the field.

Comparative studies suggest that yoga may be as effective as, or in some cases superior to, conventional exercise for improving several health-related outcomes in both healthy and clinical populations (Ross et al., 2010; Govindaraj et al., 2016). Nevertheless, important differences exist between yoga and traditional exercise, particularly regarding breath regulation, sustained postures, and mindfulness during movement (Muthappan et al., 2020).

While these features are often invoked to explain yoga's distinctive benefits, their operationalisation and measurement vary considerably across studies, further complicating synthesis and interpretation of results.

Yoga has also been recognised as a potentially valuable public health strategy. The United Nations and international organisations have highlighted its relevance to the promotion of physical activity, the prevention of non-communicable diseases, and the enhancement of quality of life (Yoga Alliance, 2023). In parallel with this institutional recognition, participation in yoga and related commercial markets has expanded rapidly, particularly since the early 2000s (Jeter et al., 2013). Despite this exponential growth in both practice and scientific output, there remains limited structured knowledge regarding how yoga research is organised, which topics dominate the literature, how methodological quality is distributed across studies, and where scientific consensus or fragmentation currently lies.

Previous reviews examining trends in yoga research have primarily focused on the clinical conditions addressed by interventions. For example, studies from 1967 to 2013 identified mental health, cardiovascular, and respiratory disorders as the most frequently targeted conditions (Field et al., 2016), while later analyses expanded the scope to pregnancy-related issues, depression, stress, PTSD, obesity, cardiovascular disease, pain syndromes, autoimmune disorders, and ageing-related problems (Wieland et al., 2021). More recent work has emphasised a shift toward the use of yoga as a health management strategy for chronic conditions and the growing distinction between therapeutic yoga and yoga therapy (Paget et al., 2021). Although informative, these contributions remain largely descriptive and clinically oriented, providing limited insight into the structural organisation of the scientific field itself, including authorship patterns, citation networks, thematic clustering, and the methodological quality of the underlying evidence base.

Systematic reviews play a central role in informing patients, clinicians, researchers, and policymakers by synthesising evidence beyond individual primary studies (Durieux et al., 2010). Bibliometric analysis, in turn, offers quantitative tools to evaluate research productivity, collaboration structures, citation impact, and the intellectual organisation of scientific domains (Van Eck et al., 2010; Sillet, 2013). However, bibliometric studies are not methodologically neutral. Many are limited by reliance on a single database, absence of quality appraisal of included reviews, and excessive emphasis on publication counts rather than on thematic coherence, methodological rigour, or evidentiary consensus (Page et al., 2021). These limitations highlight the need for more critically informed bibliometric approaches that integrate quantitative mapping with methodological and conceptual appraisal of the evidence. This study aims to conduct a critically informed bibliometric analysis of systematic reviews on yoga to map publication characteristics, thematic trends, geographic and institutional concentrations, and the methodological quality of the existing evidence base. This approach is intended to clarify how yoga research has evolved, where scientific consensus or fragmentation exists, and which gaps remain insufficiently addressed.

Based on this rationale, we formulated the following research hypotheses:

- (H1) The volume of systematic reviews on yoga has increased exponentially since the early 2000s, reflecting growing scientific and societal interest in yoga as a health intervention.
- (H2) Yoga-related systematic reviews are thematically concentrated on a limited number of clinical domains, particularly mental health and cardiovascular conditions.
- (H3) The methodological quality of published systematic reviews on yoga shows substantial variability, indicating uneven maturity of the evidence base.
- (H4) The scientific production of yoga-related systematic reviews is geographically and institutionally concentrated in a small number of countries and research centres.

## METHODS

This study adopted a mixed-methods bibliometric design, integrating quantitative mapping of publication patterns with qualitative and interpretative appraisal of thematic structures and methodological quality of the evidence base. This combination was chosen to allow both descriptive characterisation of scientific production and critical interpretation of how yoga research has evolved, matured, and organised itself conceptually and methodologically over time.

Unlike conventional systematic or scoping reviews, which typically start from highly inclusive searches with low initial precision and progressively refine records to obtain a final corpus (Grant et al., 2009), the present study followed a selective-precision bibliometric strategy. This approach is grounded in classical bibliometric laws and aims to construct analytically tractable subsamples from a well-defined and homogeneous documentary universe. Such a strategy is particularly suitable for identifying structural regularities in scientific production, concentration phenomena, and intellectual organisation of a research field.

### **Data source and database selection**

The search was restricted to the Web of Science Core Collection, specifically the Science Citation Index Expanded (SCI-EXPANDED) and the Social Sciences Citation Index (SSCI), because these two indices concentrate on journals with the highest editorial and bibliometric selectivity in biomedical, psychological, and health-related sciences. This choice ensured a high level of data standardisation, citation consistency and metadata completeness, which is critical for robust bibliometric mapping and network analysis. The decision to restrict data collection to WoSCC was taken for three main methodological reasons. First, WoSCC provides highly standardised and curated bibliographic metadata, which is essential for robust citation analysis, author disambiguation, and network construction. Second, its long-term temporal

coverage and stable indexing criteria facilitate longitudinal analyses of publication trends and citation dynamics. Third, WoSCC offers structured citation fields and journal impact metadata that are not consistently available or harmonised across other databases.

Although databases such as Scopus and PubMed are widely used in health-related research, they were not included in the present analysis. Scopus, while broader in journal coverage, exhibits greater heterogeneity in indexing policies across disciplines and time periods, which can introduce instability in longitudinal bibliometric indicators. PubMed, in turn, is primarily oriented toward biomedical literature and does not provide the complete citation-linkage data required for co-citation, bibliographic coupling, and network centrality analyses. Consequently, restricting the corpus to WoSCC was considered methodologically coherent with the bibliometric objectives of this study, even though this choice necessarily limits coverage of some regional and non-indexed journals.

### **Search strategy and corpus construction**

The search was conducted on November 11, 2024, using the thematic search tag TS (which simultaneously queries title, abstract, author keywords, and Keywords Plus®) (Clarivate, 2024). The search was conducted on November 11, 2024, using the following query or search vector: TS=(yoga) and Science Citation Index Expanded (SCI-EXPANDED) or Social Sciences Citation Index (SSCI) (Web of Science Index) and Review Article (Document Types). Records were restricted to documents classified as Review Articles. This restriction was applied to ensure conceptual homogeneity of the corpus and alignment with the objective of mapping secondary-level evidence synthesis rather than primary empirical studies.

A total of 1,260 review articles published between 1992 and 2024 were retrieved. All records included in the analysis are listed in Supplementary Materials Table S1.

## **Bibliometric framework and subsampling strategy**

To obtain analytically tractable and theoretically meaningful subsamples from the full corpus, classical bibliometric laws were applied to different analytical units (authors, documents, keywords, and journals). These laws were not treated as purely descriptive heuristics but as operational criteria for identifying concentration phenomena and structural regularities within the scientific production on yoga.

Price's Law was used to assess whether the temporal evolution of publications followed an exponential growth pattern, indicating sustained scientific interest and accumulation of knowledge (Price, 1976; Dobrov et al., 1979).

Lotka's Law was applied to characterise author productivity and to identify a core group of prolific contributors, based on the assumption that scientific output is disproportionately concentrated among a small number of authors (Lotka, 1926).

The Hirsch index (h-index) was used to identify a subset of highly cited and epistemically influential documents (Hirsch, 2005). Documents were ordered by citation count in descending order, and the value  $n$  was determined such that each of the  $n$  documents had received at least  $n$  citations ( $c \geq n$ ). This h-index subsample was subsequently used for cross-citation analysis to explore centrality, prestige, and intellectual influence within the citation network (Yan et al., 2009; Fortunato et al., 2006; Sainaghi et al., 2018).

Bibliographic coupling, defined as the number of shared references between two or more documents (Price et al., 1966), was used to explore thematic proximity and the existence of "invisible colleges" within the field (Zipf, 1932).

For author keywords, Zipf's Law was applied to identify high-frequency terms and to estimate a core vocabulary reflecting dominant research themes (Bulik, 1978).

For journals, Bradford's Law was used to identify a core set of journals that concentrate approximately one-third of the total publications, thereby delineating the main publication venues that structure scientific communication on yoga (Bond, 2016).

### **Network construction, clustering and centrality criteria**

Network analyses were conducted using VOSviewer (version 1.6.20), which was used to construct co-authorship, cross-citation, bibliographic coupling and keyword co-occurrence graphs from the Web of Science Core Collection records. Links between nodes were defined using full counting, and nodes and edges were only included in the networks if they complied with the eponymous laws of Price's Law, which describes exponential or logistic growth and obsolescence; Lotka's Law, which explains the unequal distribution of productivity among authors, Zipf's Law, which analyses the frequency of keyword usage, Bradford's Law, which evaluates the dispersion of journals, and Hirsch's h-index, which evaluates the relationship between productivity and scientific impact.

Clusters ("cores") were identified using the fractionalization method of the clustering algorithm implemented in VOSviewer, with a minimum subsampling threshold set according to each law. Networks were constructed using the fractionalization method, and layout optimisation was performed using the default VOSviewer mapping technique based on association strength. Node size in the visualisations was proportional to occurrences, while link thickness reflected the number of links between two nodes. Centrality was operationalised using all and out-degree centrality for bidirectional graphs, and network analyses were performed using subsamples according to each law, based on the indicator used (Vega-Muñoz et al., 2020), as detailed in Table 1.

## Variables, bibliometric laws, and analytical indicators

Table 1 summarises the analytical variables, bibliometric laws, and indicators used in the present study, along with brief justifications for their relevance to the objectives of mapping the productivity, concentration, influence, and thematic structure of yoga-related systematic reviews.

