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# THE ROLE OF AI (ARTIFICIAL INTELLIGENCE) FOR ALZHEIMER: A SYSTEMATIC REVIEW

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***Abstract***— *Alzheimer's disease (AD) is the most common type of dementia and represents a significant global health problem due to its profound impact on patients' quality of life and the heavy burden it places on health care. Alzheimer's is characterized by a progressive decline in cognitive function and memory, ultimately disrupting daily activities and leading to dependence on long-term care. This systematic literature review aims to explore the role of AI in diagnosing and managing Alzheimer's disease. The method used in this study refers to the PICO framework to highlight various studies on the role of AI for Alzheimer's disease. Recent breakthroughs in the field of artificial intelligence (AI), particularly machine learning (ML) and deep learning, offer promising innovative approaches to improve diagnosis, monitoring, and understanding of Alzheimer's disease.*

***Keywords***: *alzheimer's disease, artificial intelligence, deep learning, machine learning.*

***Intisari***—*Penyakit Alzheimer (AD) merupakan jenis demensia yang paling sering terjadi dan merupakan masalah kesehatan global yang signifikan karena dampaknya yang mendalam terhadap kualitas hidup pasien serta beban berat yang ditimbulkannya bagi perawatan kesehatan. Alzheimer ditandai oleh penurunan progresif dalam fungsi kognitif dan memori, yang pada akhirnya mengganggu aktivitas sehari-hari dan menyebabkan ketergantungan pada perawatan jangka panjang. Tinjauan literatur sistematis ini bertujuan untuk mengeksplorasi peran AI dalam mendiagnosis dan mengelola penyakit Alzheimer. Metode yang digunakan dalam kajian ini mengacu pada kerangka PICO untuk mengevaluasi berbagai studi tentang peran AI bagi penyakit Alzheimer. Hasil penelitian menunjukkan bahwa terobosan terbaru dalam bidang kecerdasan buatan (AI), khususnya machine learning (ML) dan deep learning, menawarkan pendekatan inovatif yang menjanjikan untuk meningkatkan diagnosis, pemantauan, dan pemahaman tentang penyakit Alzheimer.*

***Kata Kunci***: *penyakit alzheimer, kecerdasan buatan, pembelajaran mendalam, pembelajaran mesin.*

## INTRODUCTION

Alzheimer's is the most common type of dementia and is marked by the buildup of amyloid in the brain and neurovasculature, leading to cognitive decline and neuroinflammation [1]. It affects thinking, memory, and behavior, which can make daily tasks difficult [2].

Currently, more than 55 million people worldwide are living with dementia, with over 60% of them residing in low- and middle-income countries. Each year, nearly 10 million new cases are diagnosed [3]. In Indonesia, the prevalence of Alzheimer's dementia becomes a significant public health issue. Based on extensive data collected from the islands of Java and Bali, approximately 27.9% of the elderly population in Indonesia experience dementia. The percentage reveals that nearly one-third of the elderly in Indonesia suffer from dementia, with Alzheimer's being the most common form. More than 4.2 million individuals in Indonesia suffer from dementia, posing a significant burden on



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individuals, families, and the public health system [2].
More systematic solutions, such as preventive measures, early education, destigmatization of the disease, and increased social support for individuals and families with cognitive disorders, are required as this disease progresses.

In an era characterized by rapid technological advancement, the use of artificial intelligence and related technologies is becoming increasingly widespread in the business world and society [4]. AI has significant potential to improve healthcare services, particularly in disease prevention, early diagnosis, and treatment [5]. Alzheimer's disease is considered a highly significant disorder because of its ongoing consequences for society [4].

