

Chapter

2

A Scientometric Exploration of Global Publications of Yoga Research from 2002-2021

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ABSTRACT :

The paper aims to provide an in-depth evaluation of the research output of Yoga for a period of 20 years, from 2002-2021. A total of 3498 documents retrieved from the Web of Science(WoS) database are considered for this analysis. The research finds that Cramer, H. was a most prolific author in Yoga scientific research with the highest 79 publications and top 2980 global citations. The most productive country is the USA, with 23967 publications, followed by India (5822) and Australia (2258). There was a significant increase in publications during the period of study. Most articles were published in the Journal of Alternative and Complementary Medicine. The highest number of Yoga research papers were contributed by two Indian institutions: All India Institute of Medical Sciences and the National Institute of Mental Health and Neuro-Sciences. Cramer H' published the highest number of papers. The present study will be helpful for other researchers for further studies on Yoga research and policymakers for funding decisions and strategies.

Keywords: Yoga, India, Scientometrics, Biblioshiny, Bibliometrix, WoS

Introduction :

Yoga is an exercise of body and mind. It is originated in India and about 3,000 years old tradition. It comes from the Sanskrit word "Yuj" which means

union (Parchwani et al., 2022 & Woodyard, 2011). It brings balance between mind and health to the individual's physical, emotional spiritual denominations (Ross & Thomas, 2010). Yoga is perceived as an alternative medicine for humans and offers an effective method to reduce stress (Javnbakht et al., 2009). Various styles of Yoga combine physical postures, breathing techniques, and meditation or relaxation that promote mental and physical well-being.

It helps to reduce the chances of developing high blood pressure or heart disease (Khandekar et al., 2021) and changes lifestyle. Yoga is also used as a tool for the treatment of Depression (Pilkington et al., 2005). As an ancient guru, India teaches the world about Yoga as a remedy for all illnesses, unity of mind and body, thought and action, restraint and fulfilment, harmony between man and nature and a holistic approach to health and well-being. Every year on 21th of June, the world observes International Yoga Day to promote Yoga.

It is an emerging area now, and a lot of research on the domain is being conducted in different parts of the world. Although the research on Yoga accumulated from the 1990s, the actual research on modern Yoga gained momentum in about 2000 (De Michelis, 2007). This paper analyzed the research trends of Yoga published during the last 20 years, from 2002-2021, using the Scientometrics method.

This study aims to provide a systematic overview of Yoga research between 2002 and 2021 by employing Scientometrics methods based on information retrieved from the Web of Science. The study identifies the prominent and impactful (a)authors, (b)geographic regions, (c)research institutions, (d)scholarly documents, (e)significant keywords and research topics, (f) highly cited countries, (g)most publishing sources that have been highly influential in the field of Yoga over the last two decades.

Literature review :

A study published in BMJ reviewed the characteristics of the available randomized controlled trials of Yoga published from 1975 to 2014, a total of 366 papers, and it reported 312 RCTs were from 23 different countries with 22,548 participants (Holger Cramer, 2014). Another research says the number of publications was limited in the PubMed database until 2000, and it was a steady surge since 2007. It also reports that more than 200 new titles have been added annually since 2011 (McCall, 2014 & Trivedi et al., 2022). A scientometric assessment of global publications on Yoga output from 2007 to 2016 was held in 2018, examining 3966 global publications from Scopus, in which the average number of citations per paper was 10.44, and Medicine, among subjects, contributed to the largest publication (Gupta et al., 2018). A report published in 2019 investigated Yoga literature from WoS from 2009 to 2018, analyzing 3265 publications using the Bibexcel tool. The study found that the growth of publications in the field of Yoga was sequential, most of the research was

collaborative, and the USA contributed the highest number of publications, followed by India (Thirumagal & Mani, 2019). Srihari Sharma KN et.al. (2019) conducted a bibliometric study of Yoga studies on cardiovascular health based on the PubMed bibliographic database. The result reflected a rapid growth in the publication on the topics of most of the works published by researchers from the USA, followed by India (Srihari Sharma et al., 2019). An article published in 2021 analyzed 4320 Yoga scientific publications collected from the PubMed database from 1948 to 2018; the result found that the publications became tenfold after 2000, and the International Journal of Yoga was the highest-publishing journal on Yoga (Muthappan et al., 2020). One more bibliometric study of Yoga intervention in type 2 diabetes was conducted from 1975 to 2019 based on the Scopus database. The study finds 411 global research articles with an average number of citations per article of 23.82 (Ramamoorthi et al., 2021). We found a few pieces of literature that analyze Yoga publications in the past and no studies conducted after 2021. Therefore, we performed this analysis to fill the gap in understanding the current body of evidence (Trivedi et al., 2021).

