

Global Applications and Developments in Robotics and Artificial Intelligence for Alzheimer's Disease (2003-2023)

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Abstract. This study employs the VOSviewer metrology tool to explore and visually examine the literature on the utilization of artificial intelligence in Alzheimer's disease research in the Web of Science database from 2003 to 2023. It outlines the most productive nations, institutions, research trends, and focal points in this discipline, providing a theoretical framework for future study. A total of 1252 relevant publication were identified. Griffith University published the most research with 30 publications. While The United States is the leading research country in this sector with 268 articles. AI in Alzheimer's research steadily grew from 2003 to 2023, with a remarkable 32.57% average annual increase between 2019 and 2022. The main areas of focus in this research are the challenges and potential of socially assisted robots in Alzheimer's disease, early prediction of the disease, and intelligent neurorehabilitation technology. To guarantee the enduring and consistent outcomes in AI for dementia sufferers, substantial research and careful consideration are needed.

Keywords: Artificial Intelligence, Alzheimer's Disease, Research Hotspots

1 Introduction

Alzheimer's disease (AD) is a central nervous system degenerative illness marked by growing behavioral problems and mental abnormalities along with memory impairment and malfunction. In the late 1800s, German physician Alois Alzheimer made the first observations of the disorder^[1]. More than 50 million individuals worldwide are already living with dementia, and this figure is anticipated to rise to 78 million by 2030 as the population ages^[2]. The social healthcare system is under a great deal of strain due to the rising prevalence of Alzheimer's disease. AI and robots are being applied in more applications due to the fourth industrial revolution's information and technology advances. Due to AI and information technology, healthcare is a high-value industry^[3]. AI plays a crucial role in dementia research because of advances in computer power, the advent of novel algorithms, and the availability of large-scale data collected through medical and health records and wearable devices^[4]. This study uses the bibliometric visualization application VOSviewer to assess the current state and hotspots of

applied research on AI and robotics in Alzheimer's disease worldwide to inform future research orientations and researchers.

2 Method

2.1 Data Source and Search Strategy

The data for this study were sourced from Clarivate Analytics' Web of Science (Core Collection), a prominent platform in bibliometric analyses. Utilizing a blend of MeSH subject terms and free-word searches, we meticulously filtered the data, omitting irrelevant literature. After the first search, all the literature was screened and checked separately by 2 researchers to ensure that all the papers used were relevant to the study topic. A total of 1252 articles were included, as illustrated in Table 1.

Table1 . Retrieval process

Set	Results	Refinement
#3	1252	Refined by LANGUAGE: (English) and 2003-2023 (Publication Years)
#2	1283	Refined by DOCUMENTTYPES: (article OR proceeding paper)
#1	1669	TS= (("robot*" OR "android*" OR "cyborg\$" OR "Telerobotic" OR "machine intelligence" OR "artificial intelligence" OR "computational intelligence" OR "computer reasoning") AND TS= ("Alzheimer's Disease" OR "dementia" OR "cognitive impairment" OR "neurodegenerative disorder"))

2.2 Analysis Tools and methodology

The research expertise in AI for elderly care was examined and represented through VOSviewer 1.6.17, a software developed by scholars including ECK from the University of Leiden in the Netherlands. This widely used tool constructs maps from network data, analyzing and displaying relationships among research institutions, countries, and keywords. Utilizing VOSviewer, the clustering of pertinent academic entities was meticulously analyzed. To visualize the data based on specific criteria, users can click on 'Map' to generate the visual representation.

3 Result

3.1 Analysis of Publication Outputs

As of September 25, 2023, WOS listed 1,252 AD-related AI and robotics research articles. Figure 1(A) shows a general increasing trend in publications over the last two decades (2003-2022), with 2 articles published each year in 2003 and 258 in 2022. And until 2019, the number of articles produced each year does not surpass 100. Citations reached 100 for the first time in 2012 and reaches 3,463 in 2022. R2, a statistical metric, measures trendline fit. In this case, R2 = 0.946 shows an excellent match.

