Cognitive intervention for Mild Cognitive Impairment (MCI) among the elderly: A bibliographic network analysis of research trends

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Intervention cognitive chez les personnes âgées souffrant de troubles cognitifs légers (MCI) : une analyse de réseau bibliographique des tendances de la recherche

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KEYWORDS
Mild Cognitive Impairment (MCI);
Cognitive intervention;
Bibliometric analysis;
VOSviewer

Summary Cognitive intervention has emerged as an alternative therapy for Mild Cognitive Impairment (MCI) among the elderly. However, MCI patients in Indonesia continue to receive psycho-pharmaceutical prescriptions. This bibliometric analysis used Boolean logical functions to explore the literature on cognitive intervention in MCI from 2001 to 2021 using Scopus data. The data was extracted in CSV format and exported to VOSviewer to analyze according to country of origin, keywords, frequency of citation of journals and articles, and journal sources. The total of 702 documents found over roughly 20 years underscores the importance of this research topic, with a significant increase in 2019, reaching 310 articles (44.1%). The network analysis reveals that the United States (23%) is the nation that provides the most material on this subject and is interconnected followed by Italy (9.6%) and Australia (9.1%), which suggests the issue is addressed globally. The bibliography showed that 220 articles focused on cognitive training

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and prevention, often entailing changes in risk factors. The findings on the co-occurrence of MCI-related keywords (575 instances) and cognitive training keywords (236 instances) were taken into account. According to the keyword analysis, identifying and overcoming cognitive decline among the elderly now and in the future is to be found in trends and research areas related to cognitive training and prevention. From the analysis of the source co-citation list, it was found that neurology journals were the most often cited (5.53%), followed by *PLoS One* (2.09%) and neuro-imagery journals (2%). This demonstrates a strong link between the field of neurology as a source of knowledge on cognitive disorders, and psychiatry.

MOTS CLÉS
Trouble cognitif léger (MCI) ;
Intervention cognitive ;
Analyse bibliométrique ;
VOSviewer

Résumé L'intervention cognitive est apparue comme une thérapie alternative pour les troubles cognitifs légers (MCI) chez les personnes âgées. Cependant, les patients MCI en Indonésie continuent de recevoir des prescriptions psychopharmaceutiques. Cette analyse bibliométrique a utilisé des fonctions logiques booléennes pour examiner la littérature sur l'intervention cognitive dans le MCI de 2001 à 2021 à l'aide de données Scopus. Les données ont été extraites au format CSV et exportées vers VOSviewer pour analyser l'origine par pays, mots-clés, revues et articles fréquemment cités et les sources des revues. Un total de 702 articles trouvés sur environ 20 ans souligne l'importance de ce sujet de recherche, avec une croissance significative en 2019, atteignant 310 articles (44,1 %). L'analyse du réseau révèle que ce sont les États-Unis (23 %) qui publient le plus sur ce sujet, suivis de l'Italie (9,6 %) et de l'Australie (9,1 %), ce qui permet d'aborder ce sujet au niveau mondial. Le réseau bibliographique a montré que 220 articles mettent l'accent sur l'entraînement cognitif et la prévention en modifiant le plus souvent un facteur de risque. Les résultats de l'analyse de co-occurrence des mots-clés MCI (575 fois) et Entraînement cognitif (236 fois) ont été utilisés. Selon l'analyse des mots-clés, l'identification et la lutte contre le déclin cognitif chez les personnes âgées sont à chercher actuellement dans les approches et les domaines de recherche liés à l'entraînement cognitif et à la prévention. À partir de l'analyse de la liste des sources de co-citation, il a été constaté que les revues de neurologie étaient les plus citées (5,53 %), suivies de *PLoS One* (2,09 %) et de neuro-imagerie (2 %). Cela démontre un lien fort entre le domaine de la neurologie, en tant que source de connaissances des troubles cognitifs, et la psychiatrie.