**Table 1.** Analytical variables, bibliometric laws, and indicators used in the present study

| Variable        | Bibliometric law/criterion | Indicator used                     | Relevance to study objectives               |
|-----------------|----------------------------|------------------------------------|---------------------------------------------|
| Documents       | Hirsch's index             | Citation threshold ( $c \geq n$ )  | Identify epistemically influential reviews  |
| Time            | Price's Law                | Exponential growth fit             | Assess maturation and growth dynamics       |
| Authors         | Lotka's Law                | Productivity distribution          | Identify prolific authors and concentration |
| Author keywords | Zipf's Law                 | Frequency threshold ( $\sqrt{N}$ ) | Identify dominant research themes           |
| Journals        | Bradford's Law             | Core journal zones                 | Identify main publication venues            |
| Citations       | Cross-citation analysis    | Citation network centrality        | Identify intellectual influence             |
| References      | Bibliographic coupling     | Shared references                  | Detect thematic proximity                   |

## Methodological positioning and inferential limits

The present study adopts a mixed quantitative–qualitative bibliometric approach. Quantitative indicators (e.g., publication counts, citation metrics, productivity distributions, and keyword frequencies) were combined with qualitative and interpretative analyses of thematic clustering, conceptual focus, and methodological quality of the systematic reviews included in the corpus. This approach enables a richer understanding of how the scientific field on yoga is organised and how it has evolved over time. However, it also entails important inferential limitations. Bibliometric indicators are sensitive to database coverage, indexing practices, and citation behaviours, which may not directly reflect scientific quality or real-world impact. Moreover, concentration measures derived from classical bibliometric laws represent probabilistic

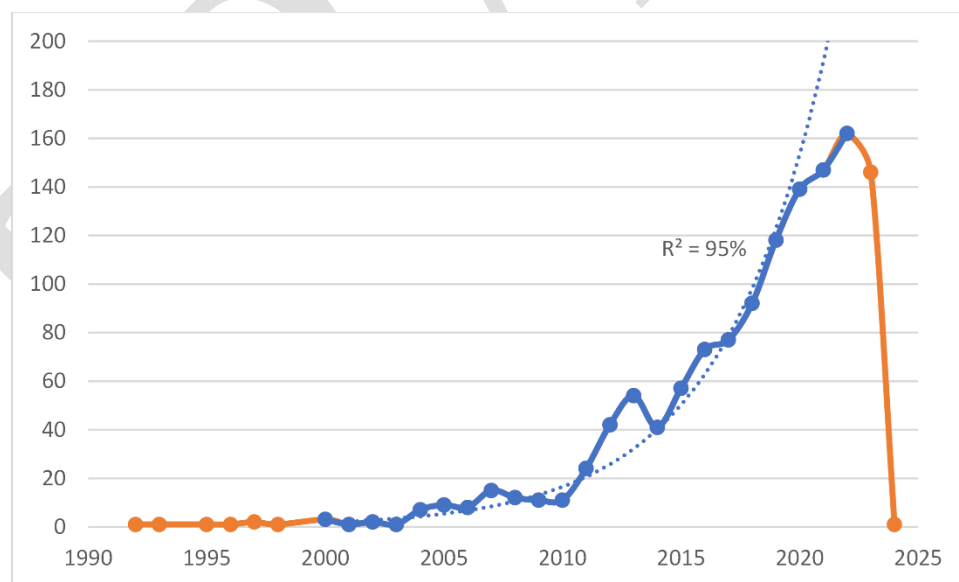
regularities rather than deterministic rules and should therefore be interpreted as structural tendencies rather than strict empirical laws.

Finally, because the corpus was restricted to WoSCC and to documents classified as review articles, the findings cannot be generalised to the entirety of yoga-related research or to non-indexed literature. The results should thus be interpreted as reflecting the organisation and dynamics of a specific, curated segment of the scientific literature rather than the totality of global yoga research output.

## RESULTS

### Coverage and trends in research focus

Temporal distribution of review articles from 1992-2024 (Figure 1) reveals exponential growth in the continuous production and complete years (2000-2022). This pattern, aligning with Price's Law, suggests a critical mass of research conducive to a bibliometric analysis.



**Figure 1.** Temporal evolution of yoga-related review articles published between 1992 and 2024. The figure displays the annual number of review articles indexed in the Web of Science Core Collection. The continuous increase in publication output and the exponential growth trend observed between 2000 and 2022 are consistent with Price's Law, indicating sustained scientific interest and maturation of secondary-level evidence synthesis in yoga research.

A breakdown of the top territories (Table 2) with the highest number of contributions and the highest degree of centrality within the set represented in Figure 1 highlights both the quantity of contributions in documents (out of a total of 1260) and the degree of centrality (out of a maximum of 75 possibilities).

In addition to total and average citation counts, dispersion metrics were calculated to characterise the heterogeneity of scientific impact across the corpus. The distribution of citations per review article was markedly right-skewed, reflecting the coexistence of a small number of highly cited seminal reviews alongside a large volume of low-cited or recently published articles. The mean number of citations per article was 35.5, with a standard deviation of 94.0, indicating substantial variability in citation impact across the 1260 reviews. This dispersion pattern is consistent with cumulative advantage and preferential attachment mechanisms commonly observed in scientific production and citation networks.

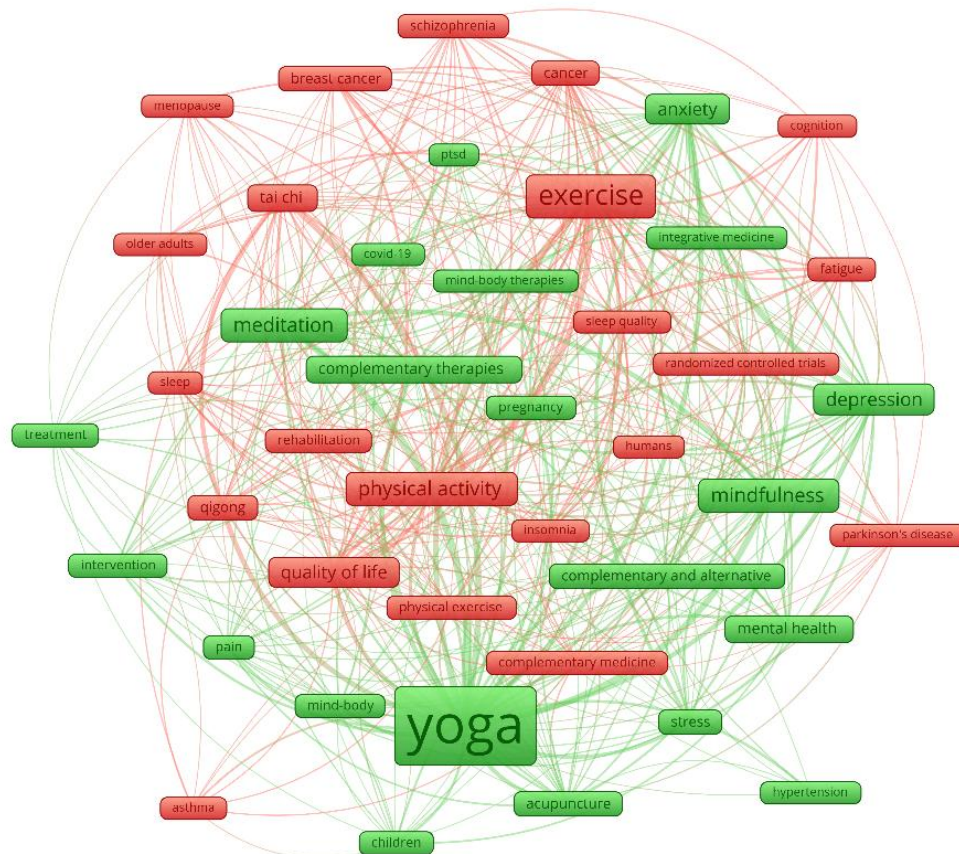
**Table 2.** Characterisation by countries or territories of the document corpus to be analysed. Centrality Degree refers to the number of distinct co-authorship links established by each country with other countries in the international collaboration network. Normalised Centrality Degree expresses this value as a percentage of the maximum possible number of links ( $n - 1$ ), where  $n$  is the total number of countries included in the network.

| Country           | Documents | Citations | Avg Citations<br>(Cit / Doc) | Centrality<br>Degree<br>(co-authorship) | Normalised Centrality Degree<br>(% over 75 countries) |
|-------------------|-----------|-----------|------------------------------|-----------------------------------------|-------------------------------------------------------|
| USA               | 419       | 19153     | 46                           | 39                                      | 52%                                                   |
| People's R. China | 174       | 2864      | 16                           | 22                                      | 29%                                                   |
| England           | 136       | 5527      | 41                           | 38                                      | 51%                                                   |
| Australia         | 129       | 5234      | 41                           | 26                                      | 35%                                                   |
| Canada            | 111       | 6234      | 56                           | 34                                      | 45%                                                   |
| India             | 103       | 2193      | 21                           | 25                                      | 33%                                                   |
| Germany           | 86        | 4540      | 53                           | 24                                      | 32%                                                   |
| Spain             | 52        | 1106      | 21                           | 23                                      | 31%                                                   |
| Brazil            | 47        | 1150      | 24                           | 19                                      | 25%                                                   |
| Netherlands       | 36        | 1859      | 52                           | 21                                      | 28%                                                   |

Countries such as the USA, England, Canada, and Germany combine high productivity with high average citation and high degree centrality (high co-authorship with the other 75 countries), indicating not only volume of output but also structural importance within the international collaboration network. In contrast, some territories with moderate output show



Review (154 occurrences), and Meta-analysis (122 occurrences) – 44 author keywords are presented in Figure 3, with a minimum clustering requirement of 10 nodes. The extreme values were Yoga, which reached a maximum of 365 occurrences, and asthma, humans, and randomised controlled trials, which reached a minimum of 14 occurrences. Table 3 details the characterisation of the document corpus to be analysed by author keywords.



