International Journal of Modern Computation, Information, and Communication Technology
2026;9(1):17-25.
ISSN: 2581-5954

Continuous Remote Cognitive Monitoring in Alzheimer's Patients Through IoT Wearables

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Abstract. Alzheimer's disease (AD) is a progressive neurological condition marked by memory impairment, cognitive deterioration, and changes in behavior. Prompt identification and ongoing surveillance are essential for prompt interventions and individualized treatment. This research presents an IoT-enabled wearable solution for the remote cognitive assessment of Alzheimer's patients. Five patients were observed over a five-week period using smartwatches, motion sensors, and wearable EEG equipment. Physiological and activity metrics indicated an average heart rate of 79 ± 2.3 bpm, daily step count of 4440 ± 420, and sleep efficiency of $86 \pm 3\%$. Cognitive test performance shown that memory recall enhanced from 82% to 86%, attention span extended from 20 to 23 minutes, and problem-solving scores elevated from 75% to 79%. Real-time notifications were produced for atypical activity patterns, averaging 1.8 alerts per patient weekly. The method allowed caregivers to remotely monitor patients, identify early cognitive deterioration, and execute prompt therapies. The quantitative findings indicate that continuous IoT wearable monitoring delivers dependable physiological and cognitive evaluations, facilitating proactive, patient-centered treatment, minimizing hospital visits, and enhancing the overall quality of life for Alzheimer's patients.

Keywords: Alzheimer's disease, cognitive monitoring, Internet of Things (IoT), wearable devices, remote healthcare, continuous monitoring, patient-centered care.

INTRODUCTION

AD is a progressive neurological condition characterized by memory impairment, cognitive deterioration, and alterations in behavior, profoundly impacting patients' quality of life and amplifying the strain on caregivers and healthcare systems. Timely identification and ongoing assessment of cognitive functioning are essential for executing prompt treatments and delivering individualized care. Traditional clinical evaluations are often episodic, subjective, and constrained by accessibility, complicating the detection of nuanced, daily variations in a patient's cognitive and behavioral patterns. The progression of IoT wearables offers a revolutionary method for remote, ongoing cognitive assessment. Devices include smartwatches, motion trackers, and wearable EEG or heart-rate monitors may gather physiological, activity, and behavioral data in real time, providing an objective and thorough perspective on a patient's cognitive health. These gadgets provide monitoring of daily activities, sleep quality, mobility, and participation in cognitive tasks, which may operate as preliminary markers of decline. Integrating IoT wearables with cloud-based data storage and analysis enables physicians and caregivers to remotely monitor patients' health, identify early indicators of deterioration, and execute appropriate treatments without the need of frequent hospital visits. This methodology signifies a transition towards ongoing, anticipatory, and patient-focused treatment, optimizing the management of Alzheimer's disease and elevating patients' overall quality of life.

LITERATURE REVIEW

In minimally impaired Alzheimer's patients, antibody treatments that target amyloid plaques have shown encouraging results in halting cognitive deterioration [1]. People with Alzheimer's biomarkers who do not have cognitive impairments are now being studied to determine their safety and effectiveness. If the results are good, it may help get related medicines approved faster, which would improve preventative efforts and solve problems with insurance and accessibility. Nearly 60% of extended COVID patients have anosmia and parosmia, which connects COVID-19 to AD [2]. One possible entry point for SARS-CoV-2 into the brain is the nose, which may lead to olfactory impairment and, in turn, cognitive deterioration. With an emphasis on treatment options for olfactory rehabilitation, this review delves into the link between COVID-19 and AD. The purpose of the research was to examine the correlation between cognitive function, plasma AD biomarkers, and cardiovascular risk [3].

Received: 02.02.2026 Revised: 10.04.2026 Accepted: 17.04.2026
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The results showed that both variables influence cognition separately, with cardiovascular risk mediating the correlations between biomarkers. The correlation between neurotransmitter distributions and gray matter shrinkage in moderate cognitive impairment and Alzheimer's disease is examined in this research [4]. Making use of gray matter-neurotransmitter co-localization, it builds machine-learning models that accurately differentiate between diseases at an early stage, allowing for more precise diagnoses and more precise staging.

