Exploring the Landscape of Alzheimer's Disease and Exercise Literature: A Bibliometric Analysis and Visual Mapping from 2014 to 2023

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Abstract: Background: Alzheimer's disease (AD) is the leading cause of dementia worldwide, imposing a significant economic burden on patients and society. While existing literature has confirmed the effectiveness of exercise as a non-pharmacological intervention for AD, there remains a lack of bibliometric studies focused on AD exercise research. To address this gap, this paper aims to provide an insightful analysis of the growth in AD exercise literature published from 2014 to 2023, using bibliometrics to offer historical insights for the scientific research community. Objective: This study's primary objective is to analyse the expansion of AD exercise literature through bibliometric methods, shedding light on historical trends and their significance in scientific research. Methods: A total of 1,552 documents were retrieved by conducting a title search on the Scopus database, utilizing Boolean operators "OR" and "AND" with keywords related to "exercise" and "Alzheimer's disease." Comprehensive bibliometric analysis was carried out using Microsoft Excel and VOSviewer, encompassing various factors such as countries, institutions, authors, and keyword terms. Results: A noteworthy Randomized Controlled Trial (RCT) conducted in 2015, investigating the impact of factors, including diet and exercise, on cognitive decline in the elderly, emerged as the most influential article in the field, with an impressive 1,955 citations, underscoring its substantial impact and recognition within the scientific community. The year 2020 marked a remarkable increase in the publication of AD exercise-related articles, with a total of 206 papers being published. Conclusion: In the future, it is essential to explore the effectiveness and feasibility of multi-mode interventions that promote an active lifestyle, including exercise, across diverse global populations and settings. This study, by providing a global overview, tracing thematic evolution, and spotlighting future research trends in the AD exercise domain, serves as a guiding reference for future research endeavours in this field.

1. INTRODUCTION

Alzheimer's Disease (AD) is a neurodegenerative condition that affects the central nervous system (WHO, 2023). It is estimated that 1 in 9 individuals over the age of 65 will be afflicted with AD by 2023 (Rajan et al., 2021). AD is also the seventh leading cause of death globally in 2021 (Keene et al., 2022).

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AD poses significant both economic and social burden. The total healthcare costs for treating AD were estimated 4,000 trillion Rupiah in 2020. These costs are exceptionally high due to the need for skilled medical personnel in caring for AD patients (Marasco, 2020). Additionally, AD imposes a social burden by reducing productivity and increasing dependency on families and healthcare providers (Skaria, 2022).

Exercise is one of the most effective ways to combat AD. It serves as both a non-pharmacological treatment (Yu et al., 2021) and a preventive strategy against AD (Alty et al., 2020; Iso-Markku et al., 2022; López-Ortiz, Pinto-Fraga, et al., 2021). Exercise interventions in Alzheimer's Disease (AD) have also been shown to enhance cognitive function (as measured by the Mini-Mental State Examination [MMSE] test), physical function (evaluated through the 6-Minute Walking Test [6MWT]), functional independence (assessed using the Barthel Index), and neuropsychiatric symptoms (monitored via the Neuropsychiatric Inventory [NPI]) (López-Ortiz, Valenzuela, et al., 2021).

Meanwhile, there is limited research of bibliometric focusing on the intersection of Alzheimer's Disease and exercise. Bibliometric studies, which analyse research trends and patterns in scientific literature (Mejia et al., 2021), are crucial for understanding the development and focus of scientific inquiry in this area. This bibliometric analysis will be a tool for decision making in conducting new research. The limited number of such studies on AD and exercise suggests a gap in the comprehensive analysis of how exercise impacts Alzheimer's Disease, both in terms of therapeutic benefits and preventive potential. Thus, this research aimed to analyse the expansion of AD exercise literature through bibliometric methods.