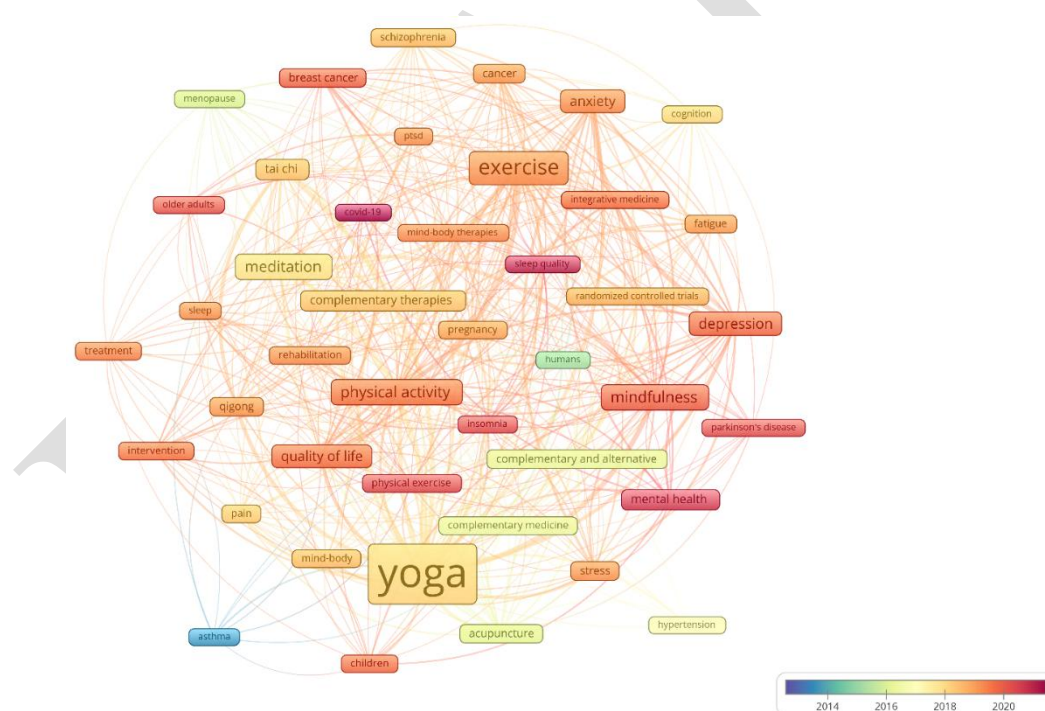
**Figure 3.** Co-occurrence network of high-frequency author keywords (n = 44) derived from 1,260 review articles. Node size is proportional to keyword frequency (number of occurrences across the corpus). Edges represent co-occurrence of keywords within the same review article, and edge thickness reflects co-occurrence strength (number of shared documents). Node colours indicate thematic clusters identified through modularity optimisation. Only keywords with  $\geq 14$  occurrences were included, following Zipf's Law-based subsampling.

**Table 3.** Characterisation by author keywords of the document corpus to be analysed. Centrality Degree refers to the number of co-occurrence links established by each keyword with other keywords in the co-occurrence network. Normalised Centrality Degree expresses this value as a percentage of the maximum possible number of co-occurrence links ( $n - 1$ ), where  $n$  is the total number of keywords included in the network.

| Author keywords         | Documents | Avg Citations * | Centrality Degree (co-occurrence) | Normalised Centrality Degree (% over 44 AKW) |
|-------------------------|-----------|-----------------|-----------------------------------|----------------------------------------------|
| Yoga                    | 365       | 32.98           | 43                                | 98%                                          |
| Exercise                | 147       | 30.73           | 38                                | 86%                                          |
| Physical activity       | 85        | 28.35           | 33                                | 75%                                          |
| Meditation              | 82        | 38.46           | 25                                | 57%                                          |
| Mindfulness             | 80        | 24.90           | 31                                | 70%                                          |
| Depression              | 77        | 36.58           | 33                                | 75%                                          |
| Anxiety                 | 63        | 30.52           | 32                                | 73%                                          |
| Quality of life         | 60        | 28.92           | 33                                | 75%                                          |
| Tai chi                 | 48        | 31.60           | 27                                | 61%                                          |
| Complementary therapies | 44        | 46.91           | 25                                | 57%                                          |

\* Calculated directly by VOSviewer.

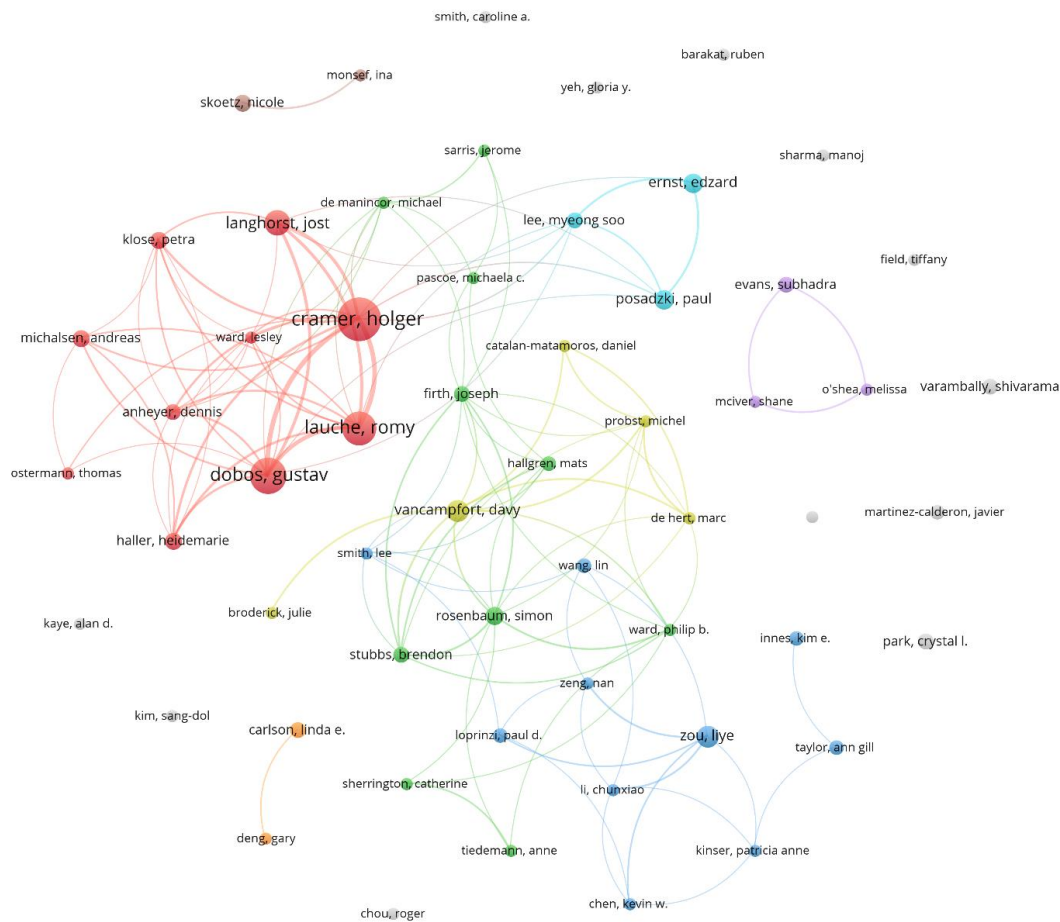
Figure 4 displays the average temporal frequency of words used by authors in these 1260 review articles.



**Figure 4.** Average temporal frequency of author keywords across the 1260 review articles (1992–2024). Each curve represents the mean annual occurrence of a given keyword, computed as the total number of times the keyword appears each year divided by the number of review articles published that year. The vertical axis indicates average keyword frequency, and the horizontal axis represents publication year. This representation enables identification of longitudinal thematic trends and shifts in research focus within yoga-related review literature.

## Assessment of quality – top publishers/authors

Owing to distinct production levels, 57 authors with 4 or more publications have been selected for this bibliometric analysis (ranging from 4 to 36 publications). Figure 5 presents these 57 authors and their diverse co-authorship relationships. Table 4 details the authorship-based characterisation of the document corpus to be analysed.

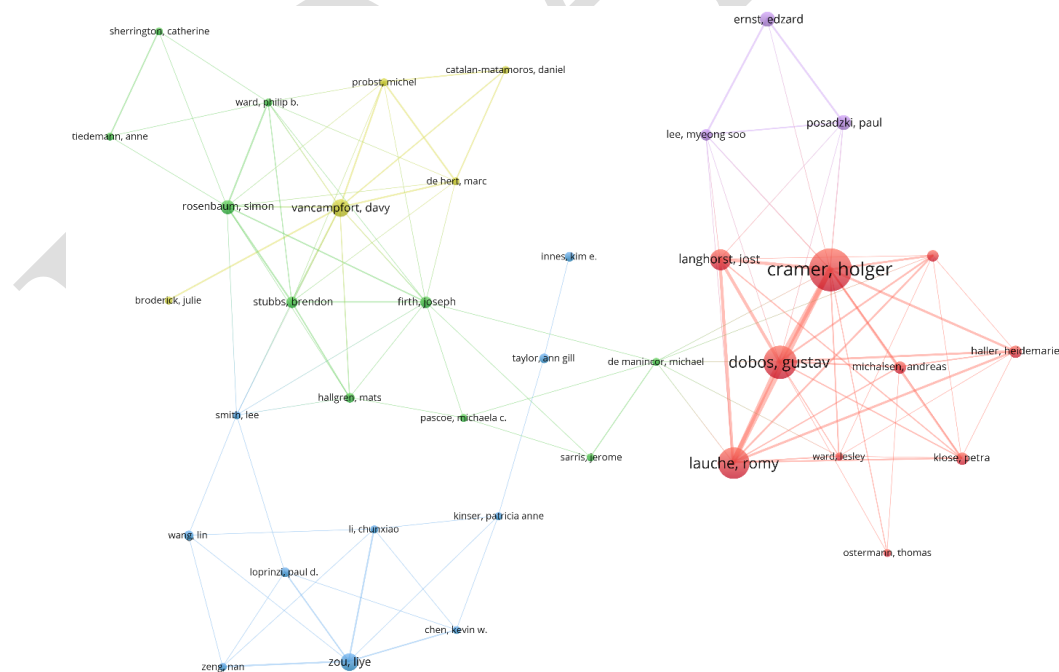


**Figure 5.** Co-authorship network of prolific authors ( $n = 57$ ) with four or more review articles on yoga. Each node represents an author. Node size is proportional to the number of review articles authored. Edges represent co-authorship ties between authors, and edge thickness reflects the number of shared publications between each pair of authors. Node colours indicate collaboration clusters identified through modularity optimisation, representing communities of closely collaborating researchers.

