

**Brain rot and Alzheimer's disease****Othman Ali Othman\*, Shrouk Ahmad Ragab**

Chemistry Department (Biochemistry Division)-Faculty of Science- Minia University-61519 ElMinia –Egypt.

**\*Corresponding Authors: Othman Ali Othman** - Chemistry department (Biochemistry Division), Faculty of Science, Minia University, 61519 El-Minia, Egypt- (Tel: 00201099632168)Email: osman.mouftah@mu.edu.eg-ORCID: <http://orcid.org/0000-0003-4061-6929>**DOI: [10.71428/JHB.2025.0204](https://doi.org/10.71428/JHB.2025.0204)****ABSTRACT**

Alzheimer's disease (AD) is a progressive neurodegenerative disorder and the most common cause of dementia worldwide. It primarily affects older adults, leading to a decline in memory, cognitive function, and the ability to carry out daily tasks. The disease is characterized by the accumulation of beta-amyloid plaques and neurofibrillary tangles in the brain, which contribute to the loss of synapses and neuronal death. Although the exact cause remains unclear, both genetic and environmental factors are believed to play significant roles in its development. Common symptoms include memory impairment, confusion, disorientation, personality changes, and difficulties in language and problem-solving.

Diagnosis typically involves clinical evaluation, cognitive tests, neuroimaging techniques, and sometimes cerebrospinal fluid analysis to detect biomarkers. There is currently no cure for Alzheimer's, but various treatments aim to alleviate symptoms and slow the progression of the disease. These include cholinesterase inhibitors and NMDA receptor antagonists, along with supportive care and lifestyle modifications. Research is ongoing to discover disease-modifying therapies, and recent studies focus on targeting beta-amyloid production and tau protein aggregation.

The impact of AD is not only personal but also societal, placing immense emotional and financial strain on caregivers and healthcare systems. As global life expectancy increases, the prevalence of Alzheimer's disease is expected to rise, making early diagnosis and effective intervention strategies more critical than ever. Public awareness, support services, and continued research efforts are essential to manage and eventually prevent this debilitating condition.

**Keywords:** Alzheimer's disease, Brain rot, NMDA.**INTRODUCTION**

In recent decades, Alzheimer's disease has shifted from being viewed as a rare condition to becoming a major public health concern that significantly affects millions of older individuals and their loved ones. With this shift, scientific interest in Alzheimer's has also grown. What began in the 1970s with only a few dedicated researchers has expanded into a global effort involving thousands of scientists (1).

At the forefront of this research in the United States is the National Institute on Aging (NIA), part of the National Institutes of Health (NIH), which launched its Alzheimer's research program in 1978. Since then, Alzheimer's disease has become one of the NIA's main priorities. Other NIH branches, such as the National Institute of Neurological Disorders and Stroke, the National Institute of Mental Health, and the National Institute of

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Nursing Research, also contribute significantly to understanding and addressing this condition (2).

In addition to government efforts, private organizations like the Alzheimer's Association and various pharmaceutical companies are playing a vital role. They fund research, influence health policies, raise awareness, and offer services to patients and caregivers, helping to drive progress in the field (3). Because of this growing network of collaboration, the pace of Alzheimer's research has accelerated, offering new insights into its causes, progression, and possible treatments. The emotional and psychological toll of the disease is illustrated through personal accounts, like that of Mary, a fictional character from the 36-Hour Day. Her experience reflects the confusion, memory loss, and emotional struggle that many patients face, as well as the pain felt by their families (3).

Alzheimer's is a chronic and irreversible disease of the brain that gradually impairs memory, reasoning, and the ability to perform basic tasks. While age increases the risk, Alzheimer's is not a normal part of aging. In fact, many people live into their 90s with healthy brain function when not affected by disease (4).

### Causes of Alzheimer's Disease

Alzheimer's disease is a complex neurodegenerative disorder influenced by various interconnected factors. The development of the condition is not due to a single cause but rather a combination of genetic, biological, and environmental influences.

#### 1. Genetic Predisposition

Genetics significantly influences the risk of developing Alzheimer's. In rare cases of early-onset Alzheimer's, inherited mutations in specific genes like amyloid precursor protein (APP), presenilin 1 (PSEN1), and presenilin 2 (PSEN2) directly cause the disease. These mutations result in abnormal processing of amyloid-beta, a protein that accumulates in the brain (5). For late-onset Alzheimer's, the presence of the APOE  $\epsilon$ 4 allele

greatly increases susceptibility but is not deterministic. This gene variant influences lipid metabolism and amyloid-beta clearance.