2. METHODS

This research was conducted on November 2nd by searching using Boolean operators “AND” and “OR” to further analyse specific document regarding Alzheimer’s Disease and Exercise. The documents were obtained from Scopus database as it is the most well-known peer-reviewed scientific journal database currently available. To improve the accuracy of search, the documents were limited to English language only, finally published journal article, and only for articles published in the last 10 years (from 2014 to 2023). The search query also limited to title, abstract, and keywords related to “exercise” and “Alzheimer’s disease”. Thus, the complete search query used in this research shown below:

(TITLE-ABS-KEY (("exercise" OR "workout" OR "aerobic" OR "anaerobic" OR "weightlifting") AND ("Alzheimer" OR "Alzheimer’s disease")) AND PUBYEAR > 2014 AND PUBYEAR < 2023) AND (LIMIT-TO (SRCTYPE , "j")) AND (LIMIT-TO (PUBSTAGE , "final")) AND (LIMIT-TO (DOCTYPE , "ar")) AND (LIMIT-TO (LANGUAGE , "English"))

To further analyse the trends in research development, key elements such as the most productive authors, the country with the highest number of publications, and the most frequently cited journals were identified from the Scopus database. This is achieved through the 'analysed results' feature, followed by downloading the relevant data. The research patterns are then visualized and analysed using the data in CSV format through VOSviewer 1.6.20 and Microsoft Excel. VOSviewer is utilized to generate a map of keywords that illustrates the interconnected networks while Microsoft Excel used to create graphs and charts.

3. RESULTS AND DISCUSSIONS

From the search query discussed in the Methods section, 1,552 documents were obtained from Scopus.

3.1. Annual and Country Distribution of AD Research related to Exercise

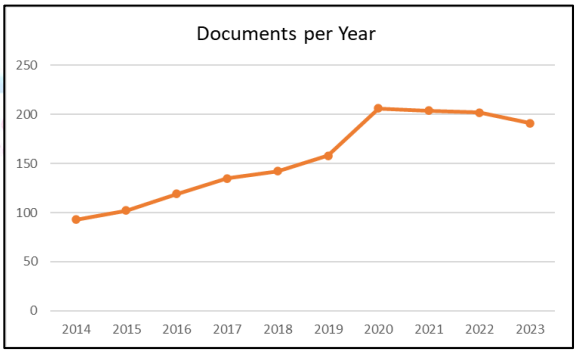

Figure 1: Number of documents per year from 2014 to 2023. The total number is 1,552 with the distribution: 2014 (93), 2015 (109), 2016 (112), 2017 (135), 2018 (142), 2019 (158), 2020 (206), 2021 (204), 2022 (202), 2023 (191).

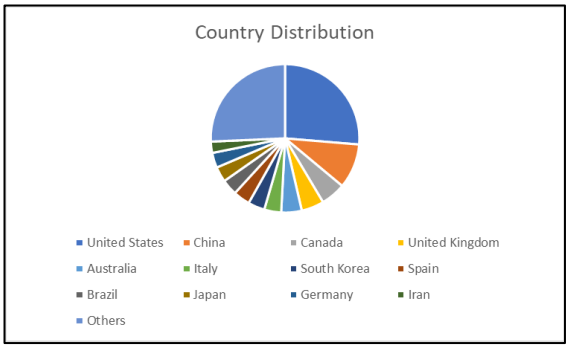

Figure 2: Country Distribution of AD and Exercise Articles.

This study examines documents published from 2014 to 2023, with the distribution of articles by year presented in Figure 1. The year 2020 stands out as the most influential, with 206 articles produced, marking a sharp increase from the previous year, 2019, which only had 158 articles. This surge is likely due to the COVID-19 pandemic, which brought significant attention to the health sector and subsequently boosted the productivity of researchers(Rousseau et al., 2023). Additionally, the trend in the number of published articles shows a general increase from 2014, but it becomes relatively stagnant from 2020 to 2023. This indicates that research in this field still has room for growth and development.

The United States leads significantly with 579 articles, suggesting a robust and highly active research environment. This could be attributed to the country's substantial investment in research and development, the presence of numerous world-leading universities and research institutions, and a large population of researchers. Significant Contribution of China: China, with 214 articles, is the second-highest contributor, which aligns with its rapidly growing research and development sector. This reflects China's increasing focus on scientific research and its emergence as a major player in the global research community. Other countries contribution was presented in Figure 2.