**Table 4.** Characterisation by authorship of document corpus to be analysed. Centrality Degree refers to the number of distinct co-authorship links established by each author with other authors in the co-authorship network. Normalised Centrality Degree expresses this value as a percentage of the maximum possible number of co-authorship links ( $n - 1$ ), where  $n$  is the total number of authors included in the network.

| Authors            | Documents | Citations | Avg Citations<br>(Cit / Doc) | Centrality<br>Degree<br>(co-authorship) | Normalised Centrality Degree<br>(% over 57 countries) |
|--------------------|-----------|-----------|------------------------------|-----------------------------------------|-------------------------------------------------------|
| Cramer, Holger     | 36        | 2406      | 46                           | 13                                      | 23%                                                   |
| Dobos, Gustav      | 26        | 1963      | 16                           | 12                                      | 21%                                                   |
| Lauche, Romy       | 24        | 1872      | 41                           | 10                                      | 18%                                                   |
| Langhorst, Jost    | 14        | 1145      | 41                           | 7                                       | 12%                                                   |
| Vancampfort, Davy  | 11        | 538       | 56                           | 10                                      | 18%                                                   |
| Zou, Liye          | 11        | 491       | 21                           | 6                                       | 11%                                                   |
| Ernst, Edzard      | 9         | 427       | 53                           | 3                                       | 5%                                                    |
| Posadzki, Paul     | 9         | 292       | 21                           | 5                                       | 9%                                                    |
| Rosenbaum, Simon   | 8         | 734       | 24                           | 10                                      | 18%                                                   |
| Haller, Heidemarie | 7         | 538       | 77                           | 7                                       | 12%                                                   |
| Klose, Petra       | 7         | 550       | 79                           | 8                                       | 14%                                                   |
| Michalsen, Andreas | 7         | 594       | 85                           | 6                                       | 11%                                                   |
| Skoetz, Nicole     | 7         | 307       | 44                           | 1                                       | 2%                                                    |

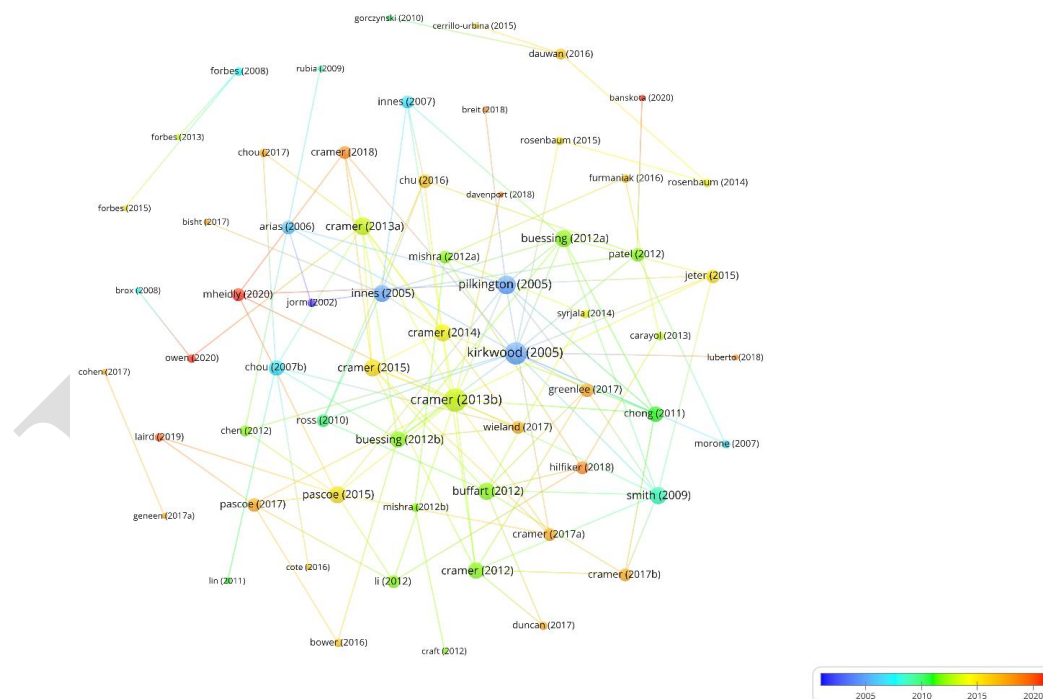
Figure 6 reveals twelve authors, with four or more publications, working individually. Two author pairs are identified (orange, Carlson, and brown, Skoetz), along with one triad (purple, Evans), and a set of 38 connected authors in four clusters (red-10, green-10, blue-10, yellow-5, and light blue-3).



**Figure 6.** Co-authorship network of the largest connected component among prolific authors ( $n = 38$ ). Each node represents an author. Node size is proportional to the number of review articles authored. Edges represent co-authorship ties between authors, and edge thickness reflects the number of shared publications between each pair of authors. Node colours indicate collaboration clusters identified through modularity optimisation. This figure displays the largest connected subnetwork extracted from the full prolific-author network (Figure 5), highlighting dense collaboration structures and intermediary authors occupying bridging positions between clusters.

Among the 38 authors, Cramer (red node) stands out, having contributed to 36 review articles on yoga. It's noteworthy to highlight the intermediary role of Smith (blue node), bridging between blue and green clusters, and De Manincor (green node), playing a similar role between green and red clusters.

The h-index for the collective set of 1260 review articles has been determined to be 93, with each article having 93 or more citations (from 1995 to 2019). An 'n' of 63 is depicted among these 93 articles, indicating reciprocal citations between them (Figure 7), allowing the establishment of causality, based on temporality, where a predecessor document can be identified as contributing to the production of the documents that cite it.



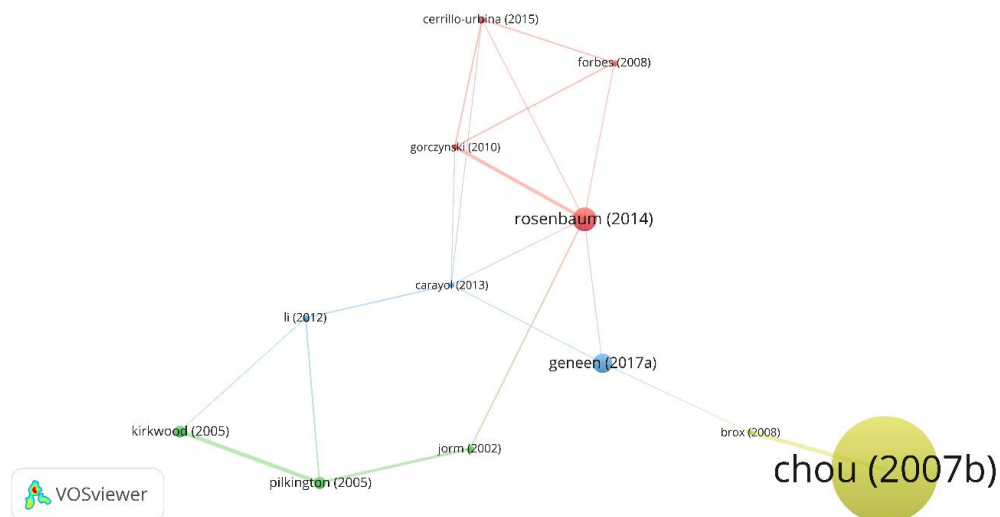
**Figure 7.** Cross-citation network among the 63 reciprocally citing documents within the h-index subsample ( $n = 93$ ). Each node represents a review article. Node size is proportional to the total number of citations received by each document. Directed edges represent citation links between documents, and edge thickness reflects the number of citation ties between pairs of articles. Node colours represent chronological ordering of publication years, from earlier (violet) to more recent (red), allowing visualisation of temporal precedence and citation flows within the epistemic core of the field.

The 63 documents depicted in the h-index are organised chronologically, beginning with the violet-coloured article by Jorm (2002) and concluding with the red-coloured articles published in 2020. The document "Chou (2007b)", distinguished by the largest light blue node, reflects its 2019 citations proportionally. For a more comprehensive overview, Table 5 explores the central documents, emphasising seminal review articles within this set of 63 documents based on their centrality.

**Table 5.** Seminal Review Articles. Centrality – All Degree refers to the total number of citation links involving each document within the h-index cross-citation network. Centrality – Out Degree refers to the number of outgoing citation links from each document to other documents in the h-index subsample. Normalised Centrality – Out Degree expresses this value as a percentage of the maximum possible number of outgoing links ( $n - 1$ ), where  $n$  is the number of documents in the network. Prestige Centrality is defined as the ratio between Out Degree and All Degree, reflecting the extent to which a document functions as a predecessor or intellectual source within the network.

| Document                  | Citations | Centrality<br>– All Degree<br>(A) | Centrality<br>– Out Degree<br>(B) | Normalised<br>Centrality<br>– Out Degree<br>(B/(n-1)) | Prestige<br>Centrality<br>(B/A) |
|---------------------------|-----------|-----------------------------------|-----------------------------------|-------------------------------------------------------|---------------------------------|
| 1. Kirkwood (2005)        | 229       | 14                                | 14                                | 23%                                                   | 100%                            |
| 2. Pilkington (2005)      | 233       | 10                                | 10                                | 16%                                                   | 100%                            |
| 3. Chou (2007b)           | 2019      | 6                                 | 6                                 | 10%                                                   | 100%                            |
| 4. Li (2012)              | 151       | 4                                 | 4                                 | 6%                                                    | 100%                            |
| 5. Rosenbaum (2014)       | 452       | 2                                 | 2                                 | 3%                                                    | 100%                            |
| 6. Jorm (2002)            | 148       | 2                                 | 2                                 | 3%                                                    | 100%                            |
| 7. Carayol (2013)         | 107       | 2                                 | 2                                 | 3%                                                    | 100%                            |
| 8. Forbes (2008)          | 127       | 2                                 | 2                                 | 3%                                                    | 100%                            |
| 9. Cerrillo-Urbina (2015) | 137       | 1                                 | 1                                 | 2%                                                    | 100%                            |
| 10. Gorczynski (2010)     | 110       | 1                                 | 1                                 | 2%                                                    | 100%                            |
| 11. Brox (2008)           | 100       | 1                                 | 1                                 | 2%                                                    | 100%                            |
| 12. Geneen (2017a)        | 367       | 1                                 | 1                                 | 2%                                                    | 100%                            |

The 12 documents listed in Table 5 serve as predecessors in 100% of their cross-citations, forming the foundation of the network of 63 documents (Figure 7). A detailed analysis of these 12 documents reveals bibliographic coupling among some of the articles (Figure 8).



