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Medithi, Srujana Dr; Muley, Arti Dr; and Mulay, Preeti Dr, "Bibliometric Analysis of Nutrition and Dietetics Research Activities in India using Web of Science database: A Trend across Forty Years" (2021). *Library Philosophy and Practice (e-journal)*. 5652.

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Bibliometric Analysis of Nutrition and Dietetics Research Activities in India using Web of Science database: A Trend across Forty Years

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Abstract:

The present bibliometric analysis studies the nutrition research activity in India. Research articles published during the years 1980-2020, under the “nutrition and dietetics” domain were retrieved from ISI Web of Science database. Entirely, 2,704 articles by 12,514 authors were identified. Karnataka published maximum papers, while USA emerged as the prominent collaborating country. An increasing trend for the number of publications and International collaborations was observed over the years. Currently, as an outcome of these nutrition research activities and with the advent of technology, IT systems along with popular mobile apps are used. Continuous innovative research will boost up IT systems developments in future and few trends are discussed here.

Keywords: Nutrition, Dietetics, India, Bibliometric analysis, Research activity, Web of Science

Introduction:

In spite of India witnessing a rapid economic growth and development, it remains burdened with nutrition concerns of under-nutrition and communicable diseases on the one hand, and an exploding epidemic of over-nutrition and non-communicable diseases (NCD) on the other (Nguyen et al., 2021). The recent outcomes from the National Family Health Survey (NFHS-5), emphasizes this crisis of malnutrition in the nation. The evidence so far stipulates a quiescence, if not deterioration, in multiple markers linked to nutritional status, predominantly in children and women. The ‘flagship’ initiative, Poshan Abhiyaan (or National Nutrition Mission) launched in 2018 with the ambitious plan to attain a *Kuposhan Mukh Bharat*, has scarcely directed to address malnutrition while most of the structural problems stay forsaken (<https://thewire.in/government/nhfs-5-data-malnutrition-food-security-india>). To tackle these twofold challenges strong investment in nutrition research activities is required.

India as a country is still far behind in terms of research activity when compared with other countries. Khandelwal et al (2013), reported that India produced only 2,712 articles (1.9% of the global total) in 2000–2005 and 3,999 articles (2.1%) in 2006–2010 in comparison to China produced 5,146 articles (4.7%) and 10,982 (5.8%), and the United State of America (USA) 42,089 (26.0%) and 47,408 articles (25.2%) in 2000–2005 and 2006–2010 respectively. Though Jeyshankar (2016) in an attempt to quantify the growth and development of food and nutrition research in India and compared it with China in terms of publication output observed that India had more records (1,321) than China records (1,045) during the period of 1983-2012 in Scopus database, the difference was not substantial. China had contributed a greater number of multi authored papers when compared to India (86.79% vs. 60.71%), followed by two authored papers which were mostly presented in India as compared to China (23.62 vs. 9.19 %).

Pritchard (1969) introduced the term Bibliometrics, which is most commonly used to analyze scientific productivity for predicting and studying scientific progress. Bibliometrics Analysis of research output from an individual country not only portrays its research activity but also showcases its current economic growth and health status. Lately no studies have been reported to capture the research output of India in the Nutrition and Dietetics area. India is a house of various old and premium nutrition institutes. Hence it is more important to track the potential in terms of the research conducted and its translation into policy making to overcome the triple burden of malnutrition. Therefore, the objective of the present review is to scrutinize the nutrition and dietetics research activity in India applying the bibliometric approach. The outcome of the study will highlight the data on the research quantity and quality, and help India invest in the right components (infrastructure, innovation and collaborations) to enhance its research competency.

Methodology:

The data for the present bibliometric analysis was retrieved from the ISI Web of Science (WoS) database. The Symbiosis International (Deemed University) Library portal was used to access the data. WoS was chosen for the present analysis as it is easy to use and has advanced search tools. The results of advanced search analysis can be moved to Microsoft Excel and saved or further analyzed very conveniently. The comprehensive analysis of the advantages and disadvantages of various databases WoS, PubMed, and Scopus; shows that WoS covers most scientific publications and not just medical and biomedical publications as seen in PubMed (Falagas et al., 2008). Scopus covers a wider journal range, which helps both in keyword searching and citation analysis, but it is currently limited to articles published after 1995 compared with WoS which covers the records to as early as 1900. However, as the subscribed resources available on our University library portal were from 1980 onwards, the research activity is studied for the time period 1980 to 2020 i.e., over a span of forty years. Another advantage to WoS is that the citation analysis that it offers superior quality graphics and is more precise than the citation analysis of Scopus. Nutrition is a medical theme, and research concerning nutrition could have been conducted and published in non-medical journals which makes PubMed less suitable for this purpose than WoS. Scopus lacks a category research discovery feature, while the WoS provides an advanced search feature that permits an author to screen for the research articles under the category “nutrition and dietetics”. This is a significant benefit when conducting the bibliometric analysis of published articles in a specific field or category (Sweileh et al., 2014).

In the present bibliometric analysis, the keywords, ‘nutrition’, ‘dietetics’, ‘food science’, ‘diet’ and ‘foods’ were entered for the literature search and Boolean's term ‘OR’ was used at the appropriate places. Studies published between 1980 to 2021 and written in the English language were considered for the present study. 1,443,403 records were obtained at the first hit. The records were then refined for the years (1980-2020); WoS category (Nutrition Dietetics) and type of document (article or review) which gave 143,077 records. Further, country/regions (India) filters were applied. Finally, a total of 2,709 documents were retrieved which represented the research activity of nutrition and dietetics in India. However, among these articles, 4 articles were retracted and one article, although listed in the search, did not contain any Indian author or author with Indian affiliation. Therefore, in the present analysis, a total of 2,704 publications were considered.

Information regarding the number of publications across the years, publications across the states of India, publications with International collaborations and collaboration trends found across the years was analyzed. Information regarding top 5 authors, a combination of authors worked towards the publication, top 10 institutes/organizations, top 10 funding agencies and top 10 journals was also retrieved during the search and analyzed for the present bibliometric analysis to obtain a comprehensive picture about the research in India. The data were analyzed using Microsoft Excel

and various representative diagrams were made using the software of Rawgraphs (www.rawgraphs.io) for visualization purposes.