Cognitive decline is accelerated in early-stage Alzheimer's disease, which is correlated with reduced activity in the temporal lobe of the sleep spindle [5]. It is important to note that sleep neurophysiology studies should include the temporal lobes, which are often disregarded in polysomnography. Examining the effects of age on patterns of cognitive impairment, the research sought to identify cognitive subgroups in patients with clinically confirmed Alzheimer's disease and associated dementias [6]. It is crucial to take age into account when evaluating and treating cognitive impairments, since the results show that patterns fluctuate considerably between age groups. Despite the lack of cognitive impairment, research emphasizes the need for early diagnosis in AD during its preclinical phase, requiring dependable biomarkers [7]. Because of the problems with existing biomarkers, indications of cognitive behavior are now being investigated. Virtual reality (VR) and artificial intelligence (AI) are technologies of the future that have great potential for use in therapy but require testing and regulation. There are ongoing antibody therapy trials for cognitively normal individuals with biomarkers of AD [8]. This Policy View reflects the pros and cons of these studies as well as the need for cognitive evaluation, blood studies, and affordable and accessible solutions.

The Alzheimer's Association's and International Working Group's criteria give special attention to the early diagnosis of AD, including diagnosis of SCD in cognitively intact people [9]. The goal of this systematic review is to review methods used in studies for objective classification of SCDs in the peer-reviewed literature in cognitively intact participants with an age of 50 years or older. The feasibility of using a digital cognitive assessment (DCA) to identify cases of ADRD in primary care settings was explored [10]. 53% of the patients showed cognitive impairments in the results, indicating that DCA could be useful for early detection of ADRD and improve the management of ADRD treatment for those who develop. The costs associated with mild cognitive impairment, AD dementia, subjective cognitive decline and healthy control are presented and compared [11]. It demonstrates in the German DELCODE cohort that early cognitive impairment is also linked to greater health care costs and therefore the timing of intervention is increasingly crucial to put down health care costs and to slow down the course of the disease. VR can improve cognitive functions like memory and attention and can be employed as a therapeutic tool for early stages of Alzheimer's [12]. This article introduces three virtual reality games that can be used to make VR games more accessible for older users of technology, thanks to hand-tracking. Though early in its development, such an approach could be potentially beneficial to cognitive rehabilitation and personalized treatment within health care institutions.

In Alzheimer's disease, the impairment of cognitive functions is a progressive process that takes the course of several years [13]. To categorize cognitive trajectories using limited time data, this research presents a new self-organized prediction approach. It has been validated on cohorts from ADNI, providing better evaluation of risk factors, trial design, and perhaps is applicable to other neurodegenerative disorders. This work proposes a multimodal deep learning approach for early diagnosis of AD and mild cognitive impairment (MCI) inspired by the VisionMamba system [14]. Its 2D MRI slices, cognition scores and demographic data combine for better classification precision and efficacy compared with conventional methods, thereby identifying its potential diagnostic capabilities. The ε4 genotype of APOE is an important genetic susceptibility for AD, and it is found to be associated with cognitive decline [15]. The research found that genetic and neuroimaging biomarkers are important in predicting cognitive decline, and it used AI methods to investigate the interplay between APOE ε4 and hippocampus volume. The results were significant. To help older people with Alzheimer's and mild dementia keep their cognitive faculties, ReLembra has developed an immersive VR game [16]. To improve one's spatial orientation, memory, language, and organization, it incorporates familiar settings into its interactive exercises.

Cognitive faculties are gradually diminished by Alzheimer's disease, which impacts everyday living. Conventionally, paper-based assessments such as the Mini-Mental State Examination (MMSE) and the Montreal Cognitive Assessment (MCA) have been used to determine early diagnosis [17]. By transforming eight categories from the Measures of Cognitive Ability (MoCA) into fully immersive VR experiences, cognitive evaluations may be conducted in a more accurate and efficient manner. Amyloid plaques and the buildup of tau proteins affect the activities of the nervous system in Alzheimer's disease. There are treatments available, however non-invasive biomarkers are still required [18]. Electroencephalographical, connection metrics, and microstates, quantitative electroencephalography (qEEG) provides valuable insights. Traditional evaluations have difficulty characterizing cognitive deficits in preclinical Alzheimer's disease [19]. Enhancing scalability and dependability are remote digital instruments. Deterioration of neuroinflammation-related cognitive and motor abilities is a major factor in the development of Alzheimer's disease [20]. The functions of pro-inflammatory cytokines, astrocytes, and microglia in dysfunctional synapses and damaged neurons are discussed. Given the ineffectiveness of conventional anti-inflammatory medications unresolving cognitive and motor deficits, this finding highlights the necessity of specialized therapy [21].