**Figure 8.** Bibliographic coupling network of the 63 h-index review articles. Each node represents a review article included in the h-index subsample ( $n = 63$ ). Edges represent bibliographic coupling links between pairs of documents, defined as the number of shared references. Edge thickness is proportional to the coupling strength (i.e., the number of references cited in common). Node size is proportional to the total number of citations received by each review article. This visualisation highlights thematic proximity and shared intellectual foundations among the most epistemically influential yoga-related reviews.

Figure 8 reveals common references among articles, where broader connections indicate a higher number of shared citations between two documents (nodes).

Manually comparing references across all articles in the h-index would be extensive. However, following a comprehensive analysis of reference patterns, schools of thought in common citations, methodologies, and key conclusions, we identified 61 yoga articles referenced in the h-index (Supplementary Materials Table S2).

Table 6 presents a detailed analysis of these 61 articles included in the 12 reviews (bibliography of the documents for this analysis in Supplementary Materials Table S3), examining patterns of references and schools of thought (invisible schools) in these common citations, as well as the methodologies employed and main conclusions reached.

**Table 6.** In-depth qualitative and methodological analysis of the 61 primary studies most frequently cited within the 12 seminal h-index review articles. This table synthesises the yoga methods used, study designs, and main conclusions of the most recurrently cited primary studies, enabling identification of dominant intervention models, methodological limitations, and shared evidentiary foundations (“invisible schools”) underlying the most influential yoga-related reviews.

| Author (year)            | Article name                                                           | Yoga method used                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                | Article Methodology                                                                                                                       | Main conclusions reached                                                                                                                                                                     |
|--------------------------|------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Jorm et al. (2002)       | Effectiveness of complementary and self-help treatments for depression | Use of yogic breathing exercises in depression:<br><ol style="list-style-type: none"> <li>yogic breathing (wrongly interpreted by the authors since the original article has shavasana in the title, which translates to relaxation techniques) – pranayama 30 minutes each morning for 30 days.</li> <li>training in yogic breathing (Sudarshan Kriya Yoga).</li> </ol>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        | Two randomised controlled trials have been used in this review.                                                                           | The limited amount of research on yogic breathing looks promising. This treatment requires further evaluation.                                                                               |
| Kirkwood et al. (2005)   | Yoga for anxiety: a systematic review of the research evidence         | Yoga of various styles:<br><ol style="list-style-type: none"> <li>1 h weekly kundalini yoga (includes specific OCD technique as well as mantra meditation);</li> <li>1 week training, then 12 weeks of 10 mins twice daily yoga (kapalabhati and ujjayi pranayama);</li> <li>3 months of Daily practice, 5 days a week instructed, 2 days home practice, 40 min duration, yoga (consisting of sukharna, talasna, pranayama, nishpand bhav, savasna).</li> <li>4 weeks minimum of daily, 1 hour, 6 days a week of Patanjali Yoga with five steps: asana, pranayama, pratyahara, dharana, and dhyana;</li> <li>6 weeks of Patanjali pranayama (kapalabhati and ujjayi pranayama);</li> <li>3 days, 20 min duration each of Broota relaxation technique (exercises adapted from yoga combined with autosuggestion);</li> <li>3 months, practised for 1 hour, 3 times a week of yoga-based intervention (various asanas, plus prayer, exercises, visualisation, and meditation);</li> <li>4 sessions (45 min each) plus home practice. Total duration: 3 weeks. And after variable scheduling, dependent on the participant’s convenience, a slightly modified form of Agni yoga.</li> <li>Studies where the intervention was solely meditation-based were not included.</li> </ol> | A comprehensive search for clinical research was carried out. Controlled trials, whether randomised or not, were included in this review. | Further well-conducted research is necessary, which may be most productive if focused on specific anxiety disorders.                                                                         |
| Pilkington et al. (2005) | Yoga for depression: The research evidence                             | Yoga of various styles:<br><ol style="list-style-type: none"> <li>20 min on 3 consecutive days of 4 exercises adapted from yoga — deep breathing, bow asana;</li> <li>Once daily, 6 days a week for 4 weeks of SKY (Sudarshan Kriya Yoga): 3 sequential components of rhythmic hyperventilation interspersed with normal breathing, followed by 10–15 min relaxation, 45 min in total;</li> <li>30 days of Yoga (Shavasana) based primarily on rhythmic breathing and relaxation, 30 min daily;</li> <li>4 weeks of SKY once daily in the morning;</li> <li>5 weeks of Yoga (Iyengar) — back bends, standing poses and inversions followed by relaxation postures 60 min in the</li> </ol>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      | A comprehensive search for clinical research was carried out. Systematic searches were conducted on a range of databases.                 | Variation in interventions and in the severity of reported depression, along with a lack of methodological details in the studies located, requires cautious interpretation of the findings. |

| Author (year)            | Article name                                                                                                                                        | Yoga method used                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     | Article Methodology                                                                                                                                           | Main conclusions reached                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |
|--------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|                          |                                                                                                                                                     | morning, twice a week. Same asanas for all (no inversions for menstruating women).                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |                                                                                                                                                               |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |
| Chou et al. (2007)       | Diagnosis and Treatment of Low Back Pain: A Joint Clinical Practice Guideline from the American College of Physicians and the American Pain Society | Viniyoga-style yoga, and no other information provided.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              | The literature search included all English-language articles reporting on randomised, controlled trials.                                                      | For chronic low back pain, moderately effective non-pharmacologic therapies include yoga, although the level of supporting evidence for different therapies varies from fair to good.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |
| Brox et al. (2008)       | Systematic review of back schools, brief education, and fear-avoidance training for chronic low back pain                                           | Yoga and no other information provided.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              | Search of the MEDLINE database of randomised controlled trials (RCTs) for relevant trials reported in English.                                                | There is moderate evidence that a brief education is less effective than yoga on short-term pain and disability.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |
| Forbes et al. (2008)     | Physical activity programs for persons with dementia (Review)                                                                                       | Experimental physical activity and no other information provided                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     | Search for all relevant, randomised controlled trials on Specialised Register of the Cochrane Dementia and Cognitive Improvement Group.                       | There is insufficient evidence of the effectiveness of physical activity programs on cognition, function, depression behaviour, and mortality in older persons with dementia and on their family caregiver's health, quality of life, and mortality.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |
| Gorczynski et al. (2010) | Exercise therapy for schizophrenia (Review)                                                                                                         | Yoga with breathing practice and relaxation techniques; three weeks of training and then continued with the program for the remaining three months. Participants met for 1 hour a day, 5 days a week.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                | Search for randomised controlled trials on the Cochrane Schizophrenia Group Trials Register.                                                                  | Yoga had a better outcome for mental state and significantly better quality-of-life scores. Findings should be viewed with caution, as the results are based on a limited number of trials with small sample sizes.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |
| Li et al. (2012)         | The Effects of Yoga on Anxiety and Stress                                                                                                           | <p>Yoga of various styles:</p> <ol style="list-style-type: none"> <li>2 weeks of meditation, yoga, and breathing – probably poorly indexed as yoga since the article title refers to mindfulness, which is a different modality;</li> <li>2 weeks of yoga;</li> <li>7 weeks of mindfulness-based Yoga;</li> <li>10 weeks of yoga;</li> <li>1 week of meditation and gentle yoga – the original article title also refers to mindfulness;</li> <li>8 weeks of yoga;</li> <li>10 weeks of restorative yoga;</li> <li>4 classes over 6 weeks of yoga;</li> <li>4 months of meditation;</li> <li>4 months of yoga;</li> <li>10 days of yoga;</li> <li>3 months of hatha yoga and Omkar meditation;</li> <li>2 months of yoga;</li> <li>5 months of meditation;</li> <li>1 hour of yoga;</li> <li>8 weeks of yoga;</li> <li>2-month intervention and 1-year follow-up yoga lifestyle and yoga plus meditation;</li> </ol> | Literature searches were conducted using PubMed. Studies were limited to human subjects, English language, clinical trials, and randomised controlled trials. | <p>While the link between yogic practices and reduced stress and anxiety lacks strong support from rigorous trials, studies suggest that using yoga alongside pharmacologic therapy may improve symptoms. Caution is advised, and yoga should not replace conventional medical practices until further well-conducted research establishes its benefits with strong statistical evidence.</p> <p>Challenges in drawing conclusions arise from diverse study populations and questions about outcome measures, subject numbers, and statistical analyses' validity.</p> <p>Standardising interventions is crucial to assess various yogic practices' effects on stress and anxiety.</p> <p>Research on different yoga styles helps determine the most effective</p> |