Results and Discussion:

The total number of documents retrieved for worldwide research activity from the WoS category Nutrition Dietetics was 143,077 records between the time period 1980-2020. An increasing trend over the years for the number of publications was observed worldwide. The leading countries in nutrition and dietetics research were the USA (44934; 31.4%) followed by England (12043; 8.4%) and Spain (8876; 6.2%). About 95% of worldwide nutrition and dietetics documents were written in English and the rest 5% were written in 13 other languages mainly Spanish (2.08%) and German (1.29%). The top 5 journals in which worldwide nutrition and dietetics research documents were published included Food Chemistry (8985; 6.28%); Nutrients (8091; 5.65%), Journal of Nutrition (8065; 5.63%), American Journal of Clinical Nutrition (7167; 5%), and British Journal of Nutrition (6304; 4.4%). The most productive institutions of nutrition and dietetics research were the United States Department of Agriculture (USDA) followed by the University of California System and Harvard University with a total of 3489, 3333 and 3031 documents respectively.

Worldwide, India ranked 17th with 2709 (1.89%) publications under the nutrition and dietetics research category. Figure 1 depicts the publication trend in India across the years. The research activity in India remained low and plateaued till 1990, after which a steady increase was observed from 1991 to 2006. A spike in the publications can be seen from then on till 2020. Overall, from 17 research publications in the year 1980, the number was increased to 261 publications in 2020.

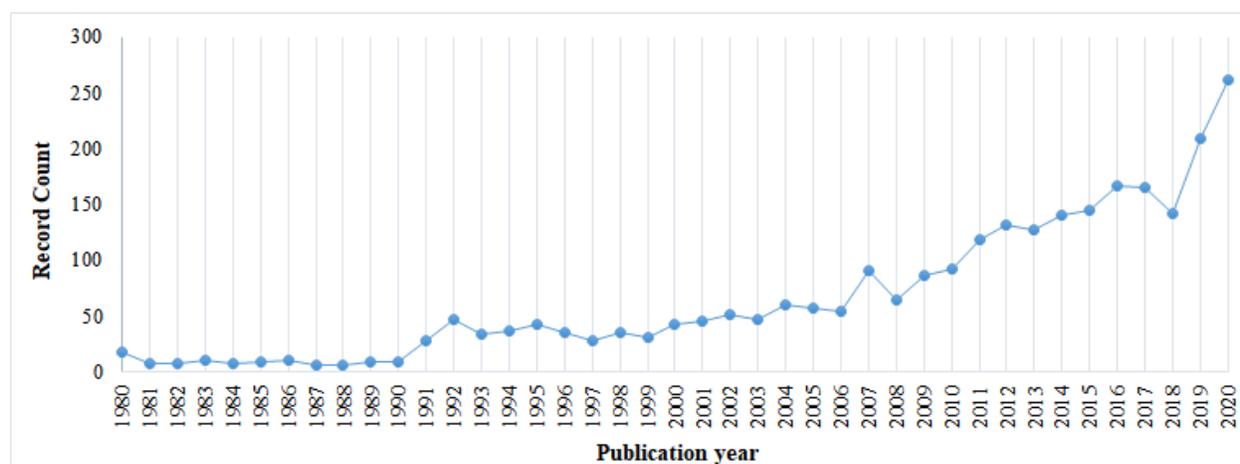


Figure 1: A line chart showing the trend of the publications from Indian authors in nutrition and dietetics research areas from 1980 to 2020 (n=2,704).

India, a confederation of states, is a Sovereign, Secular, Democratic Republic governed by a Parliamentary system. The nation is divided into 28 states and 8 Union territories. Each state and

the Union territory have made its contribution to the overall research development. Thus, in the present analysis, we documented the research output state-wise. It was observed that of the total 2704 publications, 1520 (56%) were published by authors belonging to a single state of India. It is seen from the doughnut below (Figure 2) that Karnataka contributed with the maximum number of publications (321; 21.1%) as a single state, followed by Telangana (215; 14.1%) and New Delhi (163; 10.7%). Tamilnadu and Maharashtra had a tie on the 4th position with 153 publications each; followed by Haryana with 120 and Uttar Pradesh (UP) with 112 publications respectively. Punjab, West Bengal, Kerala and the Union territory of Chandigarh contributed with a total of 283 (18.6%) publications.

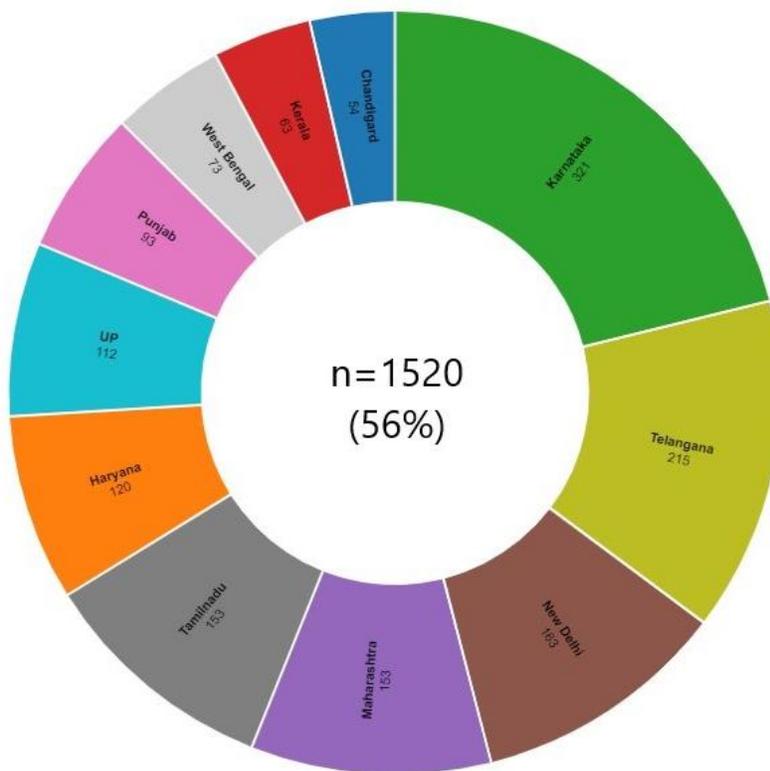


Figure 2: A doughnut representing top 10 single state publications.