The elderly population in the world continues to increase every year and currently amounts to more than 12% of the world's population, and it is expected to double by 2050, especially in low and middle-income countries [1]. The impact of the aging process on the elderly includes damage at molecular and cellular levels that decrease physical and mental capacity, and increase the risk of illness and death. Mild Cognitive Impairment (MCI), characterized by subjective cognitive complaints with objective evidence of daily activity impairment, is one of the most common conditions experienced by the elderly population. The prevalence of MCI is about 16% and it usually progresses every year [1,2]. More than 80% of people with MCI will develop dementia after six years [3]. According to research in 2013, 32.4% of Indonesians have MCI, and most are still treated with psychopharmaceuticals, particularly cholinesterase inhibitors [4].

To prevent MCI from getting worse, management and prevention are also necessary [5]. Pharmacological management for MCI is not recommended, with a view to reducing danger; there is also the risk of polymedication, and adverse effects on the aging body so that the non-drug method is more promising [3,6]. However, elderly people can still enhance their cognitive performance because of the neuroplasticity of the brain, which can be improved through simple, intricate, or multimodal interventions [7]. These interventions include cognitive remediation and compensatory approaches [7,8].

Bibliometric analysis pinpoints relationships between articles, keywords, years, authors, and the country of origin of the articles studied [9]. We can measure and evaluate the impact of research according to the topic of interest and identify the characteristics of the topic in the past, current, and future research trends [10]. The more significant are the relationships between topics, articles, and authors, the more likely are citations to be interconnected [11].

This study was conducted because despite the increase in the older population, the incidence of MCI and its significant effects, the psychopharmacological therapy used in Indonesia is still unable to address the issue. Therefore, the aim of this study was a bibliometric analysis focusing on MCI and cognitive interventions, using Scopus and the VOSviewer tool

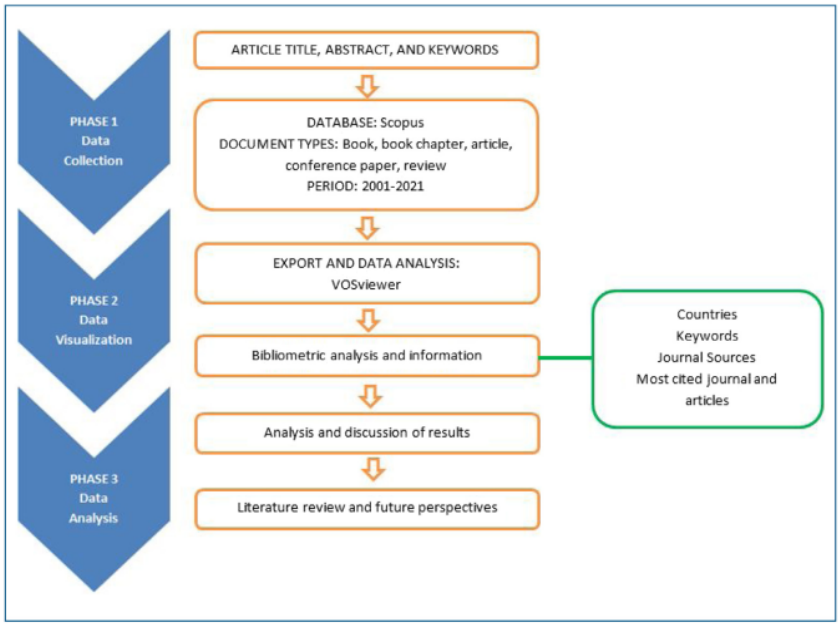

Figure 1. The methodological phases and the analysis criteria applied in this study.

to determine the scientific structure (articles, authors, keywords, countries, and years), the patterns, and the trends in the development of research on this topic. In addition, this study provides an overview of the relationship between MCI and cognitive intervention to suggest alternative methods of dealing with MCI.

Methods

This bibliometric research implemented three methodological phases (Fig. 1), namely data collection (Phase 1), data visualization (Phase 2), and data analysis and interpretation (Phase 3) [12].