3.2. The Most Productive Authors in AD and Exercise Research Field

Figure 3 presents the top 10 most productive authors in AD and Exercise research. Vidoni E.D. stands as the leading author in this domain, having authored 25 publications over the past decade. Following closely is Burns J.M., who has contributed 22 articles, with Vellas B. next in line with 21 publications. Ononkwo O.C. has produced 20 articles, while Kivipelto M. has 19. Yu F. follows with 18 publications, and both Rolland Y and Hasselbalch S.G. have each written 16 articles. Completing the list are Soininen H. with 15 publications and Cook D.B. with 14.

b. Influential Articles

Table 1 provided the 10 most cited scientific articles, each with varying degrees of impact as evidenced by their citation counts. Citations are a key metric in academic research, reflecting the influence and relevance of a study within its field. The highest cited paper in this dataset, by Ngandu T. et al., has been cited 1955 times, indicating its significant contribution to the field of cognitive decline prevention in the elderly. This is closely followed by Rinninella E. et al.'s research cited 1509 times, Other notable works include a 2021 report on Alzheimer's disease with 1396 citations and Ross R. et al.'s 2016 paper on cardiorespiratory fitness, cited 1324 times.

Ngandu T., et al. conducted an extensive randomized controlled trial, investigating the impact of a multi-domain intervention encompassing diet, exercise, cognitive training, and vascular monitoring on the prevention of cognitive decline, including AD (Ngandu et al., 2015). Their study demonstrated the successful prevention of cognitive decline in individuals at risk, suggesting that an exercise intervention has the potential to safeguard against the development of AD.

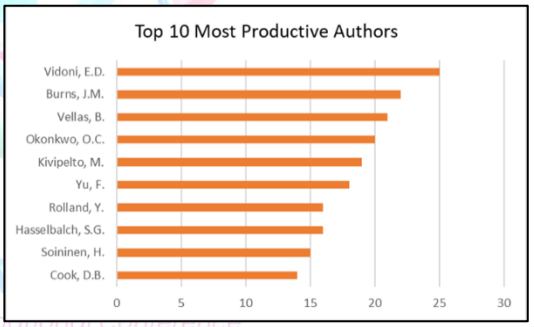

Figure 3: Top 10 most productive authors.

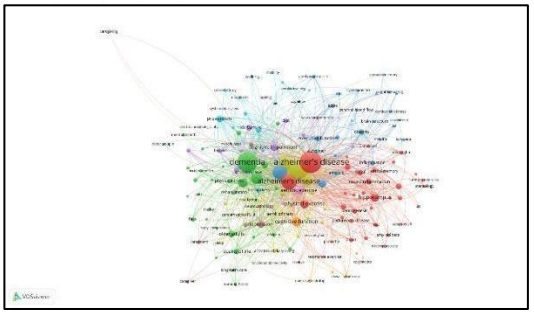
Figure 4: Visual mapping using VOSviewer of Alzheimer's Disease and Exercise research.

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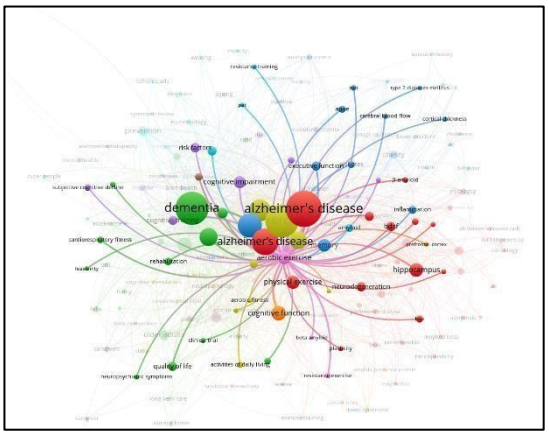

Figure 5: Aerobic exercise occurrences with other keywords.

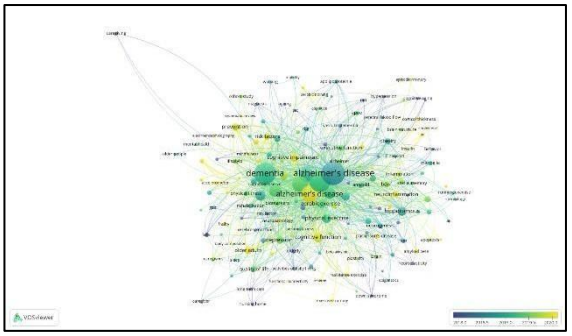

Figure 6: Overlay visualisation using VOSviewer.