#### 2. Aging

Age is the most prominent risk factor. As people grow older, their cellular repair mechanisms weaken, and toxic proteins like amyloid-beta and tau accumulate more easily in the brain. Additionally, oxidative stress and mitochondrial dysfunction rise with age, which accelerates neurodegeneration (6).

#### 3. Amyloid Plaques

Abnormal buildup of amyloid-beta peptides outside neurons leads to the formation of amyloid plaques, one of the hallmarks of Alzheimer's pathology. These plaques disturb cell-to-cell communication, activate inflammatory pathways, and ultimately lead to neuronal death (7).

#### 4. Neurofibrillary Tangles

Another defining feature of Alzheimer's is the presence of neurofibrillary tangles, which are twisted fibers of tau protein that build up inside brain cells. In Alzheimer's, tau becomes abnormally phosphorylated and forms tangles that disrupt the internal transport system of neurons, leading to cell death (5).

#### 5. Neuroinflammation

Chronic inflammation in the brain contributes heavily to Alzheimer's progression. Microglia, the brain's immune cells, become overactive in response to amyloid plaques, releasing harmful chemicals that damage surrounding neurons. This persistent inflammation worsens cognitive decline (6).

#### 6. Cardiovascular and Lifestyle Factors

Conditions such as high blood pressure, obesity, diabetes, and smoking are strongly linked to an increased Alzheimer's risk. These factors damage blood vessels and impair blood flow to the brain,

which reduces oxygen and nutrient delivery to brain cells. Physical inactivity and poor diet further elevate this risk (7).

## 7. Head Trauma

Experiencing traumatic brain injuries (TBIs), particularly repeated or severe ones, can increase the likelihood of Alzheimer's. Head injuries may trigger abnormal protein accumulation and chronic inflammation, setting the stage for neurodegeneration later in life (5).

## 8. Cognitive Reserve and Education

Lower educational attainment and reduced lifelong mental stimulation are associated with a higher chance of developing Alzheimer's. Individuals with greater cognitive reserve—built through education and engaging mental activities may delay the onset of symptoms by compensating for brain changes (6).

## Symptoms of Alzheimer's Disease

Alzheimer's disease often develops gradually, and its symptoms worsen over time. One of the earliest signs is difficulty recalling newly learned information, which is due to the initial damage in brain areas responsible for memory. As the condition progresses, individuals may find it challenging to plan tasks, solve problems, or follow familiar procedures, such as cooking a known recipe. They may also struggle with language, having trouble finding the right words or following conversations.

Disorientation is another common feature. People with Alzheimer's might get lost in familiar places or forget the date or season. In addition, judgment becomes impaired, leading to poor decision-making or inappropriate behavior. Changes in mood and personality are also frequently observed; a person may become confused, suspicious, depressed, or easily upset, especially when out of their comfort zone. As the disease advances, individuals often experience severe memory loss, lose the ability to

communicate, and eventually require full-time care (8).

## Diagnosis of Alzheimer's disease

Diagnosing AD requires a thorough approach, including reviewing the patient's medical background, conducting mental ability tests, performing brain scans, and running lab analyses to eliminate other possible illnesses.

### 1. Reviewing Medical History and Symptoms:

Physicians examine the patient's health records, focusing on any family history of dementia and observing signs like forgetfulness, confusion, or personality changes.

### 2. Mental and Cognitive Evaluations:

Tests such as the Mini-Mental State Examination (MMSE) or Montreal Cognitive Assessment (MoCA) measure thinking skills, including recall, focus, speech, and reasoning. These assessments help gauge how far the disease has advanced.

### 3. Neurological Check-Up:

A physical exam assesses brain and nerve function, distinguishing AD from other conditions like Parkinson's or stroke.

### 4. Brain Scans:

MRI scans show shrinkage in brain areas like the hippocampus, linked to memory problems. PET scans identify amyloid and tau protein buildup, hallmarks of AD. CT scans help detect other brain issues that could cause similar symptoms.

### 5. Lab Work:

Blood tests check for deficiencies or infections that might resemble dementia. Spinal fluid tests can reveal abnormal protein levels tied to AD.