Data collection

We searched for articles according to keywords using primary data from the Scopus database on August 8, 2022. The search period was determined between 2001 and 2021. The keywords used were mild cognitive impairment, mild neurocognitive disorder, early Alzheimer's disease, cognitive intervention, cognitive remediation, cognitive stimulation, and cognitive training. The selection of keywords was associated with Boolean logical functions ''OR'' and ''AND'' which led to the following search strategy: (Title-Abs-Key (''mild cognitive impairment'' OR ''mild neurocognitive disorder'' OR ''early Alzheimer's disease'') And Title-Abs-Key (''cognitive remediation'' OR ''cognitive intervention'' OR ''cognitive stimulation'' OR ''cognitive training'')). The filters used in the basic data as inclusion criteria were books, book chapters, articles, conference papers, and literature reviews. By searching these keywords and applying the filter criteria, 702 publications were found.

Data visualization

In the second phase, the data found in Scopus was extracted as data in the form of a Comma Separated Value (CSV) using Microsoft Excel. The CSV file was extracted using the OpenRefine application to streamline the number of keywords in the author and index keywords section. After extraction, the CSV data was exported by VOSviewer software for bibliometric analysis of the countries, keywords, frequently cited journals and articles, and journal sources. In this study, bibliometric methods were used to visualize MCI and cognitive interventions through VOSviewer using bibliographic coupling (which identifies two independent documents citing the same article), co-citation analysis (identifying linked journals from stored citations) and co-occurrence of keywords (providing a list of frequently repeated keywords) [9,12].

Data analysis and interpretation

In the third phase, bibliometric analysis and interpretation were carried out using scientific mapping. Data interpretation consisted in looking at the relationship between the circle, the interconnected color, and the size of the circle. The output results are displayed in the form of connected circles. The closer the distance between the two circles, the stronger is the relationship between the terms [13]. Different colors represent different groups of terms [14]. In addition, the larger the circle, the higher frequency of the term occurrence [15]. The data analysis and

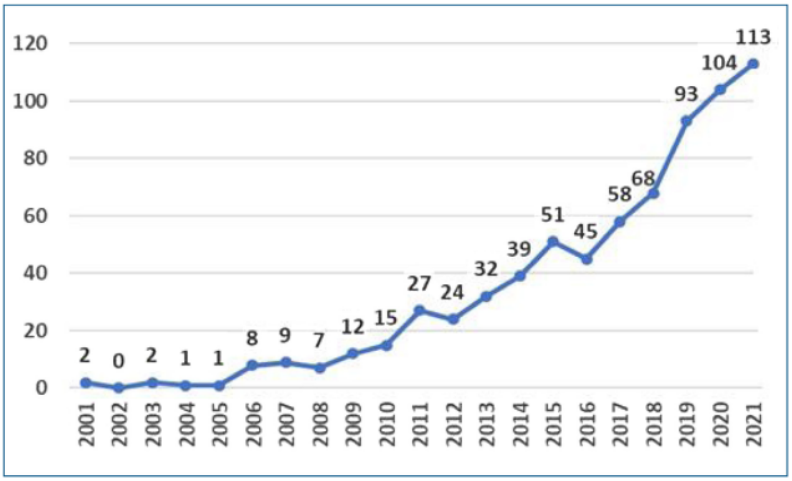

Figure 2. Increase in scientific production on MCI topics and cognitive remediation in the period 2001–2021.

interpretation phase were designed to identify and interpret the main research topics relating to MCI and cognitive intervention from year to year. Thus, bibliometric analysis enables the achievement of research objectives, namely the identification of scientific entities (articles, authors, keywords, countries, and years of publication), patterns and developments in research trends related to MCI themes and cognitive intervention in the period 2001–2021.

Results

Performance analysis

Scientific production analysis

This study obtained a total of 702 publications that met the keyword search criteria in the Scopus database for the 2001–2021 period. The year 2002 yielded no documents (Fig. 2). While books were absent over the 20 years, articles in the literature or article reviews were the most commonly identified from year to year, with 263 articles (27.5%). Original articles likewise showed the same results, 263 articles (27.5%), however the results varied yearly. From 2001 to 2009, there were no documents in the form of book chapters, they began to be observed from 2010 until 2021 when a total of 162 articles were found (22%). Although conference papers are not usually present, a total of 14 papers (2%) were identified.