Data Collection and Methods :

We used Web of Science, the world's oldest and most comprehensive citation database, to download sample data of the world output in Yoga research covering 2002-21. "Yoga" was a keyword used as the search string and qualified with the title tag. The result was then exported in plain text files, and the record content was selected as 'My custom export selections (Web of Science Core Collection)' which contains 20 WoS fields out of 29. The data were fetched from only three WoS indexes: Science Citation Index Expanded-Expanded, Social Sciences Citation Index, and Arts & Humanities Citation Index. As the WoS database only exports up to 1000 records at once, four files have been downloaded and merged to prepare a single dataset. For analyzing data, we used the software Ms-Excel and 'Biblioshiny for Bibliometrix'-the R-tool for comprehensive science mapping analysis (Aria & Cuccurullo, 2017 & Chhtrapati, 2021).

Results and Analysis

A total of 3498 publications on the topic of Yoga were identified from the WoS database between 2002 and 2022, which included 1718 (49.11%) original research articles, 885 (25.30 %) meeting abstract, 305 (8.72%) review articles, 255 (7.29%) book review, 148(7.29%) and 187 (5.39%) other forms of publications including letters, proceeding papers, news items, book chapters, etc. (**Table 1 & Figure 1**). Among them, 394 (11.26%) papers were published in 2021, 369 (10.55%) papers were published in 2020, and 316 (9.03%) papers were published in 2019. It indicates that most of the articles were published from 2011 to 2021 (**Table 2**). The dataset (**Table 3**) shows that the papers were published in 951 journals with 3300 keywords. A total of 8633 authors

authored and about 2 authors per document. Out of 8633 authors, 8065 authors have written multi-authored papers with about 4 co-authors per document and a collaboration index(CI) of 2.93.

Table 1: Document Types Analysis

Document Types	Publications	% of Documents
Article	1718	49.11
Meeting abstract	885	25.3
Review Article	305	8.72
Book Review	255	7.29
Editorial Material	148	4.23
Letter	87	2.49
Proceedings Paper	28	0.8
Correction	25	0.71
News Item	20	0.57
Poetry	10	0.29
Early Access	8	0.23
Art Exhibit Review	3	0.09
Book Chapter	2	0.06
Film Review	2	0.06
Excerpt	1	0.03
TV review, Radio Review Video	1	0.03

Figure 1: Document Types Analysis

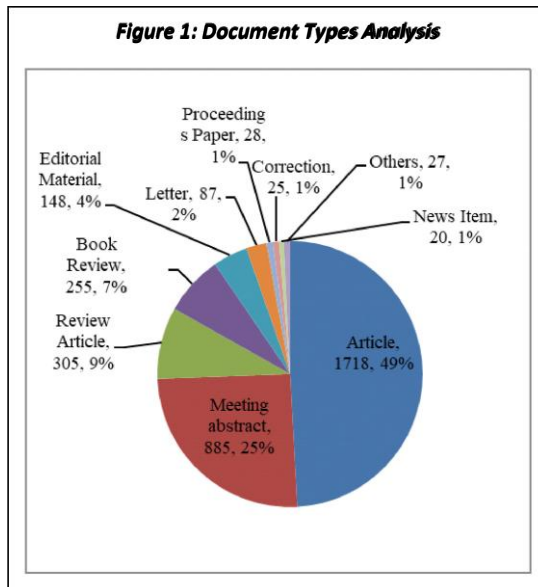


Table 2: Annual Scientific Production

Publication Years	No. of Publication	% of Total Publication
2021	394	11.26
2020	369	10.55
2019	316	9.03
2017	303	8.66
2016	290	8.29
2018	285	8.15
2014	218	6.23
2015	214	6.12
2013	205	5.86
2012	181	5.17
2011	139	3.97
2010	108	3.09
2009	77	2.20
2007	76	2.17
2008	75	2.14
2004	65	1.86
2005	57	1.63
2006	52	1.49
2003	40	1.14
2002	34	0.97