| Author (year)                 | Article name                                                                                                              | Yoga method used                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           | Article Methodology                                                                                                                                                        | Main conclusions reached                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |
|-------------------------------|---------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|                               |                                                                                                                           | 18. 1 x 20 - minute session of yoga-based deep relaxation;<br>19. 6 weeks of yoga;<br>20. 8 weeks of meditation;<br>21. 3 months of yoga;<br>22. 12 weeks of yoga;<br>23. 3 years of meditation;<br>24. 6 weeks of yoga;<br>25. 8 weeks of stress reduction program;<br>26. 16 weeks of yoga;<br>27. 3 hours of hatha yoga;<br>28. 16 weeks of yoga;<br>29. 10 weeks of yoga;<br>30. 1 hour of yoga;<br>31. 1 week of yoga;<br>32. 4 weeks of yoga and meditation);<br>33. 6 weeks of yoga;<br>34. 6 weeks of yoga;<br>35. 1 month of yoga and meditation;<br>36. 1.5 hours of hatha yoga. |                                                                                                                                                                            | approach, be it full yoga practice, meditation alone, or other.                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |
| Carayol et al. (2013)         | Psychological effect of exercise in women with breast cancer receiving adjuvant therapy: what is the optimal dose needed? | Yoga of various styles:<br>1. 18 weeks, 4.5 sessions per week with 50 mins duration of yoga;<br>2. 24 weeks, 4.5 sessions per week with 50 mins duration of yoga;<br>3. 6 weeks, 3 sessions per week with 60 mins duration of yoga.                                                                                                                                                                                                                                                                                                                                                        | Randomised controlled trials were searched on MEDLINE, PsycINFO, Pascal, PsycARTICLES, and Cochrane electronic Databases.                                                  | Yoga-based interventions were included as an intervention program involving physical activity, and the analysis showed beneficial effects of exercise on psychological factors. These findings need to be confirmed by higher-quality methodological trials and larger-sample-size trials before generalisation.                                                                                                                                                                                                                    |
| Rosenbaum et al. (2014)       | Physical activity interventions for people with mental illness: A systematic review and meta-analysis                     | Yoga as physical activity and exercise (movement-based practice):<br>1. 12 weeks of supervised and unsupervised yoga therapy;<br>2. 8 weeks of 2x45-min weekly supervised yoga classes.                                                                                                                                                                                                                                                                                                                                                                                                    | Randomised controlled trials were searched in MEDLINE, the Cochrane Controlled Trials Register, PsycINFO, CINAHL, Embase, and the Physiotherapy Evidence Database (PEDro). | The analysis demonstrated a significant reduction in schizophrenia symptom severity with various physical activity interventions, such as dance, yoga, home-based exercise, and group activities. The future of physical activity and exercise as viable and accepted components of usual care within mental health settings will be enhanced by more methodologically rigorous clinical research, using well-designed intervention protocols that adhere to established principles of physical activity and exercise prescription. |
| Cerillo-Urbina et al. (2015). | The effects of physical exercise in children with attention deficit hyperactivity disorder: a                             | Yoga considered as complementary and alternative Medicine: one 60-min session a week for 20 weeks, including respiratory, postural, relaxation and concentration training.                                                                                                                                                                                                                                                                                                                                                                                                                 | RCTs in which the control group received no physical exercise intervention were searched on PubMed,                                                                        | Yoga study results showed that exercise improved anxious/shy, hyperactivity, impulsive/restless, oppositional, social problems, and                                                                                                                                                                                                                                                                                                                                                                                                 |

| Author (year)          | Article name                                                                                        | Yoga method used                                                                                                                                                                                                                                                                                                                                                   | Article Methodology                                                                                                  | Main conclusions reached                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |
|------------------------|-----------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|                        | systematic review and meta-analysis of randomised control trials                                    |                                                                                                                                                                                                                                                                                                                                                                    | Scopus, EMBASE, EBSCO and The Cochrane Library.                                                                      | DSM-IV (Diagnostic and Statistical Manual of Mental Disorders, Fourth Edition) Total. Evidence on the benefits of yoga was scarce due to the small number of articles retrieved.                                                                                                                                                                                                                                                                                                                                                                                             |
| Geneen et al. (2017a). | Physical activity and exercise for chronic pain in adults: an overview of Cochrane Reviews (Review) | Yoga as exercise that includes breath control, simple meditation, and the adoption of specific bodily postures; incorporates stretching and flexibility training with isometric strength training (holding certain poses, with no movement against a resistance): Ivengar yoga (6-week, twice a week, 1.5-hour sessions, "Low impact", "moderate", and 70% HRmax). | Search of the Cochrane Database of Systematic Reviews (CDSR) for systematic reviews of randomised controlled trials. | There is some evidence that physical activity interventions ... may help to reduce fatigue in rheumatoid arthritis. The studies investigating strength training and Ivengar Yoga did not demonstrate a statistically significant difference between the study arms. However, the optimal parameters and components of these interventions are not yet established. Appropriate conclusions based on available data. However, no mention of the quality/risk of bias of studies in the conclusion, despite low/unclear quality scores in the results and discussion sections. |

Table 7 outlines the Bradford Nucleus, i.e., journals where in-depth discussions of review studies on Yoga occur during the study period, comprising 27 journals with 7 or more review articles on yoga, accounting for a third of the 1260 review articles under study (434 review articles).

**Table 7.** Core journals (“Bradford nucleus”) concentrating approximately one-third of the total yoga-related review articles. Journals were ranked in descending order of productivity (number of review articles published), and Bradford’s Law was applied to identify the smallest set of journals accounting for approximately one-third of the total corpus (434 of 1260 review articles). The cumulative percentage (%Acum) reflects the progressive aggregation of articles across ranked journals. Journal Impact Factor (JIF 2022) and best quartile (2022) are reported to contextualise the bibliometric prestige and disciplinary positioning of the core publication venues.

| Source Title                                                          | Total | % of 1260 | %Acum | JIF (2022) | Best quartile (2022) |
|-----------------------------------------------------------------------|-------|-----------|-------|------------|----------------------|
| 1. Cochrane Database of Systematic Reviews                            | 59    | 5%        | 5%    | 8.4        | Q1                   |
| 2. Complementary Therapies in Medicine                                | 37    | 3%        | 8%    | 3.6        | Q2                   |
| 3. Evidence-Based Complementary and Alternative Medicine*             | 35    | 3%        | 10%   | 0.0        | N.D.                 |
| 4. International Journal of Environmental Research and Public Health* | 32    | 3%        | 13%   | 0.0        | N.D.                 |
| 5. Complementary Therapies in Clinical Practice                       | 30    | 2%        | 15%   | 3.0        | Q2                   |
| 6. Journal of Alternative and Complementary Medicine                  | 26    | 2%        | 17%   | 2.6        | Q3                   |
| 7. Alternative Therapies in Health and Medicine                       | 19    | 2%        | 19%   | 1.5        | Q4                   |
| 8. Frontiers in Psychology                                            | 16    | 1%        | 20%   | 3.8        | Q1                   |
| 9. Plos One                                                           | 14    | 1%        | 21%   | 3.7        | Q2                   |
| 10. Frontiers in Psychiatry                                           | 14    | 1%        | 22%   | 4.7        | Q2                   |
| 11. Journal of Clinical Medicine                                      | 12    | 1%        | 23%   | 3.9        | Q2                   |
| 12. Medicine                                                          | 12    | 1%        | 24%   | 1.6        | Q3                   |
| 13. Current Pain and Headache Reports                                 | 12    | 1%        | 25%   | 3.7        | Q2                   |
| 14. Supportive Care in Cancer                                         | 11    | 1%        | 26%   | 3.1        | Q1                   |
| 15. Mindfulness                                                       | 10    | 1%        | 27%   | 3.6        | Q2                   |
| 16. Indian Journal of Psychiatry                                      | 10    | 1%        | 28%   | 3.1        | Q2                   |
| 17. Children-Basel                                                    | 9     | 1%        | 28%   | 2.4        | Q2                   |
| 18. British Journal of Sports Medicine                                | 9     | 1%        | 29%   | 18.6       | Q1                   |
| 19. Journal of Affective Disorders                                    | 8     | 1%        | 30%   | 6.6        | Q1                   |
| 20. Mental Health and Physical Activity                               | 8     | 1%        | 30%   | 4.7        | Q2                   |
| 21. Explore-The Journal of Science and Healing                        | 8     | 1%        | 31%   | 2.4        | Q3                   |
| 22. Disability and Rehabilitation                                     | 8     | 1%        | 32%   | 2.2        | Q2                   |
| 23. Sleep Medicine Reviews                                            | 7     | 1%        | 32%   | 10.5       | Q1                   |
| 24. Psycho-Oncology                                                   | 7     | 1%        | 33%   | 3.6        | Q1                   |
| 25. American Journal of Occupational Therapy                          | 7     | 1%        | 33%   | 2.9        | Q1                   |
| 26. Current Oncology Reports                                          | 7     | 1%        | 34%   | 4.7        | Q2                   |
| 27. BMJ Open                                                          | 7     | 1%        | 34%   | 2.9        | Q2                   |

\* Removed from WoS catalogue in 2024, without JIF 2022.

## DISCUSSION

### Coverage and trends in research focus

The temporal distribution of the 1260 review articles published between 1992 and 2024 in Figure 1 reveals a noteworthy trend of exponential growth, particularly evident during the period of continuous production and complete years (2000-2022). The substantial increase in

publications aligns with prior bibliometric reviews on yoga (Desikachar, 1999; Field, 2016; Wieland et al., 2021). This trend indicates the growing popularity and recognition of yoga as a subject for scholarly exploration and discussion within the academic community.

Insights into the global landscape of research on yoga (Table 1 and Figure 2) highlight patterns in the distribution of documents and centrality across various nations:

- The United States, People's Republic of China, and England are leaders in document volume, surpassing India – the yoga origin country.
- Europe, Germany, Spain, and the Netherlands are prominent document contributors.
- Analysis of centrality reveals England, Canada, India, and the USA with the highest degrees, playing pivotal roles in connecting and influencing the network of research activities.

Concerning keywords, Figure 3 displays 44 author keywords, with the most noteworthy being “yoga” and the prominence of keywords such as "Complementary", "Alternative", and "Integrative Medicine", as well as “Mind body therapy”, in the field of yoga publications, suggesting a growing association between yoga and medical approaches. This reflects research extending beyond traditional medical paradigms, indicating a recognition by the authors of holistic and integrative aspects of yoga in the broader context of healthcare. However, there is no evidence that the medical community recognises yoga to be effective.

Prior literature emphasises the need for additional high-quality studies to inform healthcare policy, including considerations such as insurance coverage of yoga as a complementary therapy for health conditions, including cardiovascular risk reduction, depression, musculoskeletal disorders, and asthma (Fortunato et al., 2006). Our findings (Figure 3) aggregate yoga with exercise, implying a comparison between diverse interventions or a framing of the modality itself. Recent keyword analysis underscores a focus on contemporary

health concerns such as "COVID-19," "sleep quality," and "mental health," in contrast to the less recent emphasis on "asthma," "hypertension," and "menopause" (Figure 4).

A comprehensive bibliography analysis (Table 4) listed yoga types, arranged from most to least frequently mentioned:

1. Sudarshan Kriya Yoga;
2. Hatha Yoga;
3. Mindfulness-based Meditation Therapy;
4. Integrated Yoga Program;
5. Yoga Lifestyle Intervention;

Yoga schools of thought (Zipf, 1932) were found and ordered from greater to lesser mention (Table 4):

1. Hatha Yoga
2. Kundalini Yoga
3. Patanjali Yoga
4. Sudarshan Kriya Yoga
5. Iyengar Yoga (Yoga by B.K.S. Iyengar)
6. Viniyoga

Other mentioned techniques: Brotha Relaxation Technique (incorporates yoga); Experimental Physical Activity (includes yoga); Agni Yoga (modified form).