Contributions per country

Bibliographic coupling helps provide a consistent overview and show research differences across different countries over different timescales. By applying the condition of a minimum of 5 documents per country, 28 out of 78 countries met the criterion [15].

Contributions per country, with the top 15 out of 28 between 2001 and 2021, along with the number of citations and articles from each country (Table 1) showed that the United States had the greatest number of articles and citations (23%). Italy (9.6%) and Australia (9.1%) followed. Although there were 71 articles, Australia had more connections (total strength of links) with other countries on the same topic and was cited more than Italy, with 75 articles. This shows a relationship between the number of articles found in Scopus and the number of links between articles from different countries.

The bibliographic coupling of each country is shown in Fig. 3, which gives an overview of 28 countries divided into five clusters distinguished by colors based on the strength of the link.

Sources of scientific publications

There are five related journals that published the most articles on the research topic under study, namely the *Journal of Alzheimer's Disease* (41.7%), *Frontiers in Aging Neuroscience* (17.58%), *American Journal of Geriatric Psychiatry* (14.28%), *International Journal of Geriatric Psychiatric* (13.19%), and *Trials* (13.18%). Since 2010, the *Journal of Alzheimer's Disease* has published the most articles on relevant subjects. The number of articles varies, but they generally increase over time, reaching as many as six articles by 2020. Since 2007, the *International Journal of Geriatric Psychiatry* has been publishing one article on this subject annually, and from 2017, it has published two articles regularly. Since 2010, the *American Journal of Geriatric Psychiatry* has published one article annually, with a peak of three publications in 2021. Finally, the *Frontiers in Aging Neuroscience* journal started with one article in 2014 and the year with the most publications was 2019 with a total of four.

The most frequently cited articles

There were 220 articles that matched the minimum requirement of 10 citations [16]. Bibliometric visual analysis shows the most frequently cited articles and the year of publication, divided into 21 color groups.

Table 1 Top fifteen countries by the number of articles and citations.

Citation	Country	Article	Citation	Total link strength
1	United States	183	7108	98,680
2	Italy	75	1114	47,797
3	Australia	71	3407	62,861
4	Germany	61	1397	44,867
5	United Kingdom	57	2113	46,169
6	Spain	57	864	37,370
7	China	50	616	27,030
8	Canada	48	3010	42,410
9	Greece	37	803	24,044
10	South Korea	36	230	11,945
11	France	28	1389	20,914
12	Hong Kong	20	161	10,196
13	Japan	19	118	13,553
14	Brazil	18	262	10,394
15	Netherlands	16	586	9024