Table 3: Summary of the Dataset

Description	Results
Timespan	2002:2021
Documents	3498
Sources (Journals, Books, etc)	951
Author's Keywords	3300
Authors	8633
Author Appearances	14363
Authors of multi-authored documents	8065
Authors per Document	2.47
Co-Authors per Documents	4.11
Collaboration Index	2.93

Table 4 and Figure 2 discuss the citation impact of the paper published during 2002-2021. Here, we analyzed year-wise citations(CY) ranked in descending order, along with the average citation per article(ACPA) and average citation per year(ACPY). The table indicates that the average citation per year was highest in 2009(2.65) and lowest in 2008 (0.78), whereas the average citation per article was highest in 2005, followed by 2007 and 2004, and lowest in 2003. The analysis is done using Bibliometrix software.

Table 4: Average Citations per Article/Year				
Year	Publications	CY	ACPA	ACPY
2002	34	21	16.41	0.78
2003	40	20	1.60	0.08
2004	65	19	33.71	1.77
2005	57	18	43.12	2.40
2006	52	17	18.40	1.08
2007	76	16	35.79	2.24
2008	75	15	19.51	1.30
2009	77	14	37.17	2.65
2010	108	13	24.64	1.90
2011	139	12	18.70	1.56
2012	181	11	24.78	2.25
2013	205	10	20.28	2.03
2014	218	9	19.98	2.22
2015	214	8	15.64	1.95
2016	290	7	12.64	1.81
2017	302	6	11.93	1.99
2018	286	5	7.86	1.57
2019	304	4	6.67	1.67
2020	342	3	3.95	1.32
2021	382	2	1.93	0.97

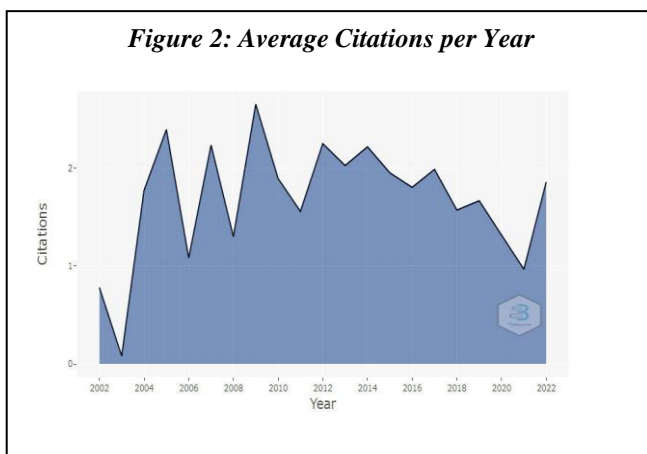


Table 5: Most 10 Relevant Authors

Authors	NP	% of 3,498
Cramer H	79	2.26
Telles S	59	1.69
Gangadhar BN	49	1.40
Dobos G	48	1.37
Lauche R	48	1.37
Nagendra HR	46	1.32
Varambally S	46	1.32
Khalsa SBS	37	1.06
Nagarathna R	36	1.03
Cohen L	33	0.94

Element	h_index	g_index	m_index	TC	NP	PY_start
Cramer H	32	53	2.67	2980	72	2012
Dobos G	31	46	2.58	2535	46	2012
Lauche R	28	47	2.33	2340	47	2012
Langhorst J	20	24	1.05	1384	24	2005
Khalsa SBS	19	34	0.95	1171	34	2004
Nagendra HR	19	39	0.95	1684	39	2004
Telles s	19	34	0.86	1294	56	2002
Gangadhar BN	17	33	0.94	1124	45	2006
Nagarathna R	17	31	0.90	1311	31	2005
Varambally S	16	29	1.07	871	39	2009

Table 5 & 6 analyze most ten influence authors and their impact in 2002-21. The result indicates that the author 'Cramer H' published the highest number of papers(NP), i.e. 79 followed by Telles S(59), Gangadhar BN (49) and Dobos G(48). However, the highest h-index was received by "Cramer H" (32), with the maximum citations(TC), followed by Dobos G(31) and Lauche R(28).