An attempt was made to study the trend of states collaborating with each other to co-author the manuscripts. It was observed that 238 manuscripts were co-authored by Indian researchers from different states. Of these 202 (84.9%) papers had authors from two states, 28 (11.7%) were written by authors belonging to three states; 6 (2.5%) from four states and one paper each by authors from five states (Kerala, Maharashtra, New Delhi, UP and West Bengal) and six states (Maharashtra, Odisha, New Delhi, Rajasthan, Telangana and UP) respectively.

The arc diagram (Figure 3) shows the collaborative network for 202 manuscripts scripted by authors of any two states of India. It shows the connections between each state with other in terms of the number of publications. New Delhi collaborated the most with other states (50 publications)

followed by Karnataka (44 publications) and then Punjab (22 publications). This is evident by the size of the bubble for each state. The width of the arc emerging from each state and the number of arcs both resemble the collaborative activity. Wider the arch and the more in number point towards more collaborations. The observed pattern was quite obvious looking at the number of publications brought out by New Delhi and Karnataka in the state-wise analysis. Another reason for such a trend would be that the oldest, very renowned and most productive food and nutrition institutes are situated in these states viz Central Food Technology Research Institute (CFTRI) and St. John's Research Institute (SJRI) in Karnataka; Council of Scientific and Industrial Research (CSIR), Indian Council of Medical Research (ICMR), All India Institute of Medical Sciences (AIIMS) and Delhi University in New Delhi; Punjab Agricultural University in Punjab and National Institute of Nutrition (NIN) in Telangana.

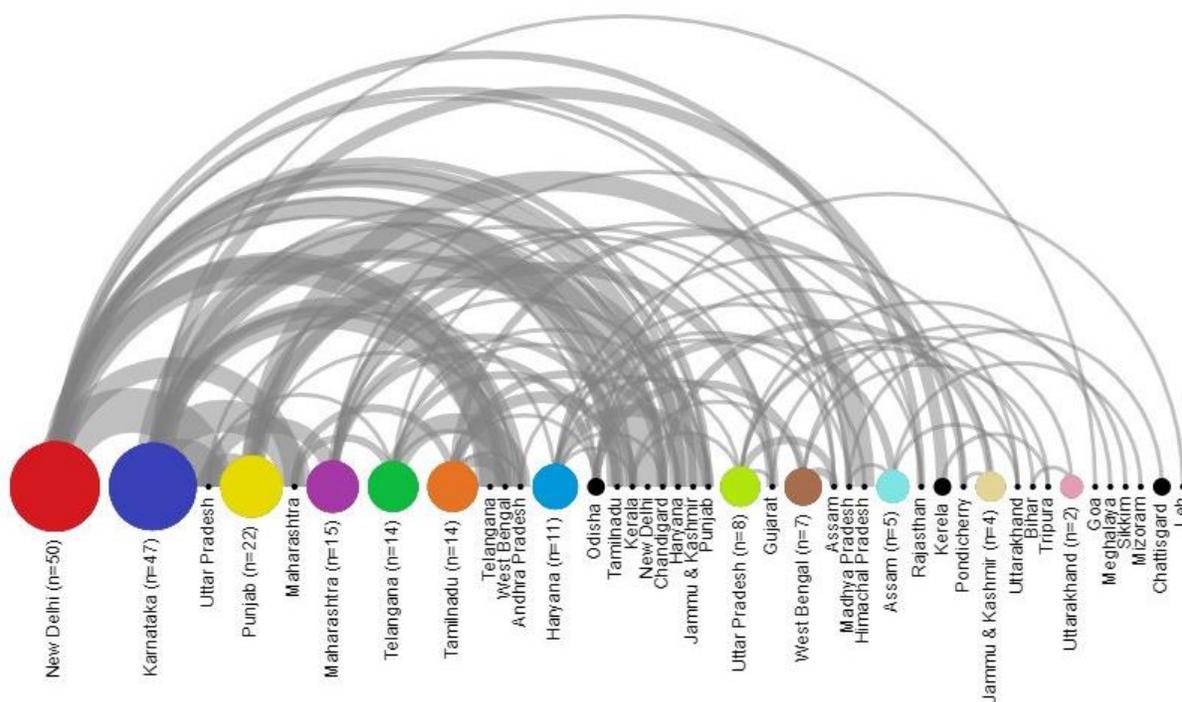


Figure 3: Arc diagram showing the co-publishing trend among the states (n=202)

Out of the 2704 publications, it was observed that about 767 research articles were published in collaboration with other countries. In total, 93 countries have collaborated with India for these publications during the period 1980-2020. Among these, four countries majorly collaborated with India such as the USA (n=377), England (n=140), Australia (n=69) and Canada (n=69) which contributed to about 655 publications. The other 89 countries contributed to about 112 research articles, which are shown in figure 4. In the figure, the height of each block (country-wise) represents the size of the cluster (proportionate contribution of publication by each country). Whereas, the height of the stream field coming from each country indicates the size of components contained in both blocks (country name and number of publications) connected by the stream field. Visually, the most prominent contributions can be seen by the increased height of the stream field.

Among them, the notable contributions were made by collaboration with China (n=35), Italy (n=34), Switzerland (n=30), South Korea (n=29), and Netherlands and South Africa (each 27 publications).