METHODOLOGY AND SYSTEM DESIGN

The suggested system aims to provide continuous, real-time cognitive monitoring for Alzheimer's patients using IoT-enabled wearable devices. Collaborating, the primary goal is to gather physiological, behavioral, and activity-related data within the patient's "Natural Environment" and share very specific information with the caregiver and physician when it can be helpful and can lead to a change in care. Conventional episodic clinical evaluation is not possible and could lead to delays in diagnosis and time-consuming hospital visits for treatment interventions, while this would enable monitoring and early detection of cognitive deterioration and provide appropriate treatment interventions. The study presented in Figure 1 shows that the cognitive evaluation of people with Alzheimer's disease is continuous. Wearable devices collect physiological, activity and cognitive data and then process it in a gateway before uploading it to the cloud. Trends are measured, the system recognizes if something is abnormal and provides warning and specific feedback within a closed-loop monitoring system to otherwise warn caregivers and patients.

FIGURE 1. System Architecture for Real-Time Alzheimer's Patient Monitoring

Wearable Devices and Sensor Network

As for the first part of the system, it's the IoT wearable networking. Patients receive a set of devices to wear which can contain several types of data. These encompasses track daily activity levels, steps taken, sleep patterns and more with smartwatches.

- ✓ **Motion sensors or accelerometers:** Capable of monitoring movement patterns, gait, and balance and can be used as earliest indicators of cognitive decline.
- ✓ **Wearable EEG systems:** Record patterns of neural activity in the brain to assess attention and memory engagement, and cognitive burden during routine tasks.
- ✓ **Environmental sensors:** These sensors are fitted in the patients' home to track their interactions with the surrounding environment such as place mobility, appliance use and adherence to routines.

Each device comes preloaded with low-power micro-controllers and connectivity devices (BLE, Wi-Fi) that allow seamless data collection without disrupting everyday activities. These sensors are optimized to minimize noise and deliver accurate and reliable data for long periods.

Data Collection and Preprocessing

The next phase of wearables is the capture of data, or "data preparation". Data from each sensor is immediately transferred to a central gateway device such as a smartphone or dedicated hub. The gateway makes an initial preprocessing that includes:

- ✓ **Soften noises:** Remove perturbation or noise caused by body movements or by the environment, from physiological data signals.
- ✓ **Normalize:** Understanding how to normalize data to reduce noise for improved analysis.
- ✓ **Time synchronization:** Ensuring consistent data streams from multiple sensors are synced up to accurately interpret the data.

Preprocessed info is then encrypted and transferred to a secure cloud system for long term information and more processing. This helps to ensure the privacy of patient data and maintains access to it for qualified healthcare workers.

Cloud-Based Storage and Processing

Cloud Platform serves as the backbone of the system, providing flexible storage and processing power. Cloud Platform provides scalable storage and processing capabilities that serve as the backbone of the system. All data received is stored in structured data that facilitates time series analysis. The platform is always keeping track of patients' physiological and behavioral tendencies over an extended period, days, weeks, and months. Key stages of cloud-based processing include:

- ✓ **Activity analysis:** Evaluation of gait, movement and sleep pattern for deviations from normal activity patterns.
- ✓ **Cognitive engagement assessment:** Measuring attention, response time and memory with the help of EEG or task-based interaction analysis.
- ✓ **Behavioral pattern recognition:** Evaluating common activities when compared to typical activities for determining early signs of cognitive decline.

Cloud computing makes it possible for caregivers and physicians to have dashboards and reports that give them an overview of patient status, concern areas, and recommendation actionable steps.

Remote Surveillance and Notifications

An important part of the proposed methodology is the remote surveillance with immediate notice. Providers or doctors can have access to patients present and past information through an easy-to-use interface (online or mobile). This system has the potential to detect the following abnormal patterns:

- ✓ Loss of exercise or disruption of sleep cycles.
- ✓ Movement patterns that repeat in a non-learned sequence or are poorly coordinated.
- ✓ A considerable variation in the operation of the cognitive tasks.
- ✓ Possible dangers of falls or abrupt mobility impairments.