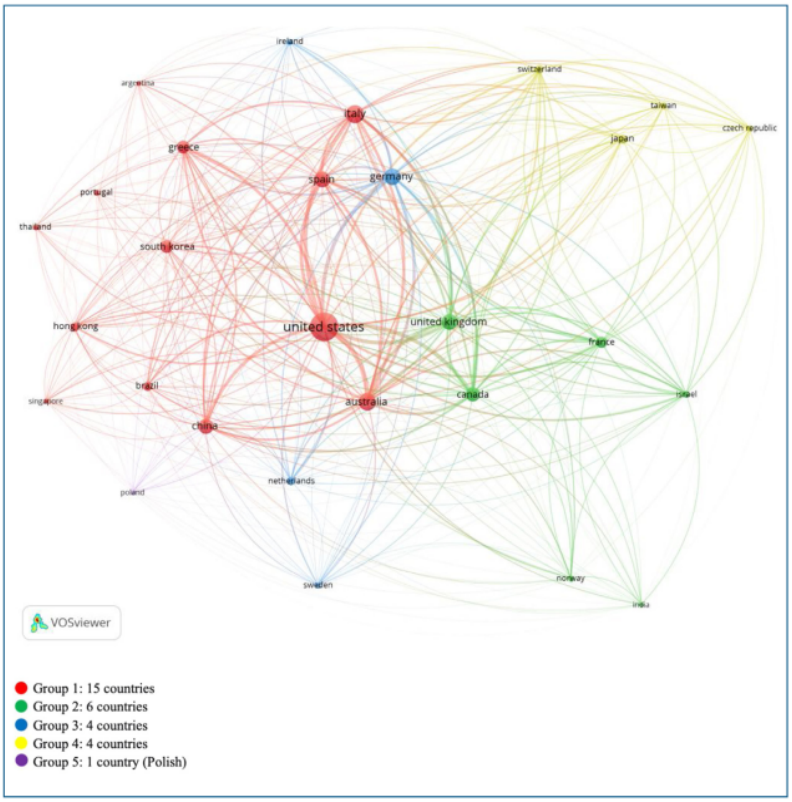

Figure 3. Bibliographic coupling between countries.

The three articles that were the most frequently cited were Livingston et al. in 2020 [17], Baumgart et al. in 2015 [18], and Petersen et al. in 2018 [19]. The work by Livingston et al. [17] reported that the welfare of the elderly and the objective of a decent quality of life are the most frequently referenced (Fig. 4) [17]. Both Livingston and Baumgart focus on modifying risk factors leading to dementia or cognitive decline [17,18]. These two studies were reviews, backed up by the 2018 review by Petersen et al. [19], which found that the best practical advice to address MCI is to

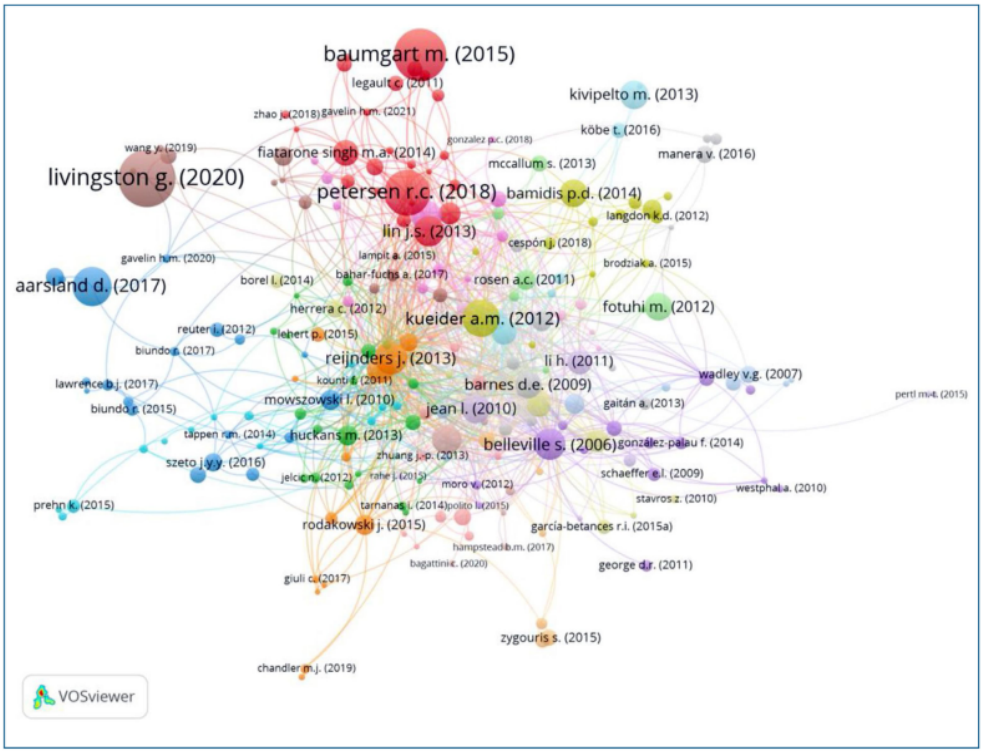

Figure 4. Visualization of the most frequently cited articles.

approach the issue from various angles. Petersen's research focused on risk factor modification, pharmaceutical and non-drug interventions, daily care, psychoeducation, and prevention.