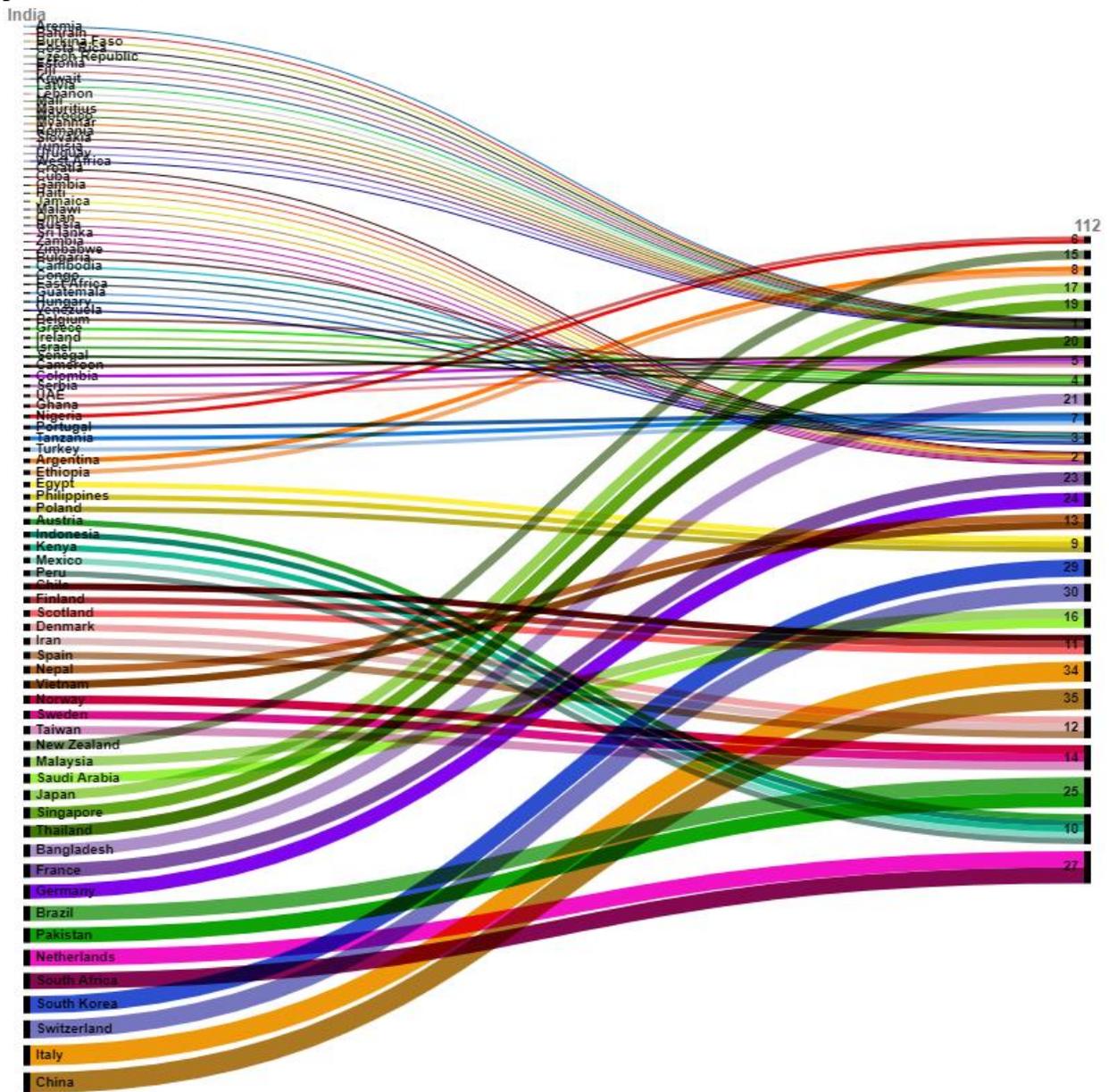


Figure 4: Alluvial diagram representing the collaboration of Indian states with other International countries (n=112).

Collaboration with esteemed foreign organizations may promote improved quality research along with the usage of novel technology. Therefore, we tried to analyze the publication trend of the research articles (n=767) which were conducted in collaboration with International agencies. The time period, 1980-2020, was divided into decades and publications in these four decades were analyzed. The decade-wise publication trend of Indian authors along with International

collaborations is depicted in figure 5. The first decade showed a very poor collaboration with only 4 publications. However, there was a gradual increase in the collaborative activity and publications in the following decades with 30 and 153 articles. The latest period, 2011-2020, showed the highest collaborative publications with 580 research accounts.

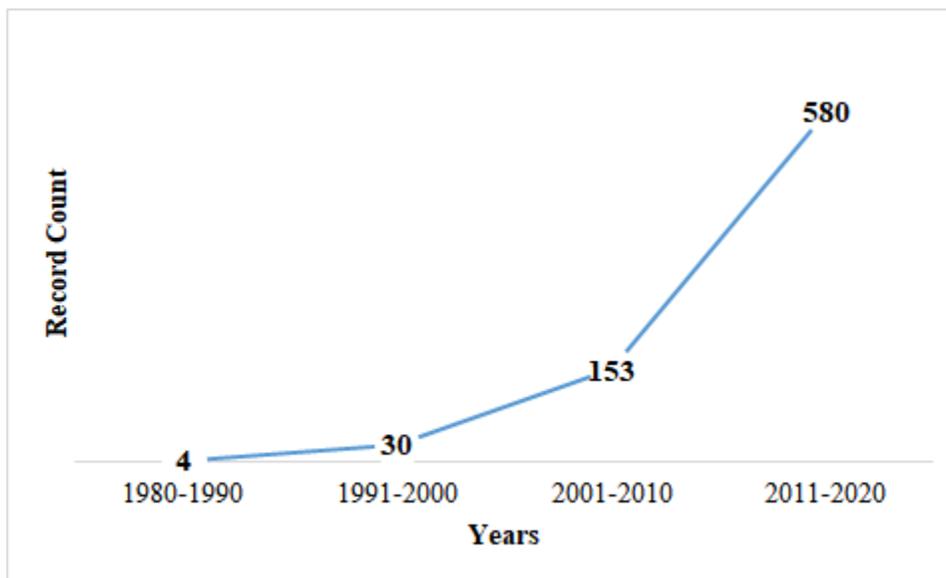


Figure 5: Trendline depicting the trend of publications of India with International collaboration across 1980-2020 (decade wise representation).