### 6. New Diagnostic Advances:

Researchers are working on blood-based biomarkers to detect Alzheimer's earlier and more precisely. Since no single exam can confirm Alzheimer's, doctors rely on multiple tests to make

an accurate diagnosis while ruling out other cognitive disorders (9).

### Treatment of Alzheimer's Disease

Although no cure exists, various treatments help manage symptoms, delay progression, and enhance life quality.

#### 1. Drug-Based Treatments

**Cholinesterase Inhibitors:** Medications such as donepezil, rivastigmine, and galantamine boost acetylcholine, a chemical essential for nerve cell communication, offering temporary cognitive improvement.

**NMDA Antagonists:** Memantine controls glutamate to prevent nerve damage, primarily used in later AD stages.

**Dual Therapy:** Combining cholinesterase inhibitors with memantine may provide better results for some individuals.

#### 2. Experimental Treatments

**Antibody Therapies:** Aducanumab and lecanemab attack amyloid plaques, possibly slowing early AD, but further research is needed.

**Tau-Based Drugs:** Scientists are exploring treatments to disrupt harmful tau protein accumulations.

#### 3. Non-Drug Strategies

**Mental Exercises:** Engaging in brain-stimulating activities like games and social interactions supports cognitive health.

**Healthy Habits:** Balanced nutrition, physical activity, and good sleep patterns may lower AD risk.

**Caregiver Support:** Psychological and practical assistance helps patients and families cope with daily difficulties.

Present therapies alleviate symptoms but do not cure AD. Future studies aim to develop interventions that can stop or prevent the disease (9).

### Prevention of Alzheimer's Disease

Although no cure exists, evidence indicates that specific lifestyle changes can help prevent or slow its progression. Effective preventive measures include: **Balanced Nutrition:** Diets such as the Mediterranean or MIND diet, which emphasize fruits, vegetables, whole grains, and healthy fats, may protect against AD by combating oxidative damage and inflammation. Foods high in antioxidants and omega-3s are particularly beneficial.

**Physical Activity:** Regular aerobic workouts improve cerebral circulation, encourage the growth of new neurons, and may prevent amyloid deposits linked to AD.

**Mental Engagement:** Activities like reading, solving puzzles, and continuous learning enhance brain plasticity, helping to delay cognitive deterioration.

**Adequate Sleep:** Proper sleep hygiene supports the removal of harmful brain toxins, whereas sleep disorders like apnea may increase amyloid buildup. **Social Interaction:** Staying socially active reduces loneliness and stress, both of which negatively impact brain health.

**Managing Health Conditions:** Controlling blood pressure, diabetes, and obesity minimizes vascular damage that could contribute to dementia.

**Avoiding Harmful Habits:** Smoking cessation and moderate alcohol consumption prevent additional brain damage.

**Stress Reduction:** Practices such as meditation and therapy help lower cortisol levels, protecting brain cells.

**Routine Medical Screenings:** Regular monitoring of vital health markers (cholesterol, vitamins) allows for early detection and management of potential risks.

While genetic predisposition influences AD, proactive lifestyle adjustments can substantially reduce controllable risk factors (9).

## BRAIN ROT

### Other Conditions of Brain Damage

Alzheimer's disease is not the only condition that negatively affects brain health. There are several other factors that can also lead to the deterioration and death of nerve cells. Collectively, these factors are often referred to by the informal term "brain rot" which describes the progressive damage to brain tissue resulting from various causes.

The term "brain rot" is not a medically recognized diagnosis but is often used informally to describe the progressive deterioration of brain function due to various causes. It can refer to neurodegenerative conditions such as Alzheimer's and other dementias, or to damage caused by infections, toxins, or prolonged substance abuse (10). In recent years, the phrase has also emerged in popular culture and social media to describe cognitive decline related to excessive digital media consumption, although this usage lacks scientific validation (11). From a medical standpoint, the concept of "brain rot" can be linked to structural and functional damage in brain tissue, often involving neuronal loss, inflammation, and biochemical changes that impair cognitive and motor functions (12). Understanding the biological mechanisms behind such brain degeneration is essential for developing effective prevention and treatment strategies.