Diagnosing Alzheimer's is often a challenge for medical professionals and patients alike. The disease is one of the most common forms of dementia, but the process of making a proper and accurate diagnosis is often complicated and confusing. Early diagnosis of Alzheimer's, often done only when clinical symptoms are very clear, has great potential for AI technology. By using neuroimaging analysis, AI could process brain images from imaging techniques such as MRI or PET scans to detect structural changes related to Alzheimer's [6]. In the context of early detection, AI-based neuroimaging techniques, such as MRI, PET, and CT scans, enable more accurate identification of Alzheimer's biomarkers. Machine learning models analyze these images to detect patterns indicating early cognitive decline. Additionally, AI algorithms are applied in the identification of genetic and proteomic biomarkers, allowing for earlier intervention. Cognitive and behavioral assessments have also advanced with the integration of AI, introducing tools that enhance the accuracy of neuropsychological tests and analyze speech and language patterns to detect early signs of dementia [7]. Moreover, AI employs machine learning algorithms to scrutinize cognitive test results, identifying declines in cognitive function that conventional clinical evaluations might have overlooked. Furthermore, AI can play an important role in predicting disease progression by building predictive models that analyze longitudinal patient data. These models enable AI to estimate the likelihood of conversion from mild cognitive impairment (MCI) to Alzheimer's dementia, providing estimates of the rate of disease progression and the risks faced by patients. With this information, doctors can design more personalized and effective treatment strategies based on those predictions [8].

This article aims to review the application of AI in enhancing the diagnosis and management of Alzheimer's disease.

## MATERIALS AND METHODS

This literature review research uses a narrative review design. The journal search was concentrated on studies that delved into and scrutinized the application of artificial intelligence (AI) technology in the prevention and management of Alzheimer's disease, encompassing the methods utilized, the outcomes attained, and the obstacles and prospects for further research and applications. The researchers included clinical trials, randomized controlled trials (RCT), experimental one-group study designs, case-control studies, and cross-sectional studies. Table 1 shows the inclusion and exclusion criteria, covering various aspects such as population characteristics, research design, and intervention focus.

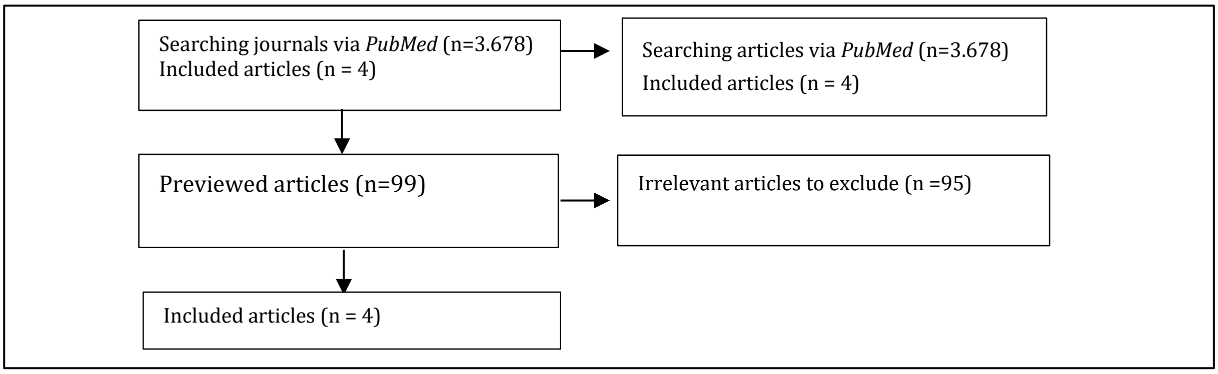
Table 1. The Inclusion and Exclusion Criteria

| PICOS | Inclusion Criteria | Exclusion Criteria |
|---|---|---|
| Patients | 1. Publications related to the theme, including AI techniques for Alzheimers diagnosis, prediction, therapy, and management.<br>2. Articles discussing AI methods applied in research or clinical practice for Alzheimers. | 1. Indirectly studies related to AI or Alzheimers.<br>2. Non peer-reviewed articles or are merely opinions and comments |
| Intervention | The study assesses the effectiveness of AI in forecasting the advancement of Alzheimer's disease from mild cognitive impairment (MCI) to Alzheimer's dementia, and in determining the pace and direction of the disease's progression. | The study excludes any data or information that could aid in analyzing the application of AI in Alzheimer's diagnosis or management. |
| Comparison | Comparing new therapies for Alzheimer's, specifically screening the latest drug candidates for Alzheimer's management | - |
| Outcome | 1. Improving diagnostic accuracy by utilizing neuroimaging analysis and cognitive tests. AI is expected to detect early signs of Alzheimer's with high sensitivity and specificity, enabling earlier detection of the disease than usual. | |

| PICOS | Inclusion Criteria | Exclusion Criteria |
|---|---|---|
| | 2. The excellence of AI model to predict the transition from mild cognitive impairment to Alzheimer's and the rate of disease progression measures the effectiveness of using AI to predict the progression of Alzheimer's. | |
| Study Design | Cross sectional study, case control | |