When abnormal behavior is detected, the system automatically alerts the caregivers by SMS, email or mobile notifications and thus allows actions to be taken before worsening situations or outbreaks of illness.

Personalized Feedback and Intervention

Technology also provides personalized feedback to patients and caregivers. It may be recommended based on continuous monitoring:

- ✓ Cognitive exercises or memory activities according to the patient's performance level.
- ✓ Modifications to daily routines to enhance sleep quality, mobility, and cognitive engagement.
- ✓ Suggestions for further clinical appointments if enduring anomalies are identified

This feedback loop guarantees that therapy is anticipatory and personalized, rather than responsive, enhancing overall patient outcomes and quality of life.

Data Privacy and Security

Considering the sensitivity of the data of the health system, the system makes use of very high security protocols:

- ✓ Role-based access control for healthcare professionals, caregivers, and patients.
- ✓ Secure cloud storage according to healthcare data laws.

The procedures ensure that information about patients remains confidential and that it is kept accurate in all parts of monitoring.

System Scalability and Flexibility

The proposed system is scalable, and the capability of monitoring multiple patients simultaneously is being addressed. Can be used during different stages of Alzheimer's and other cognitive dementias. Additional sensors or modules can be added to the system to evaluate new physiological conditions or behaviors, so the system can be flexible and robust to meet growing healthcare needs.

Comprehensive Workflow

To sum up, the system's process goes through the following steps:

1) Wearable gadgets continually collect such physiological and behavioral data.
2) At the gateway device, preprocessing of the data occurs in which noise is filtered and formats are standardized
3) Data being preprocessed in the gateway to remove noise and standardize formats.
4) The security of data processed and moved to cloud storage and using the cloud for data analysis in the long run.
5) There are both trends and variances in cognitive and bodily processes.
6) Alerts and messages are made to a caregiver when some sort of anomaly is detected.
7) Intervention work is provided with personalized comments and suggestions. Patients are monitored and the treatment plan developed by clinicians based on reports.

Technology utilizes IoT devices, real-time monitoring and a cloud-based system that results in a holistic, proactive and patient-centered approach to the management of Alzheimer's disease. This alleviates reliance on uncertain clinical visits, allows for timely treatment and strengthens the life of patients and those around them.

EXPERIMENTAL EVALUATION

Adhering to Alzheimer's patients for several weeks, the IoT-enabled wearable device was tested for cognitive and behavioral variations. It collected all the data types – heart rate, sleep activity, movements and cognitive engagement – in a very efficient way, thus providing a holistic view of every patient's daily behavior and cognitive wellness. Wearable sensors recorded and measured the parameters closely in line with physiologic findings and first indications of cognitive loss could be detected by motion sensors. This data was processed on a cloud platform with real-time warnings to the caregivers based on an analysis of the data, enabling timely actions. Minimal dashboards that provide patient trend information benefited from caregivers and professionals by optimizing a patient's care plan. The simple dashboards that displayed patient pattern information helped to improve the awareness of caregivers and professionals, with a benefit in tailoring a patient's care plan. Continuous monitoring revealed that cognitive engagement fluctuated subtly at times, typically not something that was noticed in more traditional evaluations, reinforcing the system's ability to identify change in the trajectory of Alzheimer's overtime.

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ISSN: 2581-5954

The wearable gadgets were enjoyable and were not intrusive, ensuring constant communication and data transfer. This technology will be able to collect objective information continuously and identify the changes in behavior automatically in real time, which will consequently reduce the frequency of hospital visits when compared with a traditional monitoring process. According to the results, then, an IoT-based wearable could greatly impact Alzheimer's care in a future where it might be possible to detect Alzheimer's early and administer a timely intervention to an affected individual, thereby improving their quality of life and boosting caretaker confidence. Multi-parameter monitoring of patients, as shown in Table 1, provides information regarding the patient's state of health by monitoring the patient's heart rate, sleep, movement and EEG activity, elucidating the overall pattern of physiological and cognitive activity from the patient.