Intellectual structure analysis

Co-occurrence by author keyword

Keyword analysis shows the most frequently occurring concepts from the research area investigated [20]. Out of 3919 keywords, 97 matching keywords were compared to a minimum of 29 keywords appearing five times in each article. MCI (575), human (531), elderly (360), cognition (336), cognitive defect (306), cognitive training (236), cognitive dysfunction (236), dementia (231), cognitive therapy (204), and Alzheimer's disease (163) are the top ten terms that appear the most frequently (Fig. 5).

The authors' keywords are distinguished by six color groupings, including: (1) MCI, human, (2) aging, Alzheimer's disease, (3) cognitive defect, cognitive dysfunction, (4) elderly, cognitive training, (5) attention, deep brain stimulation, (6) cognitive therapy, activities of daily living.

Co-citation source map

This co-citation source map analysis puts the emphasis on the direct observation of journals cited repeatedly by particular research disciplines [21]. Three separate color groups across the 300 samples that met the requirements were determined using a minimum of 20 citati sources.

The *Neurology* journal (green) had the most citations, with a total of 1245 citations (5.53%) and the highest total correlation (79,821) with other journals (Fig. 6). The second most cited journal is *PLoS One* (blue), with 471 citations (2.09%). The third is the *Neuroimagery* journal (blue), with 452 citations (2%).

Discussion

There has been an increase in research output on MCI and cognitive interventions from 2006 to 2018. Since 2019, there has been a sharp increase in production, reaching a peak of 113 documents (16%) in 2021 and 310 documents (44.1%) for the preceding three years. The need to address MCI has been prompt, as evidenced by the outstanding increase in research in the past three years [22].

Research continues to develop, especially in developed countries such as the United States and Australia. Countries in Asia such as China (6.4%), South Korea (6.3%), Hong Kong (2.5%), and Japan (1.27%) are also in the category of the top 15 countries for numbers of documents, citations, and the strength of links. At the same time, Singapore, Thailand, India, and Taiwan provide smaller numbers. This topic has been reported in English by various authors from diverse countries and continents, demonstrating the increasing