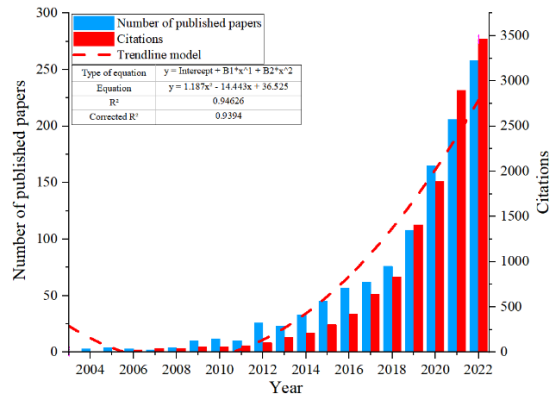


Fig.1. (A) Articles published and cited from 2003 to 2022.

3.2 Analysis of Main countries and organizations

The data about the quantity of national publications in WOS were tabulated. The United States is the leading research country in this sector with 268 articles. This accounts for 21.41% of the worldwide publications and 24.15% of the global citations. As seen in Table 2, Japan, the UK, and Italy had 11.74%, 10.06%, and 9.42% of the global total for publications, respectively. Table 2 also compiles the top ten colleges with the most articles on this topic. Griffith University lead the list with 30 papers and 1,435 citations. Tokyo University and Osaka University have 23 and 17 publications respectively.

Table 2. Top 10 countries and organizations in terms of the number of publications

Institution	Publication (1252, %)	Citation	Country	Publication (1252, %)	Citation
Griffith univ	30 (2.4%)	1435	The USA	268(21.4%)	3662
Tokyo univ	23 (1.8%)	82	Japan	147(11.7%)	1494
Osaka univ	17 (1.4%)	121	The UK	126(10.1%)	2039
Toronto univ	17 (1.4%)	377	Italy	118(9.4%)	1478
Chinese acad sci	17 (1.4%)	181	China	107(8.5%)	872
Bond univ	17 (1.4%)	158	Spain	85(6.8%)	827
Eindhoven univ technol	11 (0.9%)	103	Australia	81(6.5%)	2129
Harvard med sch	11 (0.9%)	197	Germany	76(6.1%)	1282
Maastricht univ	11 (0.9%)	158	Canada	69(5.5%)	943
Auckland univ	11 (0.9%)	305	Netherland	65(5.2%)	779