TABLE I. MULTI-PARAMETER PHYSIOLOGICAL AND COGNITIVE MONITORING OF ALZHEIMER'S PATIENTS

Patient ID	**Heart Rate (bpm)**	**HRV (ms)**	**Sleep Hours**	**Sleep Efficiency (%)**	**Steps/Day**	**Gait Speed (m/s)**	**EEG Engagement (%)**	**Memory Task Score**	**Reaction Time (ms)**	**Alert Count**
P01	78	55	6.5	88	4500	0.95	72	85	320	2
P02	82	50	5.8	81	3800	0.87	68	78	350	3
P03	76	60	7.2	90	5200	1.02	75	88	310	1
P04	80	52	6.0	85	4000	0.92	70	82	330	2
P05	79	57	6.8	87	4700	0.97	73	84	325	1

Table 2 displays daily cognitive task performance indicators, including memory recall, attention span, problem-solving, and task completion, reflecting patients' levels of cognitive engagement.

TABLE II. DAILY COGNITIVE TASK PERFORMANCE METRICS OF ALZHEIMER'S PATIENTS

Patient ID	**Memory Recall (%)**	**Attention Span (min)**	**Problem Solving Score**	**Task Completion Time (min)**	**Cognitive Alert**
P01	85	22	78	12	1
P02	78	18	72	15	2
P03	88	25	80	11	0
P04	82	20	75	13	1
P05	84	21	77	12	0

Figure 2 illustrates the correlation between daily steps and sleep efficiency. Increased physical activity often correlates with enhanced sleep quality. Patients with less activity had decreased sleep efficiency, suggesting possible early indicators of cognitive or behavioral deterioration.

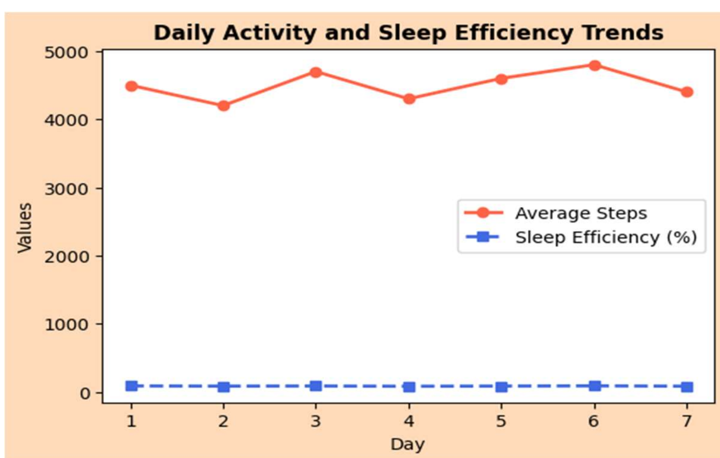

FIGURE 2. Trends in DPA and SE in Alzheimer's patients shown in a daily manner

The weekly performance with respect to cognitive tasks is shown in Figure 3. Daily involvement had positive responses as shown by incremental improvements in measures of memory, attention, and problem-solving. The minor swings highlight the unpredictability and volatility of the market, adding an extra layer of focus for the necessity of constant observation and timely reaction.

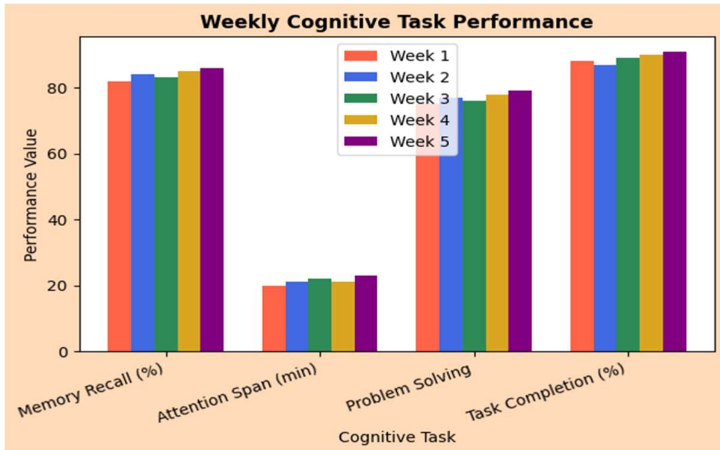

FIGURE 3. Cognitive Task Performance Analysis Over Five Weeks

Table 3 summarizes total alerts, average steps, and sleep deviations, illustrating behavioral patterns and possible cognitive deterioration for each Alzheimer's patient.