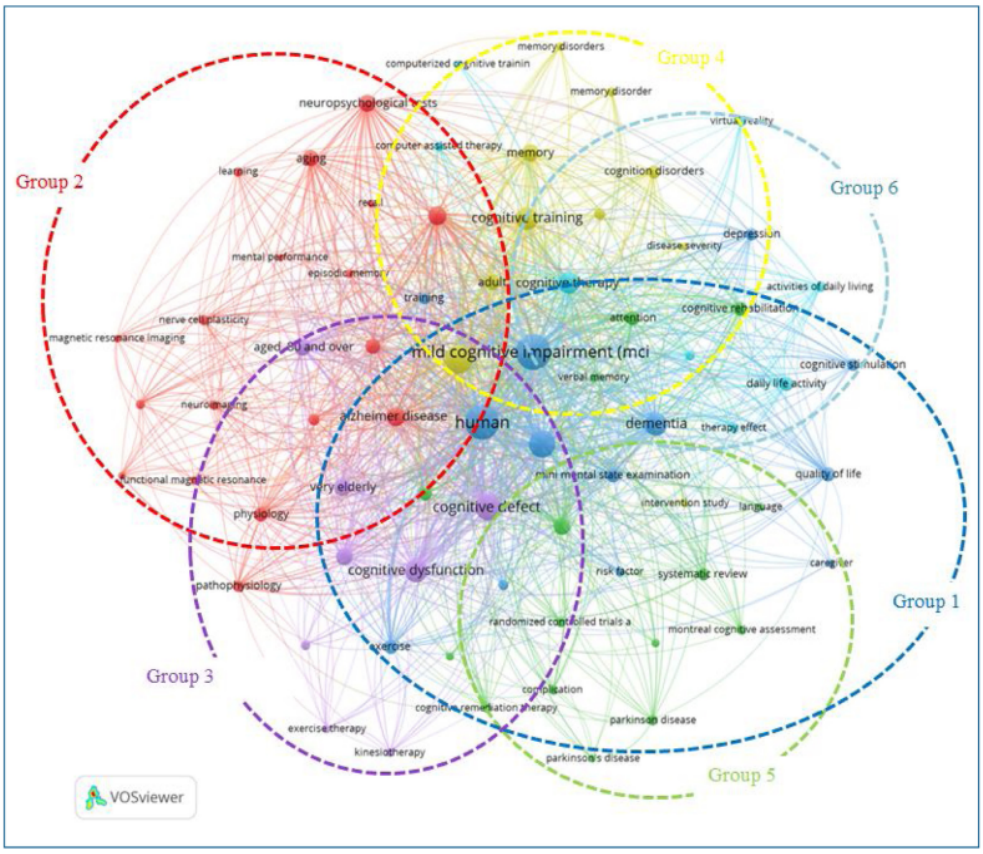

Figure 5. Visualization of co-occurrence network for author keywords.

popularity of this issue globally. The data was published in English perhaps because it is the most widely used and nearly universally understood language. The cause of the increase in research on MCI could be the increase in the elderly population, the high rate of progression from MCI to dementia, more discoveries about this issue and the need for an updated solution [23]. Even in the developed countries, there are still many people with a low level of education and occupations with a low level of complexity, which could be predictors of poorer cognitive function [24]. In addition, a strong economy in a developed country can encourage research production [25].

With 702 documents, the work by Livingston et al. [17] in 2020 and Baumgart et al. [18] in 2015 were the most often cited. Both were reviews about MCI and dementia prevention entailing changes in risk factor and therapy [17,18]. Livingston's study focused on modifying 12 risk factors to delay the onset of up to 40% of dementia cases, among which alcohol use, head trauma, air pollution, hypertension, obesity, diabetes, smoking, depression, hearing loss, lack of physical activity, social contact, and education [17]. Baumgart's study focuses on modifying risk factors that can result in cognitive decline, for instance by way of cognitive exercises [18]. The most frequently cited documents were reviews accounting for roughly one-third of the types of research identified. Our analysis showed that most studies were original articles (27.5%) and reviews (27.5%), followed by book chapters (22%) and conference papers (2%) reflecting publication trends over these 20 years. Reviews are the type of article routinely identified for each year; they are simpler to conduct but still useful to characterize the condition, even in an emergency like a pandemic [26].

Concerning the journal that published the most articles on this topic, the *Journal of Alzheimer's Disease* was the most prolific, with twice the number of articles (41.7%) compared to other jour[illegible]. The open-access policy that this journal implements has potentially contributed to the quick dissemination of information and the exponential increase in publications [27]. According to the findings on the increase in research on this topic, which has expanded in the previous ten years, widely cited articles are typically published after 2010. The keywords that appear the most in each article are also those commonly appearing after 2010, such as MCI, human, elderly, cognition, cognitive defect, cognitive training, cognitive therapy, cognitive dysfunction, dementia, and Alzheimer's disease.

In the co-citation source map, the journal with the most citations is the *Neurology* journal (5.53%), followed by *PLoS*