Source: (Research Results, 2024)

This research is structured through three main stages: planning (identifying research questions and their boundaries), conducting (searching for and identifying relevant references, followed by data extraction and synthesis), and reporting (translating research findings into article form) [9]. The research process began with identifying articles using the keywords "*The role of AI in Alzheimer's disease*", "*Personalized Treatment Plans*", and "*Prevention Programs for Alzheimer's disease*", the researchers conducted an initial search and found a total of 3,678 journals. The researchers excluded 3,579 journals because they lacked free full text, had inappropriate study designs, or had research older than 5 years. Thus, 99 journals underwent a full text review. The researchers excluded 95 of these 99 journals because they failed to meet the inclusion and exclusion criteria. This systematic review study only focused on a total of 4 journals. The following Figure 1 provides a more detailed view of the journal search results:




Source:(Research Results, 2024)

Figure 1. PRISMA

## RESULTS AND DISCUSSION

In recent years, artificial intelligence (AI) emerges as a highly promising tool for addressing major challenges in the diagnosis and management of Alzheimer's. AI, especially through techniques like machine learning (ML) and deep learning (DL), offers a more efficient and advanced approach to early detection of Alzheimer's and monitoring the disease's progression. Neuroimaging analysis is a primary application of AI in the context of Alzheimer's. Advanced imaging technologies like magnetic resonance imaging (MRI) and positron emission tomography (PET) produce highly detailed brain scans Convolutional neural networks (CNNs) can analyze these images to detect patterns associated with amyloid plaques and tau fibers, which are key indicators of Alzheimer's disease. CNNs are particularly advantageous in capturing subtle features in images that might not be visible to the human eye, thereby improving the ability to detect structural changes in the brain associated with Alzheimer's disease.

Table 2. Literature Review

| Authors and Publication Years | Titles | Methods | Results |
|---|---|---|---|
| C. Ellis Wisely et al, 2021 [10] | Convolutional neural network to identify symptomatic | -Captured multimodal retinal images, including GC-IPL thickness maps, SCP OCTA images, UWF color images, and UWF FAF | This study involved 284 eyes from 159 subjects. 123 cognitively healthy subjects provided 222 |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| Authors and Publication Years | Titles | Methods | Results |
|---|---|---|---|
| | Alzheimer's disease using multimodal retinal imaging | images, from individuals with Alzheimer's disease and healthy controls<br>- Developed a convolutional neural network (CNN) model to predict Alzheimer's disease diagnosis using the multimodal retinal images, quantitative data from OCT and OCTA, and patient data<br>- Used a sample of 284 eyes from 159 subjects (222 eyes from 123 healthy controls and 62 eyes from 36 individuals with Alzheimer's disease) to develop the CNN model | eyes, while 36 subjects with Alzheimer's disease provided 62 eyes (AD). This study utilizes data from OCT (Optical Coherence Tomography) and OCTA (Optical Coherence Tomography Angiography) to distinguish Alzheimer's patients from healthy control patients, and to create an AI model capable of diagnosing and tracking Alzheimer's disease. Alzheimer's patients and healthy controls have big differences in OCT parameters like GC-IPL thickness and subfoveal choroidal thickness. The same is true for OCTA parameters such as vascular density and vascular volume. The MMSE score also shows cognitive decline in Alzheimer's patients compared to the control group. This research shows that AI has enormous potential in diagnosing and monitoring Alzheimer's by analyzing retinal imaging data. |
| Sun Jingling et al, 2022 [11] | A novel deep learning approach for diagnosing Alzheimer's disease based on eye-tracking data | - Participants: 108 patients with Alzheimer's disease (AD) and 102 healthy controls were recruited.<br>- Eye-tracking system: A self-designed 3D eye-tracking system with high accuracy (0.66°) was used.<br>- Visual paired comparison (VPC) task: A 3D VPC task with stereo stimuli was designed, where participants viewed a series of 12 images and then viewed a similar set with objects added or removed.<br>- Data preprocessing: Fixation maps were constructed from the eye-tracking data and smoothed/normalized into fixation heatmaps. | the eye movement features observed in the 3D VPC task can serve as biomarkers for diagnosing Alzheimer's disease, the proposed deep learning-based NeAE-Eye model can significantly improve diagnostic performance, and future work will focus on further improving the model and constructing a more comprehensive eye-tracking dataset. |
| Saraceno Giorgia Et al, 2024[12] | Machine Learning Approach to Identify Case-Control Studies on ApoE Gene Mutations Linked to Alzheimer's Disease in Italy | This article discusses the use of machine learning in the study of ApoE gene mutations related to Alzheimer's in Italy. Machine learning, as part of artificial intelligence, processes large and complex data to find useful patterns. This research uses the MySLR platform, which integrates the Latent Dirichlet Allocation (LDA) algorithm to analyze scientific literature on ApoE gene mutations in Alzheimer's patients in Italy.<br>Researchers analyzed 164 scientific publications, removed duplicates, and grouped the papers into two main topics. The findings show that 65.22% of the articles focus on Italian Alzheimer's patients and 5.4% discuss the ApoE gene mutation, an important genetic factor in Alzheimer's risk.<br>Despite the geographical and topical limitations of the papers examined, the MySLR platform assisted in locating case-control studies on ApoE gene mutations and SNP polymorphisms associated with Alzheimer's in Italy. | The MySLR machine learning platform successfully identified studies relevant to the query on ApoE gene mutations in Alzheimer's disease within the Italian population, with a low level of bias. |