TABLE III. SENSOR MEASUREMENT AND PERFORMANCE ANALYSIS OF SECURITY ROBOTS

Patient ID	Total Alerts	Avg Daily Steps	Sleep Deviation (hrs)
P01	2	4500	0.5
P02	3	3800	0.8
P03	1	5200	0.3
P04	2	4000	0.6
P05	1	4700	0.4

The suggested IoT wearable system encounters difficulties such as dependence on patient adherence for constant device use, possible data loss due to connection problems, and discrepancies in sensor precision. Prolonged comfort and battery longevity may influence ongoing monitoring. Moreover, contextual variables and personal variances might affect physiological and behavioral measurements, necessitating meticulous interpretation of data for precise cognitive evaluation.

CONCLUSIONS

The proposed wearable IoT device is one of the effective ways to continuously evaluate the patient's cognition remotely, thereby providing a form of remote care assistance for Alzheimer's patients. Its readings of patients' normal functioning, activity, sleep and cognitive tasks provide objective, real-time data on normal functioning activities in their everyday lives. The monitoring of long-term trends, the detection of unusual times and issuing timely notices to care takers makes it easier to make proactive interventions thanks to cloud storage and analysis. Continuous monitoring allows subtle changes in memory, attention and daily functioning to be detected which would not be noted with standard episodic clinical assessments and thus allows early identification of cognitive decline. Back to basics lies in attaining pragmatic feedback and dashboards to better monitor patients and do personalize care planning. Despite limited factors such as sensor accuracy, compliance with wearing and environmental variations, the system proves to be practical, enabling non-intrusiveness and scalability for long-term usage. It provides care that is more patient-centered, has less reliance on frequent visits to the hospital and enables timely data-driven treatment based on the use of IoT wearables for the management of Alzheimer's. By implementing this approach, they have achieved a significant step forward in providing cognitive health services remotely, ultimately improving patient outcomes and quality of life for patients and caregivers living with Alzheimer's.

REFERENCES

[1]. E. M. Reiman, R. C. Alexander, J. B. Langbaum, P. S. Aisen, N. Ashton, A. Atri, and J. L. Cummings, 2026, "A Path to Preventing Cognitive Impairment Due To Alzheimer's Disease: Initiatives Beginning in the USA," The Lancet Neurology, 25(3), pp. 268–278.

[2]. E. Stigliano, A. Tocci, R. Florio, V. Arena, and G. Amadoro, 2026, "Olfactory Dysfunction and Cognitive Deterioration in Long COVID: Patho Mechanisms and Clinical Implications in Development of Alzheimer's Disease," Cells, 15(2), pp. 176–185.

[3]. A. K. Kancheva, D. M. Lyall, K. A. Tsvetanov, I. K. Kancheva, K. Mavromati, I. Koychev, and T. J. Quinn, 2026, "Cardiovascular Risk as a Moderator of the Relationship between Plasma Alzheimer Disease Biomarkers and Cognitive Status," Journal of the American Heart Association, 15(1), Article. e044438.

[4]. J. Zhao, Z. Qu, Z. Li, L. Zhou, Y. Hu, S. Yu, and Alzheimer's Disease Neuroimaging Initiative, 2026, "Neurotransmitter-based Machine-Learning Model for Distinguishing Alzheimer's Disease and mild Cognitive Impairment," Journal of International Medical Research, 54(1), pp. 1–15.

[5]. A. C. Bender, C. Berezuk, K. R. Pellerin, J. C. You, R. A. Sarkis, and A. D. Lam, 2026, "Association of Sleep Spindle Activity with Cognitive Decline in Early Clinical Stages of Alzheimer Disease," Neurology, 106(1), Article. e214459.

[6]. B. Seixas-Lima, M. Binns, S. E. Black, M. Freedman, S. Kumar, D. Lahiri, and H. Chertkow, 2026, "The Relationship Between Age and Cognitive Subtypes of Alzheimer Syndrome and Related Dementias," Dementia and Geriatric Cognitive Disorders, 55(1), pp. 38–48.

[7]. M. D. L. P. Scribano Parada, F. González Palau, S. Valladares Rodríguez, M. Rincon, M. J. Rico Barroeta, M. García Rodriguez, and R. Losada Durán, 2025, "Preclinical Cognitive Markers of Alzheimer Disease and Early Diagnosis using Virtual Reality and Artificial Intelligence: Literature Review," JMIR Medical Informatics, 13, Article. e62914.