### Neurodegenerative Causes

Degenerative causes of brain damage refer to a group of progressive conditions that result in the gradual loss of neurons and deterioration of brain function. These disorders are typically chronic and worsen over time, ultimately affecting cognition, movement, and behavior. One of the most common degenerative diseases is Alzheimer's disease, which primarily impairs memory and other cognitive functions due to the buildup of beta-amyloid plaques and tau tangles in the brain. Parkinson's disease is another example, where there is degeneration of dopamine-producing neurons in the

substantia nigra, leading to tremors, muscle rigidity, and impaired movement. Similarly, Huntington's disease is a hereditary condition that leads to the breakdown of nerve cells in the brain, causing motor dysfunction, psychiatric issues, and cognitive decline. These neurodegenerative conditions are usually irreversible and are influenced by a mix of genetic, environmental, and age-related factors. Early diagnosis and intervention may help manage symptoms, but currently, there are no cures for these diseases (13).

### Infectious Causes Affecting the Brain

Infections can affect the brain when pathogens enter through the bloodstream, spread from nearby infected areas, or travel along nerves. A variety of microorganisms—such as bacteria, viruses, fungi, and parasites—are responsible for these infections. Conditions like encephalitis, meningitis, brain abscesses, and parasitic diseases, including toxoplasmosis and neurocysticercosis, are typical examples. Viruses like herpes simplex and West Nile can cause inflammation in the brain, leading to symptoms like fever, confusion, seizures, and neurological impairments. Bacterial meningitis, on the other hand, often causes intense headache, stiffness in the neck, and decreased consciousness, and can be fatal if not promptly treated. Fungal and parasitic infections are particularly severe in individuals with weakened immune systems. Timely medical intervention is essential to reduce the risk of long-term brain damage (14).

### Toxic and Drug-Related Brain Damage

Brain damage resulting from exposure to toxic substances or drugs occurs when certain chemicals harm brain cells and disrupt neural function. Examples include alcohol, stimulants like cocaine and methamphetamine, opioids, and even some legally prescribed drugs. These agents may damage neurons by increasing oxidative stress, altering neurotransmission, or promoting inflammation within brain tissues. Prolonged use can lead to physical brain changes, including volume loss,



deterioration of white matter, and breakdown in communication pathways between regions of the brain. These changes can cause problems with thinking, memory, behavior, emotions, and motor skills. The possibility of recovery depends largely on how long and how intensely the brain was exposed to the damaging substance (15).

## **Prevention and Management of “Brain Rot”**

### **1. Lifestyle Modifications**

Engaging in regular physical activity plays a vital role in maintaining brain health. Exercise improves cerebral blood flow, reduces inflammation, and stimulates the release of neuroprotective chemicals, which help to preserve cognitive functions (16).

A nutrient-rich diet, particularly the Mediterranean or DASH diet, has been associated with lower risks of neurodegenerative diseases. These diets emphasize fruits, vegetables, whole grains, lean proteins, and healthy fats, which combat oxidative stress and support neuron health (17).

Furthermore, maintaining mental and social engagement helps build cognitive reserve, making the brain more resilient to the effects of degeneration. Activities such as learning new skills, playing strategic games, and engaging in meaningful social interactions are beneficial for long-term brain function (17).

### **2. Risk Factor Management**

Control of cardiovascular risk factors—such as hypertension, diabetes, obesity, and smoking—is essential. These conditions can damage blood vessels, impair blood flow to the brain, and accelerate neuronal damage. Regular health check-ups and adherence to treatment plans are key to minimizing these risks.

### **3. Medical Management and Early Detection**

There is currently no cure for brain rot or Alzheimer’s disease, but pharmacological treatments can help manage symptoms and slow progression. Drugs like cholinesterase inhibitors (e.g., donepezil) and NMDA receptor antagonists

(e.g., memantine) are commonly prescribed to enhance communication between nerve cells and delay decline.

Early diagnosis through cognitive screening, brain imaging, and genetic tests can improve management outcomes by allowing the timely implementation of both medical and lifestyle interventions.

### **4. Preventive Public Health Measures**

Promoting public awareness about dementia, encouraging early screening, and providing community support programs can significantly reduce the burden of brain rot. These measures help in reducing stigma, encouraging timely help-seeking behavior, and supporting caregivers (17).