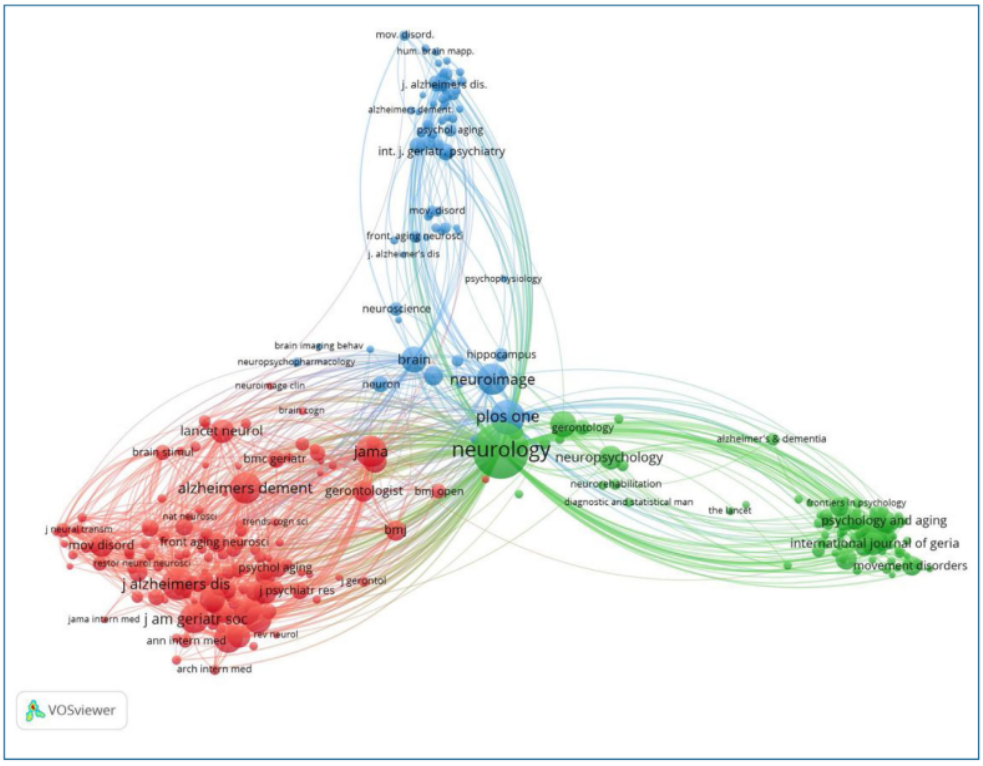

Figure 6. Co-citation source map visualization.

One (2.19%) and *Neuroimagery* (2%). This result is in line with articles published by numerous experts in the domains of neurology, psychiatry, radiography, gerontology, and other disciplines by different experts [28]. This highlights the value of interdisciplinary collaboration between medical speciality fields [29]. This is all the more so, given the expanding use of brain imagery technology recently for the prevention and treatment of MCI [30].

The limitations and shortcomings of this research are intertwined. The search strategy for this study is limited by Scopus fundamental data, so it is still possible that some links will over or under-estimate numbers or offer an overview from a different angle. The data is taken only from Scopus because this research is a preliminary study, and Scopus is the largest multidisciplinary database. Of course this limitation can be used to orient further research towards the use of a wider database, adding Web of Science and Pubmed. Furthermore, because they do not provide access to information from before the year 2000, the search years following 2001 do not provide a comprehensive picture of developments over the years. It is possible that there was not any research on this subject, or that the research patterns in the past were completely different. Another finding was that the publication productivity seemed to rely on developed countries with probably strong economies to produce research. To improve global research productivity, support and incentives should be implemented in countries with less strong economies and in developing countries. Of course, these findings can shed light on knowledge in a broader sense. Future studies should consider these limitations to derive results that are more relevant to the subject of MCI and cognitive interventions.

Conclusion

This bibliometric study explores MCI and cognitive intervention from 2001 to 2021. The Scopus search for the study provided as many as 709 items that met the selection criteria. After 2006, publications increased, particularly in 2019–2021, with a peak in 2021. Most of the scientific output on this subject consists in reviews and original articles. The United States (23%) has the highest scientific production level, and the *Journal of Alzheimer's Disease* is the primary source of these scientific papers. The keywords MCI, human, elderly, cognitive defect, cognition, human, dementia, cognitive training, cognitive dysfunction, cognitive therapy, and Alzheimer's disease are the most frequent. This 20-year trend worldwide can be seen by looking at the most-cited keywords and articles about risk factor modification, prevention and non-pharmacological interventions focusing on cognitive enhancement. To improve MCI problems in geriatric psychiatry in Indonesia and around the world, the results of this research can be used.

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Contribution

All authors contributed equally to this work.

A. T, W. R: Majorly participated in article conception anddesign..

D. S: Majorly participated in drafting the article, data acquisition, and final approval of the manuscript to be published.

N. H: Majorly participated in critical revision and final approval of the manuscript to be published.

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Disclosure of interest

The authors declare that they have no competing interest.

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