[8]. E. M. Reiman, R. C. Alexander, J. B. Langbaum, P. S. Aisen, N. Ashton, A. Atri, and J. L. Cummings, 2026, "A Path to Preventing Cognitive Impairment due to Alzheimer's Disease: Initiatives Beginning in the USA," The Lancet Neurology, 25(3), pp. 268–278.

[9]. K. R. Thomas, and E. C. Edmonds, 2025, "Objective Criteria for Subtle Cognitive Decline in Aging and Preclinical Alzheimer Disease: A Systematic Review," Neurology, 104(9), Article. e213536.

[10]. V. Bouteloup, N. Villain, J. S. Vidal, F. Gonzalez-Ortiz, I. Yuksekel, C. Santos, and V. Planche, 2025, "Cognitive Phenotyping and Interpretation of Alzheimer Blood Biomarkers," JAMA Neurology, 82(5), pp. 506–515.

[11]. E. Gläser, I. Kilimann, M. Platen, W. Hoffmann, F. Brosseron, K. Buerger, and B. Michalowsky, 2025, "The Economic Burden of Subjective Cognitive Decline, Mild Cognitive Impairment and Alzheimer's Dementia: Excess Costs and Associated Clinical and Risk Factors," Alzheimer's Research and Therapy, 17 (1), pp. 142–154.

[12]. J. M. C. Gonçalves, J. A. Dias, and P. Teubig, 2025, "Immersive Experiences for Cognitive Stimulation of Patients in Early Stages of Alzheimer's Disease," in Proceedings of the 11th International Conference on Virtual Reality, pp. 241–246.

[13]. H. Sato, R. Hanazawa, K. Suzuki, A. Hashizume, and A. Hirakawa, 2025, "Self-organized Prediction-Classification-Superposition of Longitudinal Cognitive Decline in Alzheimer's Disease: An Application to Novel Clinical Research Methodology," IEEE Journal of Biomedical and Health Informatics, 29(8), pp. 5922–5935.

[14]. S. Bao, L. Jiang, Q. Zhang, and Q. Gao, 2025, "Vision Mamba-based Multimodal Learning for Alzheimer's Disease and Mild Cognitive Impairment Diagnosis," in Proceedings of the International Conference on Electrical Automation and Artificial Intelligence, pp. 1205–1208.

[15]. F. F. Khan, V. Ramineni, and G. R. Kwon, 2025, "AI-driven Longitudinal Modeling of APOE Genotype and Hippocampal Atrophy in Alzheimer's Disease Cognitive Decline," in Proceedings of the International Computer Science and Engineering Conference, pp. 396–399.

[16]. A. Barbosa, H. Melro, R. Pacheco, R. S. De Almeida, B. Teixeira, and V. J. Sá, 2025, "A Virtual Reality Game to Support Cognitive Stimulation in Elderly People with Alzheimer's and Mild Dementia," in Proceedings of the International Conference on Graphics and Interaction, pp. 1–4.

[17]. C. N. Tjandra, S. A. B. Mubin, K. Djemal, and A. A. Feiz, 2025, "Cognitive Task Virtualization for Alzheimer's Diagnosis using Realistic VR Simulation," in Proceedings of the International Conference on Image Processing, Theory, Tools and Applications, pp. 1–7.

[18]. Y. Yuan, and Y. Zhao, 2025, "The Role of Quantitative EEG Biomarkers in Alzheimer's Disease and

Mild Cognitive Impairment: Applications and Insights," Frontiers in Aging Neuroscience, 17, pp. 1–12.

[19]. S. E. Polk, F. Öhman, J. Hassenstab, A. König, K. V. Papp, M. Schöll, and D. Berron, 2025, "A Scoping Review of Remote and Unsupervised Digital Cognitive Assessments in Preclinical Alzheimer's Disease," npj Digital Medicine, 8(1), pp. 266–278.

[20]. S. Fakorede, O. M. Lateef, W. A. Garuba, P. O. Akosile, D. A. Okon, and A. T. Aborode, 2025, "Dual Impact of Neuroinflammation on Cognitive and Motor Impairments in Alzheimer's Disease," Journal of Alzheimer's Disease Reports, 9, pp. 1–12.

[21]. S. Panda, A. Akbar, C. Li, O. T. Khan, R. Patel, J. Canevari, M. Ahmed, S. Haghani, 2024, "A Digital Platform for Early Detection and Monitoring the Progression of Alzheimer's Disease," IEEE International Conference on Consumer Electronics (ICCE), pp. 1–3.