The top 5 authors who contributed to most of the articles were analyzed and depicted in figure 6. The highest publications were contributed by Dr. AV. Kurpad, Professor and Former Head, SJRI, Karnataka. With more than 30 years of research experience, his research focus includes nutrient metabolism, obesity and diabetes, public health nutrition, the interaction between gut health and nutrient status, translational nutrition, and human nutrition-agriculture interface. The next author, Dr. K. Srinivasan has about 49 publications and is also from Karnataka state and is affiliated with CSIR-Central Food Technological Research Institute. Dr. T. Thomas has contributed to 38 publications and is affiliated with St. John's Medical College, which is also located in Karnataka. It is interesting to note that the top three authors are affiliated with institutes located in Karnataka, the state with the highest publications as a single entity. Dr. P. Menon has about 31 publications and is associated with International Food Policy Research Institute (IFPRI) and is also a theme leader for South Asia Nutrition Programs in IFPRI's poverty, health and nutrition division. The next author is an eminent diabetologist, Dr. V. Mohan with 28 research publications in nutrition. He is the Chairman and Chief of Diabetology at Dr. Mohan's Diabetes Specialties Centre and he is also honored with Padma Shri National Award by the Indian Government for his incredible services in the field of diabetology.

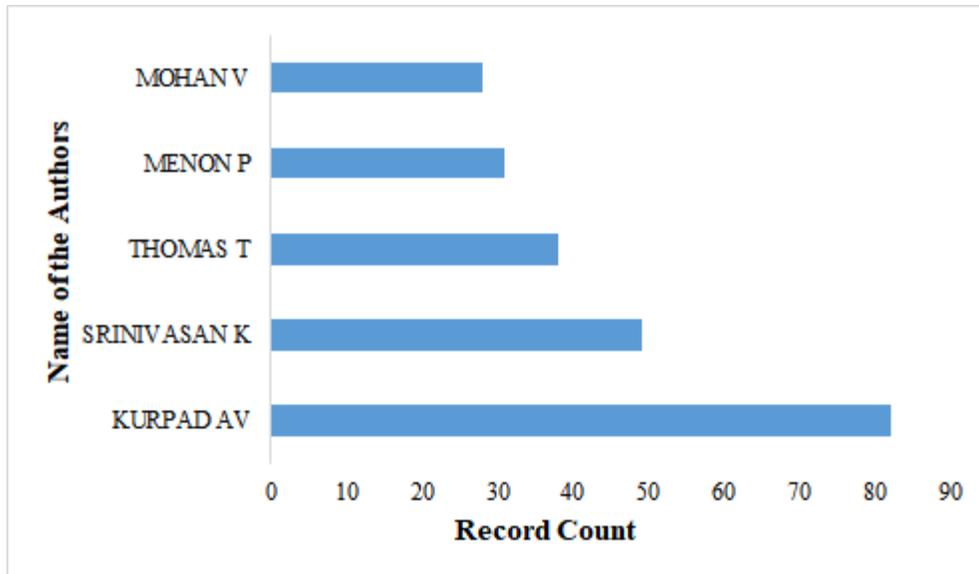


Figure 6: A clustered bar chart representing the top 5 authors from India in nutrition and dietetics research.

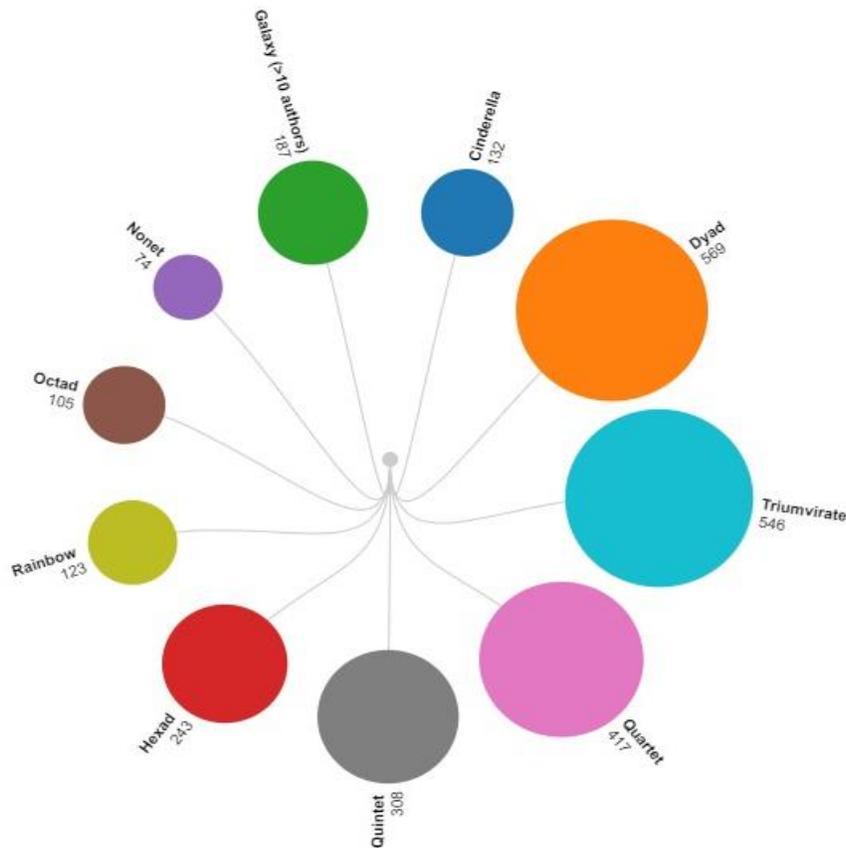


Figure 7: A circular dendrogram depicting the publications by a group of authors (n=2,704).

A total of 12,514 authors contributed to the included 2,704 manuscripts; of which 8,914 (71%) authors belonged to India. Hence an attempt was made to study the proportion of manuscripts based on the number of authors involved (Figure 7). The legends for the dendrogram are as follows- Cinderella = 1 author; Dyad = 2 authors; Triumvirate = 3 authors; Quartet = 4 authors; Quintet = 5 authors; Hexad = 6 authors; Rainbow = 7 authors; Octade = 8 authors; Nonet = 9 authors and Galaxy = 10 or more authors. The authorship pattern for the 2704 articles revealed that maximum manuscripts were written by a pair of two authors (21%); 20% of manuscripts penned by a group of three authors followed by four authors contributing to 15% of the total published literature.