Paper	Total Citations	TC per Year
OKEN BS, 2004	370	18.5
ROSS A, 2010	341	24.3571
SHERMAN KJ, 2005	290	15.2632
CRAMER H, 2013	287	26.0909
OKEN BS, 2006	275	15.2778
COHEN L, 2004	261	13.05
STREETER CC, 2012	248	20.6667
MOADEL AB, 2007	229	13.4706
PILKINGTON K, 2005	228	12
KIRKWOOD G, 2005	223	11.7368

Table 7 describes the ten most globally cited publications. The article 'Randomized controlled trial of yoga and exercise in multiple sclerosis' was written by 'Oken B.S' and published in 'Immunology' received the highest 370 citations and 18.5 citations per year, followed by 'The Health Benefits of Yoga and Exercise: A Review of Comparison Studies' by 'Ross A' and

published in ‘The Journal of Alternative and Complementary Medicine’ with 341 citations, and ‘Comparing Yoga, exercise, and a self-care book for chronic low back pain: a randomized, controlled trial’ by ‘SHERMAN KJ’ published in ‘Annals of internal medicine’ received 290 citations and so on. The table also shows that ‘Cramer H, 2013’, although positioned at the 4th rank in the total citation column, received the highest citation per year, followed by Ross A, 2010

Table 8a: Most 10 Influential Countries

Country	Articles	SCP	MCP	MCP_Ratio
USA	1513	1430	83	0.055
INDIA	346	320	26	0.075
CHINA	145	124	21	0.145
GERMANY	135	82	53	0.393
AUSTRALIA	123	89	34	0.276
UNITED KINGDOM	112	73	39	0.348
CANADA	108	90	18	0.167
BRAZIL	53	48	5	0.094
KOREA	38	34	4	0.105
JAPAN	37	30	7	0.189

Table 8b: Most 10 Cited Countries

Country	Total Citations	Average Citations per Article
USA	23967	15.84
INDIA	5822	16.83
GERMANY	3956	29.30
AUSTRALIA	2258	18.36
UNITED KINGDOM	2248	20.07
CHINA	2080	14.34
CANADA	1722	15.94
BRAZIL	780	14.72
SWEDEN	669	19.68
NETHERLANDS	475	31.67

Table 8a & 8b shows the ten most influential counties and their citations. The USA contributed the most scientific papers in Yoga (1513 Publications; 23967 Citations), followed by India (346; 5822), China (145; 2080), Germany (135; 3956), Australia (123; 2258), UK (112, 2248), Canada (108, 1722) and Brazil (53, 780). The table also reported that the USA topped in single-authored and multiple-authored papers and citation indexes. India

contributed a significantly good number of publications compared to other top economic nations.

Table 9 shows the top ten institutes/organizations in yoga research. The analysis says that 'ALL INDIA INST MED SCIENCE' contributed the highest number of 123 publications, followed by the National Institute of Mental Health and Neuro-Sciences with 92 publications and 'The University of Duisburg-Essen' having 88 publications stands in third position. The table also specifies that although USA organizations contribute the highest number of Yoga research papers, the two Indian institutions are top contributors globally.

Table 10 : Most 10 Influential Institutions

Affiliations	Publications
ALL INDIA INST MED SCI	123
NATL INST MENTAL HLTH AND NEUROSCI	92
UNIV DUISBURG ESSEN	88
BOSTON UNIV	79
BROWN UNIV	79
UNIV CALIF LOS ANGELES	72
UNIV MINNESOTA	67
UNIV CALIF SAN FRANCISCO	66
HARVARD UNIV	62
UNIV CALIF SAN DIEGO	62

The top-ranking journals on yoga research were Journal of Alternative and Complementary Medicine(139 papers), Medicine and Science In Sports And Exercise(118 papers), Complementary Therapies In Medicine(117 papers), Complementary Therapies In Clinical Practice(104 papers) and Annals of Behavioral Medicine (97 papers) during the period 2002-21 as listed in **Table 11**. Our analysis also find that the 'Journal of Alternative And Complementary Medicine' received the highest h-index(33), followed by 'Evidence-Based Complementary and Alternative Medicine' with 32 h-index, 'Complementary Therapies in Medicine' with h-index-25, and 'Alternative Therapies in Health and Medicine' and 'BMC Complementary and Alternative Medicine' having each was 20 h-index (**Figure 3**).