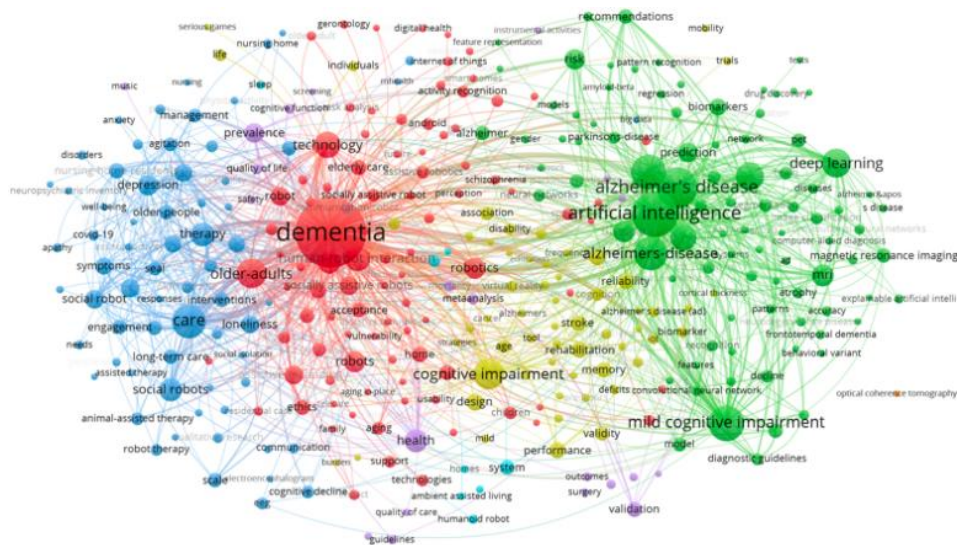


Fig.2. Literature keyword co-occurrence map

3.3 Investigation into prominent areas of international research

Figure 2 shows that AD research on artificial intelligence and robotics may be classified into 4 groups based on the correlation strength between co-occurring words. For a more detailed and specific examination of the relevant data, please consult table 3, the Cluster 1 include dementia, older persons, and others. This cluster's main study focuses on dementia patients' opinions and ethical concerns about AI. Cluster 2 consists of terms such as therapy, social robotics, and others. This cluster primarily investigates the use of social robots in AD, particularly those who are depressed. Cluster 3 consists of keywords such as AI, Alzheimer's disease, etc. The research in this cluster focuses on utilizing AI to create more precise prediction tools for AD. The co-occurring terms in Cluster 4 include cognitive impairment, rehabilitation, etc. The primary objective of the study is to investigate the function of AI in assisting the rehabilitation and treatment of patients with cognitive impairment.

Table 3. Co-occurring word clustering and strength of association

Clusters	Cluster terms and frequency
Cluster 1 (Red)	dementia (506), older persons (89), technology (73), human-robot interaction (65), assistive technology (37), attitude (27), ethics (24), acceptance (22)
Cluster 2 (Blue)	care (120), therapy (58), social robotics (54), depression (44), loneliness (36), Paro (34), companion robotics (30), quality of life (30), nursing home residents (25), management (22)
Cluster 3 (Green)	Artificial intelligence (221), Alzheimer's disease (175), mild cognitive impairment (130), deep learning (83), classification (81), diagnosis (73), MRI (52), risk (43), prediction (41), biomarkers (30)
Cluster 4 (Yellow)	cognitive impairment (100), rehabilitation (32), symptoms (31), performance (28), memory (25), stroke (24)

4 Discussion

4.1 The growing importance of AI in Alzheimer's research

In the last two decades, there has been a significant rise in research articles specifically dedicated to exploring the application of AI in the context of Alzheimer's disease. The increase experienced from 2019 to 2022 has been very significant, with an average annual growth rate of 32.57%. Developed nations have been the main driving force for research in the field of national geography. This can be ascribed to the adoption of AI healthcare policies in several developed countries. For instance, Japan launched "Society 5.0" in 2016 to establish a highly intelligent society that prioritizes human needs and uses advanced technologies like AI, robots, and the Internet of Things^[5].

4.2 Hot Topics of AI Applications in Alzheimer's Disease

Dementia psychosocial health results for socially assisted robots (SARs) are promising. Paro and Nao reduced loneliness and improved emotional and social ties in Alzheimer's patients^[6]. Moley et al found that telepresence robots help dementia patients bond with their families^[7]. Nevertheless, this domain has raised urgent issues as it evolves. Technology adoption has been seen as a significant obstacle, especially for dementia patients^[8]. Additionally, patient-social robot interaction is important to thoroughly investigate^[9]. In implementation, the financial load is crucial. The NAO robot costs roughly US\$10,000, and the Paro robot around US\$6,000^[10].

A thorough investigation found a 61.7% comorbidity rate for unknown dementia patients worldwide, suggesting underdiagnosis^[11]. Late detection makes dementia worrisome. AI has promising promise for dementia diagnosis systems that are easy to use. AI can analyze medical data and biomarkers using Machine Learning (ML), which helps identify dementia risk factors for early screening and assessment, as well as effectively identify between Mild Cognitive Impairment (MCI) and AD.

AI has enhanced the efficacy of neurorehabilitation therapies and made therapy more easy and pleasant. Immersive virtual reality (iVR) technology has been shown to improve long-term physical and vestibular rehabilitation^[12]. Telemedicine enhances neurorehabilitation by providing real-time monitoring and feedback, increasing patients' involvement in high-quality rehabilitation activities.

5 Conclusions

The influence of artificial intelligence in dementia research is expected to persist in the upcoming years. This study found that social robots for Alzheimer's care, machine learning algorithms for early diagnosis, and AI-integrated neurorehabilitation are the primary research fields. To guarantee enduring and consistent outcomes in AI for dementia sufferers, substantial research and careful consideration are needed.

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