| Authors and Publication Years | Titles | Methods | Results |
|---|---|---|---|
| Leonardsen Asten et al, 2024[13] | Constructing personalized characterizations of structural brain aberrations in patients with dementia using explainable artificial intelligence | This research demonstrates the effectiveness of machine learning-based methods, particularly convolutional neural networks (CNNs), in distinguishing between different types of dementia and comparing them to control groups. In this study, the authors use CNNs to analyze scanner-generated images to identify structural differences between patients with various types of dementia (such as Alzheimer's, vascular dementia, and other dementias) and healthy control groups. The success of CNNs in this task lies in their ability to identify complex patterns in image data that may not be detectable by traditional analysis methods. CNNs can capture subtle features from brain images associated with characteristic structural changes of dementia, such as thinning of the brain layers or changes in the vascular network, and use this information to make accurate predictions about the type of dementia. | The main conclusion is that the explainable AI model was able to provide clinically relevant insights into the structural brain changes associated with dementia. |

Source: (Research Results, 2024)

Additionally, cognitive tests use AI. Through machine learning, algorithms can analyze cognitive test results to detect cognitive decline that may not yet be apparent in traditional clinical assessments. This approach can identify early cognitive decline and predict progression from mild cognitive impairment (MCI) to Alzheimer's dementia, providing opportunities for earlier and more effective intervention [14]. Several studies have explored the application of AI in diagnosing and monitoring Alzheimer's disease through various methods, including neuroimaging, eye-tracking, and genetic analysis. Table 2 provides a summary of relevant literature in this area.

Ellis Wisely et al. (2021) highlight the vast potential of AI-based approaches in diagnosing and monitoring Alzheimer's Disease (AD) through retinal imaging analysis. In this study, researchers analyzed data from 284 eyes belonging to 159 subjects, consisting of 222 eyes from 123 cognitively healthy subjects and 62 eyes from 36 subjects diagnosed with Alzheimer's. They used Optical Coherence Tomography (OCT) and Optical Coherence Tomography Angiography (OCTA) to get information on different parts of the retina, such as the thickness of the Ganglion Cell-Inner Plexiform Layer (GC-IPL) and the thickness of the subfoveal choroid. They also got information on OCTA parts, such as the density. The AI model created in this study used convolutional neural networks (CNNs) to successfully analyze this data to tell the difference between Alzheimer's patients and healthy controls, finding big differences in OCT and OCTA parameters [10]).