The exponential growth observed in yoga-related review articles reflects not only an expansion of scientific interest but also a broader institutional and cultural legitimization of yoga within biomedical and public health discourse. This growth appears to be driven less by theoretical consolidation of yoga as a coherent intervention modality and more by its progressive assimilation into complementary and integrative medicine frameworks. Importantly, the bibliometric network structures observed in this study indicate that this growth has not been accompanied by a proportional integration of conceptual or methodological diversity. The identified clusters reflect relatively closed epistemic communities organised around specific clinical domains (e.g., mental health, musculoskeletal disorders) and biomedical framings of yoga, rather than around yoga modalities or pedagogical traditions. This suggests that scientific

production on yoga is structured more by institutional and disciplinary logics than by the internal theoretical coherence of yoga as a practice system.

The dominance of keywords such as “complementary,” “alternative,” and “integrative medicine” suggests that yoga is primarily framed as an adjunctive therapy rather than as a standalone, theoretically grounded health intervention. The persistent absence of precise yoga-style identifiers and training variables across reviews indicates that the field has evolved more through pragmatic clinical incorporation than through systematic methodological standardisation. This pattern helps explain why proportional gains in intervention specificity, reproducibility, or mechanistic understanding have not accompanied thematic growth. This biomedical reframing of yoga is likely driven by structural incentives within academic publishing and research funding systems. Clinical applicability, alignment with randomised controlled trial paradigms, and relevance to guideline-oriented healthcare contexts increase the likelihood of publication in high-impact journals and inclusion in systematic reviews. As a result, yoga research has progressively converged toward medicalised outcome domains, while pedagogical, philosophical, and traditional knowledge dimensions remain structurally marginalised within indexed scientific literature.

## **Gaps and concentration in research focus**

The absence of keywords specifying yoga types intensifies the challenges previously encountered (Brinsley et al., 2021; Field, 2016), especially with the growing annual number of publications. Despite extensive research, a gap remains, highlighted by the lack of keywords related to yoga for health prevention or well-being, or for performance enhancement, among the general population (Figure 4).

These concerns become evident upon a more thorough examination of the articles in the h-index (Table 4) regarding yoga interventions: most studies present challenges and limitations

in methodology – namely not using the most reliable out of all the epidemiological studies available (Sillet, 2013; Cuschieri, 2019), intervention specificity, and program characterisation (volume, intensity, periodicity). These issues include misidentification of yoga modalities and a lack of detailed descriptions, which affect the precision and robustness of the conclusions. Another common concern across all articles in the h-index is the lack of reference to the experience or qualifications of professionals administering yoga practices.

Lifestyle factors, including cognitive engagement, sleep quality, and nutritional habits, are known to significantly impact the effectiveness of yoga practice (Panjwani et al., 2021; Desai, 1990). These components often work together synergistically, influencing cognitive health and enhancing resilience against cognitive decline. Adequate sleep is essential for memory consolidation, neuronal repair, and overall brain health, and disruptions in sleep patterns have been linked to increased risks of both physical and mental impairment (Panjwani et al., 2021). Similarly, nutrition plays a critical role, with a balanced diet rich in antioxidants, omega-3 fatty acids, and vitamins supporting brain function, reducing inflammation, and impacting aerobic fitness (Gómez-Pinilla, 2008). Understanding the complex interaction among these lifestyle factors and their collective influence on health is crucial for developing effective strategies to promote their well-being (Panjwani et al., 2021; Xie et al., 2024; Kolimechikov et al., 2022). Incorporating yoga into daily routines can offer holistic benefits by addressing these interconnected aspects of health and well-being.

Addressing concentration in yoga articles is also challenging due to variability in methodologies and protocols across specific populations/medical conditions.

## **Top publishers/authors**

Regarding the quantity indicators (20), as shown in Figures 5 and 6, Cramer stands out as a central figure in the red cluster. Affiliated with the University of Duisburg-Essen in Germany,

particularly the Department of Internal and Integrative Medicine, Cramer has authored 36 yoga review articles. Smith, from Anglia Ruskin University in the UK, specialises in researching lifestyle behaviours' impact on mental and physical health. Acknowledged for collaborative efforts, Smith connects the blue and green clusters. De Manincor, founder of the Yoga Institute in Sydney, Australia, is a reference within the green node, fostering connections between the green and red clusters.

Regarding structural indicators (Sillet, 2013) and according to the article citations (Figure 7), Jorm, from the Centre for Mental Health Research at the Australian National University, is an investigator with literature reviews on yoga treatment for mood or anxiety disorders. Notably, Chou's document on "Nonpharmacologic therapies for acute and chronic low back pain" is distinguished by the largest node in light blue, reflecting its 2019 citations.

Focusing on quality indicators (Sillet, 2013), our findings become more specific (see Table 2), particularly with reference to Chou. Additionally, noteworthy contributions are observed from:

- Kirkwood (Research Council for Complementary Medicine, London) – "Yoga for anxiety: a systematic review of the research evidence",
- Pilkington (Research Council for Complementary Medicine, London) – "Yoga for depression: the research evidence",
- Li (St. Elizabeth's Medical Centre, Brighton) – "The effects of yoga on anxiety and stress",
- Rosenbaum (AEP, The George Institute for Global Health, Sydney) – "Physical activity interventions for people with mental illness: a systematic review and meta-analysis".
- Among these, the works of Kirkwood and Pilkington stand out as the most influential references (Figure 8), receiving 14 and 10 citations, respectively, representing perspectives on alternative methods for addressing mental health conditions, evident in European, American, and Australian countries.
- Regarding Figure 8, there are 12 intertwined articles:
- Red cluster – all authors studying specific mental disorders, then connected with the broader field of mental health by Rosenbaum.
- Blue cluster – Li relating yoga to mental health, Carayol citing Gorczynski, Cerrillo-Urbina and Rosenbaum to relate the mental health aspect within her population with breast cancer, and finally Geneen with an intervention for a musculoskeletal disorder.
- Yellow node – authors focusing on musculoskeletal disorders.
- Green cluster – focusing on mental health.

A discerning approach to author quality involves counting publications in the highest-quality journals, such as those with high impact factors, or calculating the author's h-index (20). However, calculating the h-index is complicated by issues related to the researcher's digital identity. Extracting data from each author's ResearchID profile in WoS for all 5052 authors is impractical but becomes feasible for the 57 or 38 prolific authors. For journals, combining efficiency with relevance is crucial. Exploring the possibility of utilising Bradford zones, focusing on core journals, aims to streamline the process and enhance the efficacy of analysis.

## **Top journals**

Bibliometric indicators help researchers measure article impact and guide journal selection. The journal impact factor (IF), reflecting citations, assesses a journal's significance. However, comparisons using IF are influenced by variability in popularity across fields, including researchers, articles, and journals' IFs (Sillet, 2013). Certain topics may not be covered in journals with the highest Impact Factors (IF), and a high IF does not necessarily ensure an in-depth expert discussion on a particular subject.

Table 5 contrasts journals with the JIF of WoS and their best JCR quartile among the WoS indexing categories. It reveals that Yoga studies hold a semi-peripheral position, with some documents reporting publication in journals with a high JIF in 2022 (18.6, 10.5, 8.4) and others zero, with the average IF weighted by number of publications equal to 3.9. As well as some with journals whose highest categorical quartile is 1, and others are even outside this cataloguing, with a mode of the 25 quartile journals in Q2. For yoga research and their authors, a Q2 means that the journal has a moderate impact compared to other journals in the same field. While it may not be among the highest-impact journals, being in the second quartile still indicates a certain level of quality and recognition within the academic community. Articles

published in Q2 journals can reach a relevant audience and contribute to the advancement of knowledge in the field of yoga and related disciplines.

The exclusive emphasis on the yoga field in all the articles would ensure a uniform research context when the journals publishing the articles are related to yoga. However, potential variability may arise concerning the population or medical condition focus corresponding to the specific journal in which an article is published.

## **Research methodology**

Different epidemiological study designs are available, one of which is the randomised controlled trial (RCT). RCTs are the gold standard in evaluating and efficiently translating research data into clinical practice. In fact, this type of study provides the fundamentals of evidence-based medicine and is the most reliable research design out of all the epidemiological studies available (Price, 1966). Therefore, reporting of these invaluable interventions requires high-quality reporting techniques, which allow transparency while enabling the readers to critically appraise the trial findings (Price, 1966). The article's methodology is indicative of the quality of the study to some extent (Jeter et al., 2012); therefore, by choosing to study RCTs, there's an expectation of high quality among the research observed.

The most used methodology from the set of articles in Table 4 appears to be the comprehensive search for RCTs across multiple databases, including PubMed, MEDLINE, Cochrane Controlled Trials Register, PsycINFO, CINAHL, Embase, and others, indicating a thorough effort to identify relevant literature, crucial for ensuring that all available evidence is considered and that potential biases are minimised. This approach involves systematically searching various sources to identify relevant studies, limiting them to clinical trials, controlled trials, and RCT's. Additionally, it seems that the search was restricted to studies in the English

language and involved the inclusion of clinical trials with physical exercise interventions, with or without a control group.

Even so, the challenge of addressing quality or redundancy in yoga articles lies in the variability of not only methodology, but also protocols and modalities employed to address specific populations/medical conditions.

Regarding Table 4, most articles do not refer to all the principles commonly used in research in the exercise physiology field, regarding Training Variables as: volume, intensity, frequency and exercise selection, which would help assess quality as well as reproduce the findings in future studies.

A central finding of this study is the high degree of methodological heterogeneity across yoga reviews, particularly with respect to intervention characterisation, outcome operationalisation, and study inclusion criteria. Reviews frequently aggregate highly dissimilar yoga modalities under a single label, thereby conflating fundamentally distinct practices in terms of postural demands, breathing techniques, meditative components, and pedagogical structure. This methodological compression likely contributes to the inconsistent and sometimes contradictory conclusions regarding yoga's effectiveness across clinical domains. It also limits the interpretability of pooled effect estimates and undermines attempts to identify dose-response relationships or modality-specific therapeutic mechanisms. As a result, the current evidence base remains structurally underpowered to support strong causal or clinical inferences.