The institutes/organizations with which the authors were affiliated while publishing the research article were categorized and the top 10 organizations were listed (Figure 8). CFTRI has the highest number of scientific publications (n=171) related to nutritional research. CFTRI works under the CSIR and its broad research focus revolves around Engineering Sciences, Technology Development, Translational Research, and Food Protection and Safety. ICMR stands second in the list with 134 research articles. The institute is one of the pioneers to meet the demands of scientific advances in biomedical research and also participate in understanding and providing practical solutions to health problems in India. The next organization is the NIN with about 90 publications. It works under the ICMR and is one of the oldest nutrition research centers in India focusing their prime interest in Indian public health and nutrition and translational research, it has reached a milestone of completing 100 years too. The fourth organization in the list with 85 publications is the CSIR, which covers a wide spectrum of science and technology and strives to improve the transdisciplinary areas of research. CSIR also engages to provide library services via technical information systems in India (Mahesh and Gupta, 2010). Research from the AIIMS contributed to about 81 publications. It has a medical school, hospital and a medical research university and the prime research interests include clinical and epidemiological studies to prevent and treat national health-related issues and advance research including neurosciences, and hormone-receptor interactions. The next institute on the list, St. John's National Academy of Health Sciences contributed for about 72 publications, which is a renowned institute for health care professionals who thrive to improve the health at the community level through research and development. IFPRI has about 56 publications in nutritional research and its main thrust area is to improve national agricultural and food policies and also to adopt innovative agricultural technology. Punjab Agriculture University and Delhi University have contributed with 53 publications each while Haryana Agricultural University contributed to 48 publications indicating the active nutritional research conducted even in the universities.

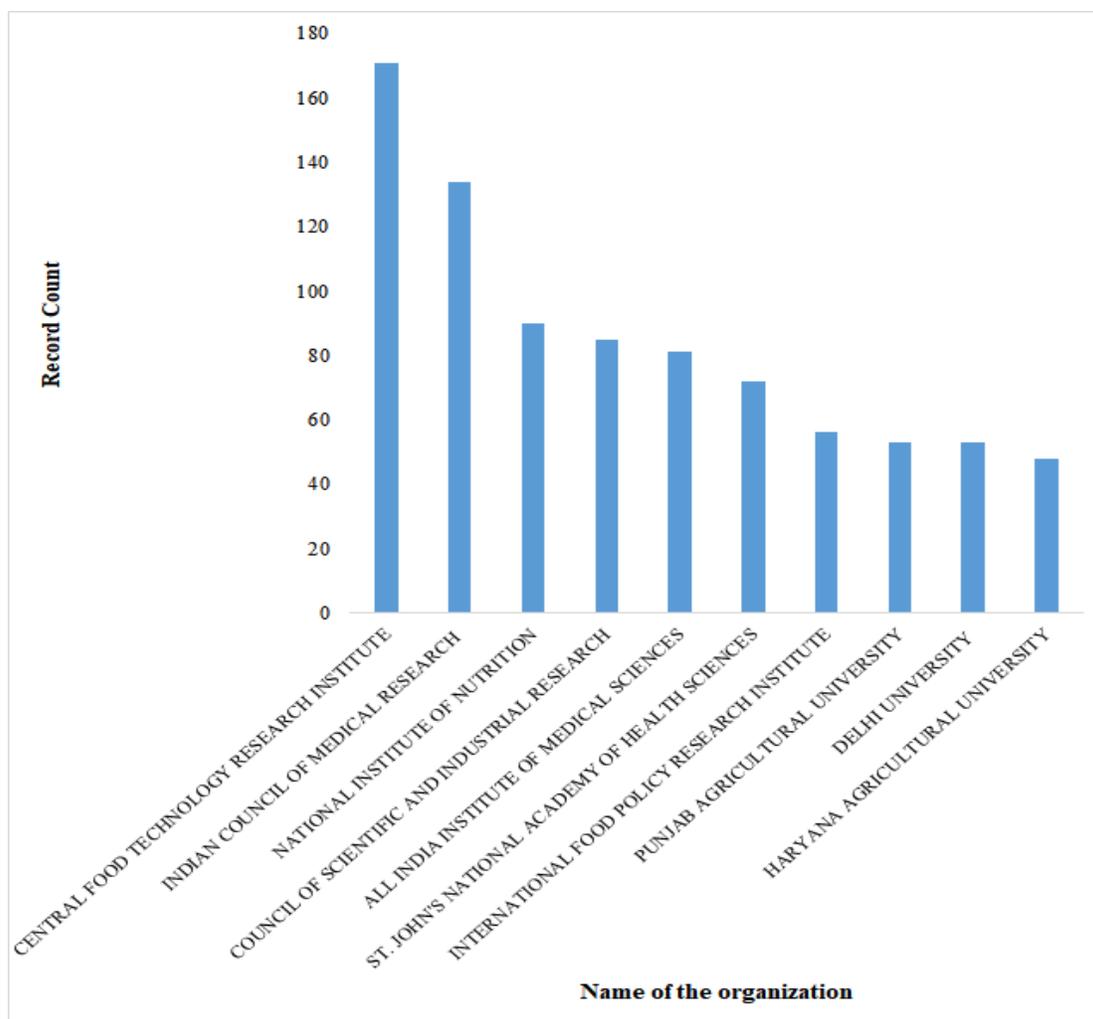


Figure 8: A clustered column chart representing top 10 institutes/organizations in nutrition and dietetics research publications in India.