The study results show that CNNs can detect structural differences associated with Alzheimer's with high accuracy. We trained the model using 11 different datasets to ensure its effectiveness across various conditions. These findings confirm that the combination of retinal imaging technology and machine learning has significant potential for early diagnosis and monitoring of Alzheimer's disease. With high accuracy in distinguishing Alzheimer's patients from healthy controls, this study suggests that OCT and OCTA could become effective diagnostic tools, while CNN offers a systematic approach to improve diagnosis accuracy and disease progression monitoring. Recent advancements in Alzheimer's research highlight the combined potential of AI and machine learning in enhancing diagnostic capabilities through digital biomarkers. These technologies enable the efficient analysis of extensive datasets, recognizing intricate patterns that improve predictions of disease progression. Additionally, their application supports the development of personalized treatment approaches by providing deeper insights into individual responses to therapies and interventions [15]. The CNN demonstrated significant accuracy in distinguishing between symptomatic AD patients and cognitively normal individuals. The model's performance was particularly notable given the relatively small dataset used for training, highlighting its potential


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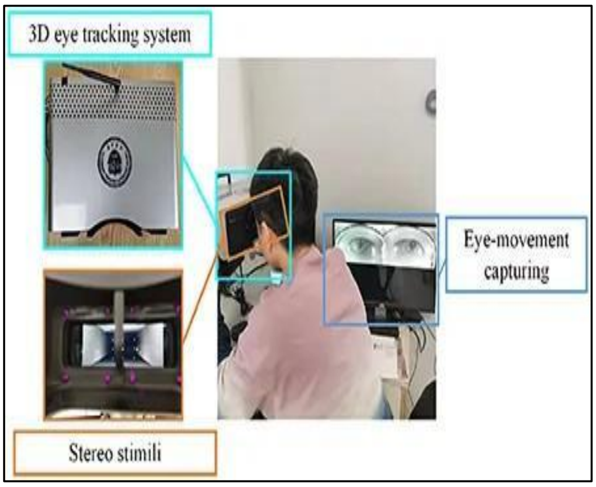
as a proof-of-concept for using retinal imaging in AD diagnosis [16].

Sun Jingling et al.'s research from 2022 explores the potential of machine learning and deep learning-supported eye-tracking technology in diagnosing Alzheimer's disease [11]. The study recruited 108 Alzheimer's patients and 102 healthy controls, aged between 40 and 92, from the Cognitive Disorder Clinic at Tianjin HuanHu Hospital in China between September 2020 and September 2021. Researchers used eye-tracking technology to collect data on participants' eye movements while they performed a 3D Visual Perspective Change (VPC) task, designed to assess how participants focus on various areas within a 3D scene. Consequently, it can be argued that this task has low ecological validity. Recent studies have attempted to address this limitation by assessing inhibitory control, using a gaze-directed target to eliminate antisaccade eye movements [17].




Source: (Sun Jingling et al, 2022) [11]
Figure 3. The Descriptions of Ocular Motion Data of Alzheimer Patients

The study results show that Alzheimer's patients tend to focus more on the central areas of the scene and pay less attention to the Region of Interest (RoI), where new objects are added or removed. Differences in eye movement patterns indicate memory decline and reduced interest in novelty, typical characteristics of Alzheimer's. These findings suggest that combining eye-tracking technology with deep learning algorithms can provide additional diagnostic data useful for assessing patients' cognitive condition. These findings suggest that combining eye-tracking technology with deep learning algorithms can provide additional diagnostic data useful for assessing patients' cognitive condition (Figure 3). By analyzing eye movement patterns, this study offers a potential method for early identification of Alzheimer's, which could expedite detection and intervention before further clinical symptoms appear. This approach suggests that eye tracking technology can be an effective diagnostic tool for evaluating cognitive decline, offering significant potential for developing earlier and more accurate diagnostic methods for Alzheimer's. The success of this technique paves the way for broader applications of eye-tracking technology in research and clinical practice to address dementia and other cognitive disorders.

Saraceno Giorgia et al.'s (2024) research demonstrates how machine learning, specifically the Latent Dirichlet Allocation technique, can analyze and organize scientific literature data to identify important topics in Alzheimer's research [12]. Researchers can categorize relevant scientific papers and filter out duplicates using MySLR, leading to a more structured understanding of the conducted research area. Some problems with this study are that it only looked at literature from Italy and only looked at certain types of literature. However, the results show that using machine learning to look at the literature can help find important patterns about ApoE gene mutations and Alzheimer's risk. This approach not only filters relevant information but also uncovers deeper insights into Alzheimer's genetic research that traditional literature analysis methods might overlook. This research underscores the potency of machine learning in Alzheimer's genetic research, showcasing its ability to pinpoint knowledge gaps and steer new research paths in this domain. The success of the MySLR platform in analyzing scientific literature opens up opportunities for the use of similar methods in genetic and epidemiological research in other fields of neurodegenerative diseases, demonstrating how modern technology can expand the scope and effectiveness of scientific research [12].

