Biomarkers for Early Alzheimers Disease

Unsa Saleem[1]

[1] Liaquat university of medical and health sciences, Jamshoro

Date of Submission: 9th June 2025 Date of Acceptance:22nd July 2025 Date of Publication: 15th August 2025

ABSTRACT

Alzheimer's disease (AD) is a progressive neurological disorder characterized by memory loss, cognitive decline, and neurodegeneration. Early diagnosis through biomarkers is crucial for improving treatment outcomes and managing the disease. This review highlights invasive and non-invasive biomarkers for AD diagnosis which includes cerebrospinal fluid, blood-based, exosomal, and fluid-based biomarkers. Neuroimaging techniques, such as structural MRI and functional imaging, are also discussed. Recent advancements in blood-based biomarker technology and emerging AI and machine learning techniques offer promising avenues for early AD diagnosis. Future non-invasive diagnostic tools which includes wearable sensors may aid in early detection and personalized treatments. a reliable marker for monitoring neurodegeneration. Additionally, novel biomarkers like flotillin have the potential for early AD diagnosis.

To the editor,

Alzheimer's disease is a progressive, irreversible neurological disorder characterized by memory loss, cognitive decline, and neurodegeneration, involving the accumulation of amyloid-β and tau proteins, neuronal apoptosis, synaptic loss, and inflammation .[1] The World Health Organization estimated that 55 million people will be living with dementia worldwide in 2023, with projections suggesting this number will exceed 60 million by 2024 .[2] Given the growing global prevalence of Alzheimer's disease, early diagnosis through biomarkers is crucial for improving treatment outcomes and managing the disease.

Biomarkers are measurable indicators of a biological process or a disease. Biomarkers of Alzheimer's include invasive Invasive biomarker includes cerebrospinal fluid (Reduced Aβ-42, Elevated Tau, BACE1, Neurogranin, Inflammatory proteins) and[2]. MicroRNAs in CSF (miRNA-125b, miRNA-146a). Non-invasive includes Blood-based biomarkers (Aβ-42, Tau, Neurofilament proteins) and Exosomal biomarkers in the blood (Neuron-derived extracellular vesicles (EVs) and Astrocyte-derived extracellular vesicles (EVs) .[4]

Access this article online

Website: https://www.nepjol.info/index.php/NJN

DOI: 10.3126/njn.v22i2.80007

HOW TO CITE
Unsa Saleem. Biomarkers For Early Alzheimer's Disease Diagnosis .NJNS. 2025;22(1):63-64

Address for correspondence:
Corresponding author:
Unsa Saleem
Liquat university of medical and health sciences, Jamshoro
Email: unasasaleem11@gmail.com

ISSN: 1813-1948 (Print), 1813-1956 (Online)

Despite the invasiveness of cerebrospinal fluid (CSF) collection, CSF remains one of the most reliable sources for detecting biomarkers of Alzheimer's disease (AD) due to its proximity to the brain. Key biomarkers include neurofilament light chain (NfL) as a marker for neuronal damage, neuron-specific enolase (NSE), and neurogranin as a marker of synaptic degeneration, TREM-2, GFAP, and YKL-40 as a marker of glial activation and BACE-1 is a progression marker in AD .[5]

Blood biomarkers have become a focal point of research due to their easier collection compared to cerebrospinal fluid (CSF). While blood provides a less invasive and more accessible method for monitoring AD, however, the challenges remain due to the blood-brain barrier (BBB) which restricts the passage of brain-derived proteins into the bloodstream. Core AD biomarkers such as amyloid-β (Aβ) and tau proteins are commonly studied, with neurofilament light chain (NfL) as a reliable marker for monitoring neurodegeneration.

Fluid-based biomarkers include saliva, urine, and tears. Urine biomarkers like 8-OHdG and AD7c-NTP show promise for early detection. Neuroimaging techniques, such as structural MRI, Diffusion Tensor Imaging (DTI), and Proton Magnetic Resonance Spectroscopy (MRS) provide information on brain atrophy and neurodegenerative changes. Functional imaging techniques, including SPECT and PET, offer additional information on cerebral perfusion and metabolic changes ultimately aiding in early diagnosis of Alzheimer's disease[5].

Advancements in blood-based biomarker technology are offering more accessible and non-invasive methods for AD diagnosis. Emerging AI and machine learning techniques are enhancing the accuracy of biomarker analysis. The future holds non-invasive diagnostic tools including wearable sensors which could help in early detection and personalized treatments.

References

1. Uzer, Altaf, Shaikh., Shraddha, Shinde. Alzheimer Disease. World Journal of Biology Pharmacy and Health Sciences, (2024).;18(2):049-057. doi: 10.30574/wjbphs.2024.18.2.0239
2. D, V, Parums. A Review of the Current Status of Disease-Modifying Therapies and Prevention of Alzheimer's Disease.. Medical Science Monitor, (2024).;30:e945091-e945091. doi: 10.12659/msm.945091
3. Rani S, Dhar SB, Khajuria A, Gupta D, Jaiswal PK, Singla N, Kaur M, Singh G, Barnwal RP. Advanced overview of biomarkers and techniques for early diagnosis of alzheimer's disease. Cellular and Molecular Neurobiology. 2023 Aug;43(6):2491-523.
4. Ausó E, Gómez-Vicente V, Esquiva G. Biomarkers for Alzheimer's disease early diagnosis. Journal of Personalized Medicine. 2020 Sep 4;10(3):114.
5. Gunes S, Aizawa Y, Sugashi T, Sugimoto M, Rodrigues PP. Biomarkers for Alzheimer's disease in the current state: a narrative review. International journal of molecular sciences. 2022 Apr 29;23(9):4962.