Authors	Title	Year	Cited by	Citation
Ngandu T., et al.	A 2year multidomain intervention of diet, exercise, cognitive training, and vascular risk monitoring versus control to prevent cognitive decline in at-risk elderly people (FINGER): A randomised controlled trial	2015	1955	(Ngandu et al., 2015)
Rinninella E., et al.	What is the healthy gut microbiota composition? A changing ecosystem across age, environment, diet, and diseases	2019	1509	(Rinninella et al., 2019)
Alzheimer's Association	2021 Alzheimer's disease facts and figures	2021	1396	(Alzheimer's Association, 2021)
Ross R., et al.	Importance of Assessing Cardiorespiratory Fitness in Clinical Practice: A Case for Fitness as a Clinical Vital Sign: A Scientific Statement from the American Heart Association	2016	1324	(Ross et al., 2016)
Baumgart M., et al.	Summary of the evidence on modifiable risk factors for cognitive decline and dementia: A population-based perspective	2015	1040	(Baumgart et al., 2015)
Baber R.J., et al.	2016 IMS Recommendations on women's midlife health and menopause hormone therapy	2016	635	(Baber et al., 2016)
Arvanitakis Z., et al.	Diagnosis and Management of Dementia: Review	2019	538	(Arvanitakis et al., 2019)

Andrieu S., et al.	Effect of long-term omega 3 polyunsaturated fatty acid supplementation with or without multidomain intervention on cognitive function in elderly adults with memory complaints (MAPT): a randomised, placebo-controlled trial	2017	513	(Andrieu et al., 2017)
Beydoun M.A., et al.	Epidemiologic studies of modifiable factors associated with cognition and dementia: Systematic review and meta-analysis	2014	467	(Beydoun et al., 2014)
Choi S.H., et al.	Combined adult neurogenesis and BDNF mimic exercise effects on cognition in an Alzheimer's mouse model	2018	462	(Choi et al., 2018)

Table 1: 10 most cited articles.

3.4. Visual Mapping of AD and Exercise Literature

The analysis of Scopus data was carried out using VOSviewer 1.6.20. This tool creates a map filled with circular nodes and connecting lines. Each node symbolizes an author's keyword from the article, with larger nodes signifying more frequent usage of that keyword (Donthu et al., 2021). For this study, a threshold of a minimum of 5 occurrences was set for the keywords, meaning each keyword had to appear in conjunction with at least 5 other keywords. Based on this requirement, 211 keywords qualified for inclusion.

According to the data presented in figure 4, "Alzheimer's Disease" stands out as the most commonly used term, appearing 328 times. This keyword is consistently highlighted on the map, underscoring its strong correlation. Following "Alzheimer's Disease," researchers observed "Dementia" with 321 occurrences and "Exercise" with 320 occurrences.

Regarding physical activity, "Aerobic exercise" is distributed across the map, appearing 48 times. Figure 5 illustrates the connections between "aerobic exercise" and other keywords. Aerobic exercises are known for its benefit on reducing the cognition declining in AD (Yu et al., 2021).

On the other hand, resistance training, as depicted in figure 6, represents a relatively recent area of study. In contrast to the previous map, this map uses colour intensity to signify the recency of research, with brighter colours indicating newer findings (Shvindina, 2019). A review conducted on March, 2023 showed that resistance training has a great potential to reduce the effects of AD and also prevent it (he effects of resistance). With only 29 occurrences (on figure 4) and relatively newly published (on figure 6), this field of research is the hotspot for new coming research.

4. CONCLUSIONS

From 2014 to 2023, 1,552 articles regarding Alzheimer's Disease (AD) and Exercise were obtained from Scopus database. The year 2020 is the most significant number of articles with 206 articles published. The US stands as the most productive country in this field. Research by Ngandu T., et al. is noted as the most influential article with 1,955 times cited. In visual mapping, researchers found out that "Alzheimer's Disease" is the most related keyword. Aerobic exercise and resistance training stands out as two keywords relating to types of exercise that correlated to AD. This bibliometric study could pave the way for new researches in this field.

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