The persistence of methodological and thematic gaps over more than three decades suggests that these limitations are not merely technical oversights but reflect deeper structural characteristics of the field. These include the absence of internationally accepted taxonomies for yoga modalities, weak integration between exercise physiology and contemplative science frameworks, and limited regulatory oversight of yoga-based interventions in clinical research.

In addition, the interdisciplinary positioning of yoga—situated between medicine, psychology, sports science, and traditional knowledge systems—has generated epistemic fragmentation. This fragmentation impedes the development of standardised protocols, shared reporting guidelines, and cumulative methodological learning. Consequently, similar design weaknesses occur longitudinally despite repeated critical calls in the literature.

## **General assessment of quality in yoga research**

The exploration of research coverage and trends in yoga literature reveals a significant exponential growth in publications from 1992 to 2024, reflecting the increasing popularity and recognition of yoga as a subject for scholarly exploration. Notably, systematic reviews have emerged as the preferred approach, offering unparalleled comprehensiveness and impartiality in synthesising research priorities. Insights into the global landscape of yoga research highlight prominent contributors such as the United States, China, and England, underscoring the widespread interest in the field. The analysis of keywords reflects a growing association between yoga and medical approaches, signalling a recognition of holistic and integrative aspects within healthcare. However, gaps persist, particularly in the identification of specific yoga types and methodologies, impacting the precision and robustness of conclusions drawn from studies. The concentration of articles around certain authors and journals further emphasises the need for a discerning approach to author quality and journal selection. Despite challenges in methodology variability and reporting standards, the emphasis on randomised controlled trials underscores a commitment to rigorous evidence-based research. Overall, while the growth in yoga literature signifies progress, ongoing efforts are required to address gaps, ensure methodological rigour, and advance the quality and relevance of research in the field.

# **Methodological and Conceptual Implications of the Bibliometric Findings**

Beyond thematic growth and citation concentration, the present bibliometric analysis reveals structural methodological weaknesses that systematically constrain the interpretability and translational value of yoga research syntheses. A recurrent limitation across highly cited reviews is the absence of standardised descriptors of the yoga intervention itself, including explicit identification of the yoga style or school, pedagogical lineage, session structure, and instructor qualifications. This lack of intervention specificity undermines reproducibility and prevents meaningful cross-study comparisons.

More critically, yoga is rarely operationalised as a form of structured physical training. Fundamental exercise physiology variables—such as session duration, movement density, intensity modulation, progression, weekly frequency, and cumulative training volume—are either inconsistently reported or entirely absent from most reviews. Consequently, dose–response relationships cannot be established, and the observed therapeutic or functional effects cannot be translated into prescriptive guidelines for either clinical or performance-oriented contexts.

This limitation has direct implications for health and performance applications. In healthcare settings, intervention fidelity, instructor qualifications, and training load are central to safety, efficacy, and clinical decision-making. In occupational and sport performance contexts, the absence of standardised training descriptors prevents yoga from being meaningfully compared with or integrated into evidence-based conditioning and recovery programs.

At a meta-research level, the bibliometric dominance of reviews focused on anxiety, depression, and chronic low back pain suggests that scientific visibility in yoga research is driven primarily by alignment with biomedical and clinical research paradigms. While this thematic concentration reflects legitimate global health priorities, it also contributes to the

marginalisation of preventive, performance-oriented, and occupational applications of yoga, which remain underrepresented despite their practical relevance.

Importantly, these weaknesses are not confined to primary studies but are amplified at the level of secondary evidence. Many systematic reviews prioritise maximising sample size and thematic inclusivity over intervention homogeneity and methodological transparency. This strategy produces statistically larger but conceptually diluted syntheses, limiting their capacity to generate cumulative, mechanistically interpretable, and clinically actionable knowledge.

Taken together, these findings indicate that future progress in yoga research will depend less on further increases in publication volume and more on a structural recalibration of methodological standards. This includes the development of standardised taxonomies for yoga modalities, minimum reporting requirements for intervention structure and instructor qualifications, and explicit adoption of exercise science principles when yoga is investigated as a training-based intervention.

## **Limitations**

This study is subject to several important bibliometric biases. First, restricting data collection to the Web of Science Core Collection introduces indexation bias, favouring journals with higher editorial selectivity and stronger representation of Western academic institutions. This necessarily underrepresents yoga research published in regional, non-indexed, or practitioner-oriented journals.

Second, although the search strategy did not explicitly filter by language, the dominance of English-language journals within WoSCC generates a de facto linguistic bias. This likely excludes a substantial body of yoga-related scholarship produced in India and other non-English-speaking contexts, thereby distorting the global epistemic map of yoga research.

These limitations directly affect the interpretation of the present findings. The observed dominance of Western countries, authors, and journals may partly reflect database coverage rather than true intellectual leadership in yoga research. Similarly, the apparent thematic concentration around biomedical and mental health outcomes may be amplified by indexing practices that privilege clinical and experimental designs over philosophical, pedagogical, and traditional knowledge-based studies.

Consequently, the results should be interpreted as describing the structure and dynamics of a curated, Western-indexed segment of yoga research rather than the totality of global scholarly production on yoga.

## **Future directions**

Scientifically, the present bibliometric findings indicate that future yoga research must shift from exploratory aggregation toward protocol-driven, modality-specific investigation. The observed thematic concentration, methodological heterogeneity, and absence of standardised intervention descriptors provide a direct empirical justification for this strategic redirection.

Practically, the lack of standardised reporting and instructor qualification data severely constrains the translational potential of yoga interventions in healthcare systems. This undermines their incorporation into clinical guidelines, reimbursement frameworks, and preventive medicine strategies. For policymakers and clinicians, the current evidence base therefore supports cautious endorsement of yoga as an adjunctive therapy but does not yet justify its systematic integration into standard care pathways for most conditions.

Future research should prioritise: the development of internationally agreed taxonomies for yoga modalities and intervention components; the mandatory reporting of training variables (volume, intensity, frequency, session duration, and progression); standardised qualification criteria for yoga instructors involved in clinical research; protocol registration and replication

studies focused on modality-specific effects; and (v) multimodal trials integrating physiological, psychological, and behavioral outcome layers.

At the review level, future systematic reviews should adopt stricter inclusion criteria based on intervention specificity and reporting quality, rather than maximising sample size through methodological dilution.

## CONCLUSIONS

This bibliometric analysis indicates that yoga has consolidated as a sustained and expanding research field, with a marked concentration of secondary evidence in clinically oriented domains. However, the findings also reveal important structural and methodological limitations that constrain the interpretability, reproducibility, and translational utility of the existing evidence base.

The first critical issue concerns terminological heterogeneity. The lack of standardised keywords and controlled vocabulary for yoga-related research limits bibliometric retrieval accuracy, hampers cross-study comparability, and weakens cumulative knowledge building. Notably, descriptors explicitly linking yoga to “health,” “prevention,” or “performance” remain marginal or absent in high-frequency keyword cores, despite the widespread real-world application of yoga in these domains. This terminological gap reflects and reinforces a narrow conceptual framing of yoga primarily as a therapeutic modality rather than as a multidimensional health and performance practice. Consistent with this pattern, citation concentration analyses show that the most influential reviews predominantly focus on anxiety, depression, and acute or chronic low back pain. While this thematic dominance mirrors legitimate global interest in non-pharmacological interventions for prevalent clinical conditions, it also highlights the underrepresentation of preventive, occupational, and performance-oriented applications of yoga. Consequently, the broader spectrum of yoga

practices—encompassing health promotion, functional optimisation, and long-term resilience—remains insufficiently synthesised and theoretically underdeveloped at the level of secondary evidence.

A further and more fundamental limitation is the systematic absence of intervention specificity. Across highly cited reviews, essential information on yoga style or school, pedagogical lineage, instructor qualifications, and session structure is frequently missing or reported inconsistently. In parallel, core exercise physiology descriptors—such as training volume, intensity, frequency, progression, and cumulative load—are rarely operationalised. This methodological deficit prevents the establishment of dose-response relationships, compromises reproducibility, and severely restricts the formulation of evidence-based guidelines for both clinical and performance contexts.

These weaknesses pose a major challenge to the development of a standardised framework for quality assessment, comparability, and redundancy evaluation across yoga reviews. Although bibliometric indicators such as citation counts and journal impact factors guide journal selection and signal scientific visibility, they do not guarantee conceptual depth, methodological rigour, or intervention transparency. The dispersion of yoga reviews across both high- and low-impact factor journals further underscores the heterogeneity of editorial standards and scientific framing within the field. Importantly, these limitations are not confined to primary studies but are amplified at the level of secondary synthesis. Many systematic reviews appear to prioritise maximising thematic inclusivity and sample size over intervention homogeneity and methodological precision. This strategy produces quantitatively larger but conceptually diluted syntheses, limiting their capacity to generate cumulative, mechanistically interpretable, and clinically actionable knowledge.

From a forward-looking perspective, future bibliometric and systematic research should move beyond descriptive mapping and adopt stricter inclusion criteria based on intervention

specificity, reporting transparency, and exercise science principles. The development of standardised taxonomies for yoga modalities, minimum reporting requirements for instructor qualifications and session structure, and harmonised keyword frameworks would substantially improve both bibliometric tractability and scientific interpretability.

Finally, greater attention should be given to cross-national and cross-cultural patterns in the dissemination and application of different yoga schools. Examining how cultural, pedagogical, and institutional factors shape the adoption of specific yoga modalities across countries may provide critical insight into the heterogeneity of research practices and outcomes observed in current literature.

The present findings delineate the epistemic boundaries of the yoga literature researched (the results caution against overgeneralization beyond the curated corpus of WoS-indexed review articles analysed here, and should be interpreted as characterising a methodologically filtered segment of the global yoga research landscape rather than its full epistemic scope) and clarify the structural constraints under which current evidence has been produced. They suggest that future progress in the field will depend less on further increases in publication volume and more on a systematic recalibration of conceptual frameworks, methodological rigour, and reporting standards. Within these clearly delimited constraints, the present study provides a structured bibliometric baseline for future health- and performance-oriented yoga research, while underscoring the need for greater intervention specificity, terminological standardisation, and cross-disciplinary integration.

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