Leonardsen Asten et al. (2024) conducted a study that demonstrates how CNNs, being machine learning-based tools, can provide more detailed and accurate brain image analysis in the context of dementia [13]. CNNs, a specific type of neural network, analyze image data efficiently and effectively. In this study, CNNs process MRI and PET scan data to identify structural changes associated with various types of dementia. The advantages of CNNs in Analyzing Brain Images offer a number of advantages over traditional analysis methods when it comes to brain image analysis [13].

Conventional methods might miss complex patterns in brain images that CNNs can detect. For example, CNNs can identify the thinning of brain layers or changes in vascular networks with very high detail, which is an important feature in the diagnosis of dementia. This study demonstrated the excellent ability of the CNN model to distinguish between Alzheimer's, vascular dementia, and other types of dementia. Training the model with large and diverse datasets enables CNNs to learn and generalize from various structural features associated with those conditions. CNNs can identify small differences in brain images that may be important indicators of various types of dementia. CNNs, for example, can identify with high accuracy differences in cerebral thinning or changes in brain volume that might not be visible in manual visual analysis. In addition to the technical capabilities of CNNs, this research also emphasizes the importance of understandable AI in a medical context. Explainable AI is an approach that allows users to understand how AI models make decisions or generate predictions. In the context of dementia diagnosis, this feature is crucial because, by using explainable AI techniques, researchers can provide insights into the specific features of brain images that CNNs consider in the diagnostic process. This helps understand the model's decisions and provides additional confidence to medical practitioners about the AI analysis results.

While drug studies offer therapies to slow down or treat Alzheimer's, AI can enhance diagnosis and monitoring processes. Both have great potential in the management of Alzheimer's disease, but with different focuses—AI on diagnosis and therapy and drug studies on the development of treatments.

These four studies show significant progress in the application of machine learning and artificial intelligence technologies for the diagnosis and monitoring of Alzheimer's disease. Ellis Wisely et al. (2021) and Sun Jingling et al. (2022) focus on the development of diagnostic techniques based on retinal imaging and eye tracking [10], [11]. On the other hand, Saraceno Giorgia et al. (2024) demonstrate how machine learning can be used to analyze scientific literature to identify important research in Alzheimer's genetics [12]. Leonardsen Asten et al. (2024) highlight the potential of CNNs in detecting structural brain changes for the diagnosis of various types of dementia [13].

Future actions for this CNN model should involve obtaining a larger and more diverse dataset to enhance the density of sample points available for the model's learning process, thereby improving its generalizability. Expanding the dataset with additional high-quality images is likely to result in significant improvements in prediction accuracy and will also facilitate the evaluation of the advantages associated with an increased model size.

Overall, these four studies demonstrate that machine learning and AI have enormous potential to address challenges in the diagnosis and monitoring of Alzheimer's, and to provide new insights in genetic research and therapy development. Both offer different yet complementary approaches in understanding and managing Alzheimer's disease, from early diagnosis to further research on genetic mutations and potential therapies.

The use of AI in the public policy cycle offers a range of opportunities that have the potential to revolutionize governance and decision-making processes. AI can play a critical role in improving data analytics, prediction, risk assessment, and public service communication. These capabilities empower policymakers to make more informed, efficient, and tailored decisions, effectively responding to the complex challenges of the modern era.

## CONCLUSION

Overall, these four studies highlight the great potential of machine learning and AI (artificial intelligence) in addressing challenges in Alzheimer's diagnosis and genetic research. They introduced a new approach to improve early detection, disease monitoring, and understanding of genetic mutations and structural changes associated with dementia. These approaches emonstrate how modern technology can expand the capacity of scientific research, enhance clinical practices, and drive innovation in the field of neurodegenerative diseases. However, challenges remain, including the need for large, diverse datasets and ensuring interpretability of AI models. Despite these hurdles, AI shows promise in revolutionizing AD diagnosis, potentially leading to earlier interventions and personalized treatment strategies.

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