The top 10 funding agencies (Figure 9) were listed to identify the agencies which encouraged and provided funds for nutritional research in India which is depicted from the number of publications produced. Among them, the first five agencies are Indian organizations and supported by the government of India. CSIR provided funds for the highest number of publications (n=132). Established in 1942, CSIR stands as one of the ancient and largest research and development organizations by the Indian government, which principally provides financial assistance to promote research in the areas of agriculture and medicine. About 124 publications were funded by the Department of Biotechnology (DBT), which is affiliated with the Ministry of Science and Technology, India. They provide grants to competent researchers to conduct investigations related to medical biotechnology, agriculture and allied sciences. The next organization in the list, which also provided financial assistance for about 124 publications is the University Grants Commission (UGC) of India under the Ministry of Education, which not only aims to maintain the standards of

university education but also provides scholarships and funds to individuals aiming for higher education and research. ICMR is one of the oldest medical research establishments in the globe and is the apex for the formulation, coordination and promotion of biomedical research in India and present analysis reveals that it has funded about 113 publications in nutritional research. Department of Science and Technology (DST), is also an organization under the Ministry of Science and Technology, India which plays an important role in promoting research related to science and technology in India and funded 102 nutritional research publications of India during our analysis period.

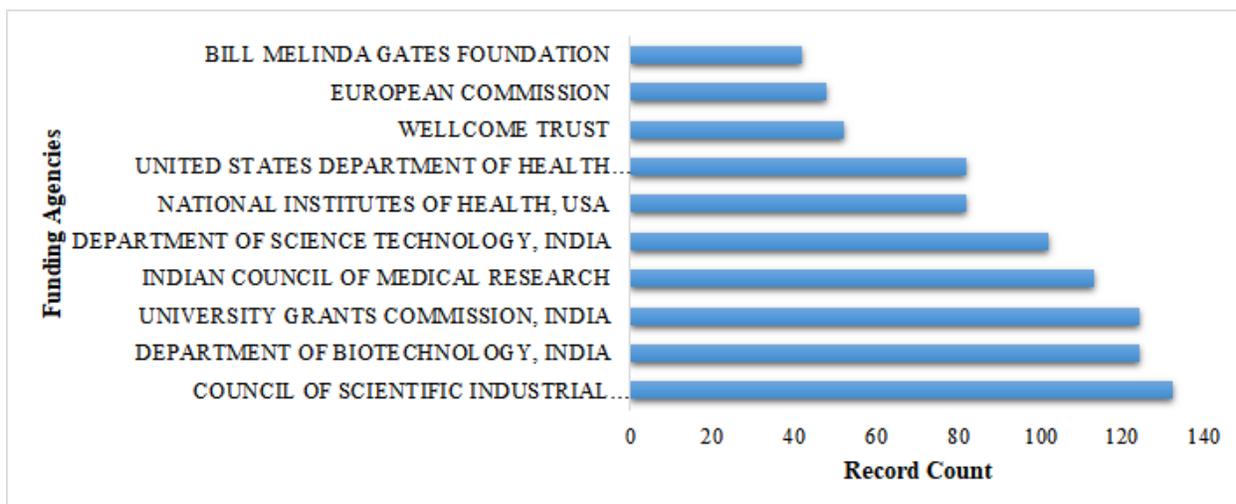


Figure 9: A clustered bar chart representing top 10 funding agencies in India for nutrition and dietetics research.

The next five organizations on the list are not Indian organizations. The organizations, National Institutes of Health, and United States Department of Health are USA-based funding agencies and were listed as funding agencies by 82 publications each. The International associations in these Indian studies show the highest collaboration with the USA which suggests the role of USA-based funding agencies in providing grants to Indians researchers. While, Wellcome Trust, a United Kingdom (UK) based agency was acknowledged as a funding agency in 52 publications. The European Commission is governed by European Council and was listed in about 48 publications and the tenth agency was Bill Melinda Gates Foundation, again a USA-based research grant agency which was listed in 42 publications.

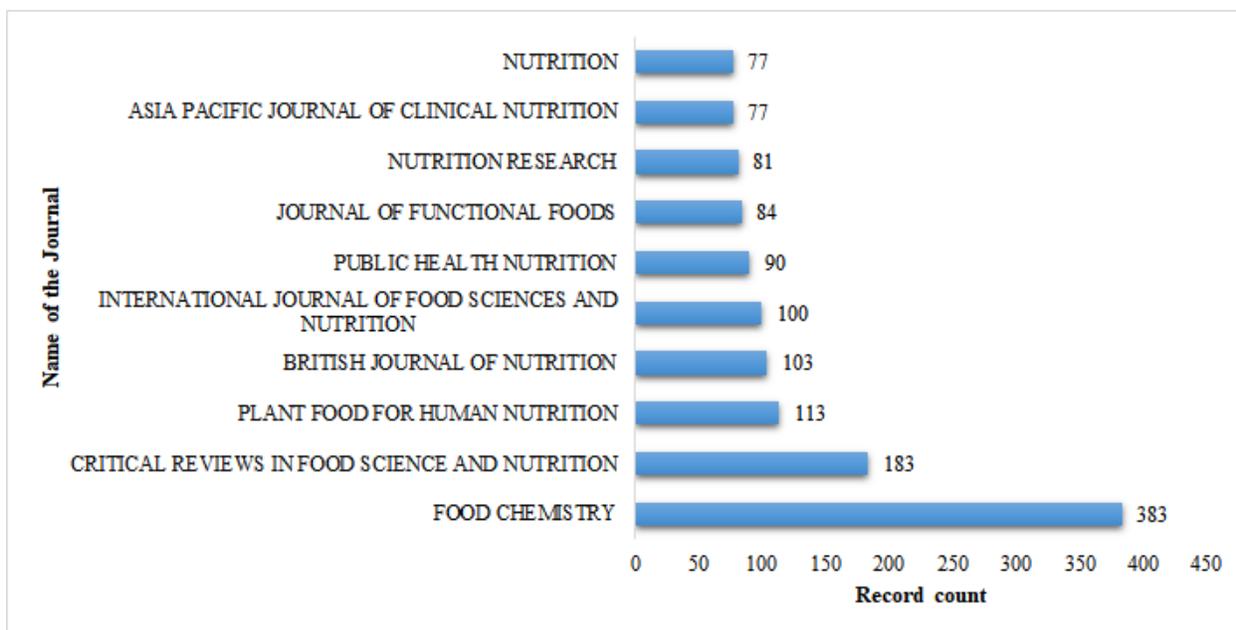


Figure 10: A clustered bar chart showing the top 10 journals in which nutrition and dietetics research publications from Indian authors has been published.