Table 11: Top 10 Journal Sources

JOURNALS	Publications
JOURNAL OF ALTERNATIVE AND COMPLEMENTARY MEDICINE	139
MEDICINE AND SCIENCE IN SPORTS AND EXERCISE	118
COMPLEMENTARY THERAPIES IN MEDICINE	117
COMPLEMENTARY THERAPIES IN CLINICAL PRACTICE	104
ANNALS OF BEHAVIORAL MEDICINE	97
LIBRARY JOURNAL	94
EVIDENCE-BASED COMPLEMENTARY AND ALTERNATIVE MEDICINE	73
ALTERNATIVE THERAPIES IN HEALTH AND MEDICINE	45
INDIAN JOURNAL OF PSYCHIATRY	42
EXPLORE-THE JOURNAL OF SCIENCE AND HEALING	39

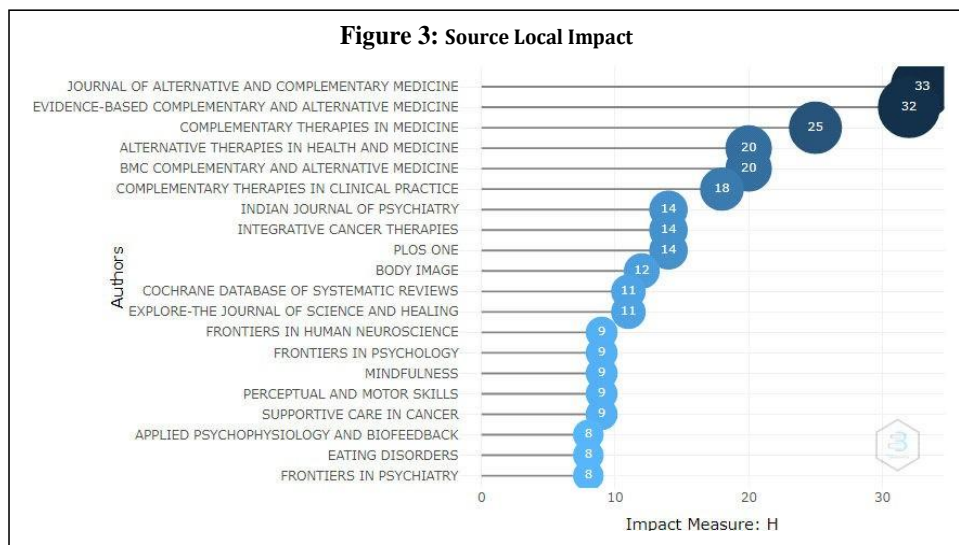


Table 12 & 13 reveals the ten most frequent keywords listed in decreasing order of their occurrence during 2002-21. In all keywords table (no. 12), the term ‘Exercise’ appears most of the time in the publications under study with 357 occurrences followed by Depression(259), Quality of life(259), Intervention(233), Stress(231), and Anxiety(205). Whereas, in the case of the author keywords table (no.13), the word ‘Yoga’ with 1144 occurrences, followed by Mindfulness(144), Meditation (126), Depression(120), Anxiety(111), Quality of life(107), Exercise(93) and Stress(93).

Table 12: Most 10 Frequent Keywords		Table 13: Most 10 Frequent Author's keywords	
All Keywords	Occurrences	Author's Keywords	Occurrences
Exercise	357	Yoga	1144
Depression	259	Mindfulness	141
Quality-of-life	259	Meditation	126
Intervention	233	Depression	120
Stress	231	Anxiety	111
Anxiety	205	Quality of life	107
Women	191	Exercise	93
Therapy	170	Stress	91
Program	164	Physical activity	55
Physical-activity	158	Meta-analysis	50

Conclusion :

This study provides a quantitative and qualitative description of yogic sciences over 20 years, from 2002 to 2021. The study calculated 3498 scientific productions collected from the WoS database. Most of the contributions to Yoga were from the USA, India, China, Germany, Australia and the United Kingdom during the period. English was the most preferred language in yogic research published. The authorship pattern says that most collaboration was held in the USA, whether single-authored or multiple-authored papers. India contributed a significantly good number of publications compared to other Asian and European nations. The two Indian institutions are the top contributors globally. The results will benefit researchers and practitioners worldwide in understanding the research pattern on Yoga and the potential researchers. Moreover, this analysis will provide a direction for further studies on the progress of Yoga research. Organizations and policymakers also find this study very helpful concerning selecting the expert's and funding strategies.

Limitations and future scope of research :

This paper only considers the publication from 2002 to 2021 and from the WoS database, which is again limited to SCI, SSCI, and A&HCI. Second, the analysis uses a few scientometric and bibliometric parameters; however, many parameters can be employed to conduct bibliometric research and science mapping. This result may change over time.

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