## **CONCLUSION**

In conclusion, Alzheimer’s disease remains one of the most complex and devastating neurodegenerative disorders, primarily affecting memory, thinking skills, and behavior. Although its exact cause is still under investigation, numerous contributing factors have been identified, including genetic predispositions, abnormal protein accumulations, aging, and lifestyle-related influences. As the disease progresses, it gradually deteriorates brain cells, leading to severe cognitive decline and emotional disconnection.

Furthermore, this deterioration of the brain, often referred to as brain rot, may stem from various causes beyond Alzheimer’s. These include chronic infections, repeated exposure to environmental toxins, traumatic brain injuries, and poor vascular health. All of these can contribute to the decay of brain tissue and lead to irreversible damage over time. Understanding both Alzheimer’s and the broader category of brain degeneration is essential not only for advancing scientific research but also for promoting early intervention, prevention strategies, and improved care for those affected. Continued research in this field is vital to unravel the underlying mechanisms of these conditions and to develop effective therapeutic approaches (18).

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## REFERENCES

1. Alzheimer's Association. (2023). 2023 Alzheimer's disease facts and figures.
2. Cummings, J., et al. (2019). "Alzheimer's disease drug development pipeline: 2019." *Alzheimer's & Dementia: Translational Research & Clinical Interventions*, 5, 272-293.
3. World Health Organization (WHO). (2021). Dementia fact sheet.
4. National Institute on Aging. (2011). *Alzheimer's Disease: Unraveling the Mystery*. U.S. Department of Health and Human Services, National Institutes of Health.
5. Scheltens, P., Blennow, K., Breteler, M. M., de Strooper, Frisoni, G. B., Salloway, S., & Van der Flier, W. M. (2016). Alzheimer's disease. *The Lancet*, 388 (10043), 505-517. [https://doi.org/10.1016/S0140-6736\(15\)01124-1](https://doi.org/10.1016/S0140-6736(15)01124-1).
6. Lane, C. A., Hardy, J., & Schott, J. M. (2018). Alzheimer's disease. *European Journal of Neurology*, 25(1), 59-70. <https://doi.org/10.1111/ene.13439>.
7. Masters, C. L., Bateman, R., Blennow, K., Rowe, C. C., Sperling, R. A., & Cummings, J. L. (2015). Alzheimer's disease. *Nature Reviews Disease Primers*, 1, 15056. <https://doi.org/10.1038/nrdp.2015.56>.
8. Alzheimer's Association. (2024). 2024 Alzheimer's disease facts and figures. *Alzheimer's & Dementia*, 20(3), 325-420. <https://doi.org/10.1002/alz.13491>.
9. Alzheimer's Association. (2023). Retrieved from [www.alz.org] (<https://www.alz.org>).
10. Hardy, J., & Selkoe, D. J. (2002). The amyloid hypothesis of Alzheimer's disease: progress and problems on the road to therapeutics. *Science*, 297(5580), 353-356.
11. Montag, C., & Walla, P. (2016). Carpe diem instead of losing your social mind: Beyond digital addiction and digital detox. *Addictive Behaviors Reports*, 4, 14-17.
12. Perry, V. H., Cunningham, C., & Holmes, C. (2007). Systemic infections and inflammation affect chronic neurodegeneration. *Nature Reviews Immunology*, 7(2), 161-167.
13. Hodges, J. R. (2012). *Neurodegenerative Disorders*. Springer Science & Business Media.
14. Ropper, A. H., & Samuels, M. A. (2009). *Adams and Victor's Principles of Neurology* (9th ed.). McGraw-Hill Medical.
15. Squire, L. R., Berg, D., Bloom, F. E., du Lac, S., Ghosh, A., & Spitzer, N. C. (2012). *Fundamental Neuroscience* (4th ed.). Academic Press.
16. Alzheimer's Association. (2023). 2023 Alzheimer's Disease Facts and Figures. Retrieved from <https://www.alz.org/media/documents/alzheimers-facts-and-figures.pdf>.
17. Livingston, G., et al. (2020). Dementia prevention, intervention, and care: 2020 report of the Lancet Commission. *The Lancet*, 396(10248), 413-446. [https://doi.org/10.1016/S0140-6736\(20\)30367-6](https://doi.org/10.1016/S0140-6736(20)30367-6).
18. Smith, J. (2021). *Understanding neurodegeneration: Causes, impact, and potential therapies*. Oxford University Press.