Figure 10 represents the top 10 journals that have published articles of nutrition and dietetics submitted by Indian authors. The highest number of articles (n=383) were published by ‘Food Chemistry’, a peer-reviewed scientific journal by Elsevier established in 1976. The journal encourages a vast dimension of nutritionally related research topics including food components, bioactive constituents, processing effects on food composition and chemistry of food additives and contaminants. The journal, ‘Critical Reviews in Food Science and Nutrition’ which was established in 1970 by Taylor and Francis publications has about 183 publications from Indian authors and stands second in the list. The journal mainly focuses on nutrition-related areas such as functional foods, food safety and food science technology. The third top journal is ‘Plant Food for Human Nutrition’, a Springer publication which focuses on research involved in enhancement and assessment of the nutritional quality of plant foods by techniques of biotechnology, food science and technology, functional foods, nutraceutical or pharma foods and nutrients and non-nutrient inherent in plant foods.

One of the oldest journals (established in 1947), ‘British Journal of Nutrition’ is published by Cambridge University Press on behalf of The Nutrition Society falls next in the list with about 103 publications from Indian authors during these four decades of research. This journal encourages articles of a broad spectrum of nutritional sciences that can contribute to adding knowledge in research related to human or animal human. The other journals in the list include ‘International Journal of Food Sciences and Nutrition’ published by Taylor and Francis which includes research articles on food engineering, enhancing the shelf life of food, food deterioration, food handling

and processing. The journal ‘Public Health Nutrition’ encourages articles from epidemiologists who focus on understanding the cause and evaluate to obtain a solution for any nutrition-related public health situations or achievements across the globe.

Technology in nutrition and diet practices

After carefully observing the published articles over 40 years in nutrition and diet domain it is visible and necessary to bring Information Technology (IT) based systems and apps in use at large scale (McNulty et al., 2021) on their conference blog website mentioned that *“Technological advances bring new opportunities for scientific research to aid our understanding of human mechanisms. This enables researchers and practitioners to build on traditional methods using different assessment tools to advance research and give the most appropriate advice to patients.”*

With the increased use of internet-of-things (IoT) based devices and huge surge in data volumes, researchers from nutrition domain also started making use of various IT systems or tools, for instance, Nutrigenomics technology. It is an emerging science which analyses influx of health data based on complex biomarkers which in turn may lead to developing new biomarkers for health. Nutrigenomics technology may include analysis of proteins, metabolites, mRNA etc. to name a few.

Data for diverse health measures can be collected automatically using multiple wearable and mobile app technologies. This automatic data collection and analysis reduces burden of all participants including health professionals for prescribing accurate diet using auto created nutrition charts, exercises and medicines if any etc. The most wonderful and informative example of this is “Bath Breakfast Project” detailed report, showcasing importance of having breakfast for daylong activities and movements (Betts et al., 2011, Chowdhary e al., 2016)

As per the expert Dr Kathryn Hart Nutrition and Dietetics at University of Surrey *“Using mobile phones to record dietary intake and photograph food prior to consumption can be an effective method for dietary analysis, reducing reliance on self-report and recall”*.

Personalization is achieved using varied Machine Learning and Artificial Intelligence tools to recommend nutrition and diet requirements to individuals. And this is definitely the growing field of collaborative research among IT and nutrition domains. There are specialized apps and AI based systems developed to plan, track and maintain athletic performance as every athlete or sports person’s or individual’s nutrition intake requirement is different. Use of such modern tools will improve the overall quality and lifespan of people.

In addition to this data analytics-based systems are helping reduce or avoid food loss or waste, or reuse wasted food into beneficial ingredients or products. Also, software systems data analysis will help investors to invest in the business related to developing unique plant-based mineral and

vitamins to cater to increasing demands of such immunity booster products. Regenerative agriculture practices, sustainable agriculture and smart supply chains etc. will give new life to the domain of nutrition and diet indirectly using latest technological concepts, tools and platforms.

Conclusion:

An attempt was made to review the research activities in the field of nutrition and dietetics in India by conducting bibliometric analysis using the web of science database. The present analysis presented the trend of original research and review articles across four decades (1980-2020) and interesting observations were made. Over time an appreciable increase in the number of publications during this period can be seen indicating the recognition of nutrition and dietetics in research. An exemplary increase is also observed in the inter-state and also International collaborative research activities across the years. However, the nutritional research in India contributes to only 1.89% globally, which is considerably low given the present population in the country, and insufficient agricultural crop yields and escalating nutritional-related health problems. To combat the challenges related to food, nutrition and health, there is a need to encourage researchers/health professionals and accelerate nutritional research.

Various reforms can be introduced in India to improve and encourage research related to nutrition and dietetics. It was observed that very few organizations under the Government of India were involved in providing research grants actively. Amplified provision of research funds by the government or private Indian organizations can encourage the researchers/scientists/faculty to conduct both basic fundamental and applied research in nutrition-related fields. Improved promotional programmes not only in terms of providing research grants/funds but also by facilitating the training of sophisticated techniques and suitable research fellowships can help to nurture the young researchers in India. It was interesting to note that educational universities also promoted research publications. Therefore, multidisciplinary education can be integrated into the nutrition curriculum to relate other fields such as agriculture, food technology, genetics, biotechnology, economics, and policy to promote interdisciplinary research. Core research courses including research methodology and biostatistics must also be included to increase the comprehensive understanding of research initiation and implementation among the upcoming researchers. The Indian National Education Policy (NEP), 2020 has also proposed a multidisciplinary curriculum where weightage is given to research activity during the regular academics. Implementation of this policy can help in increased experiential learning and research outcomes too.

Escalated research activity can be observed in inter-state or International collaborative work. Therefore, efficacious collaborations with developed countries must be encouraged to increase research productivity and improve the quality of research. This can also lead to upgrading the research design to effective, scientific, and innovative research strategies. Recognition and

promotion of nutritional research in India can gain wide therapeutic applications in implementing policies and suitable intervention programs to handle the present and upcoming nutrition-health issues.

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