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## ALZHEIMER'S DISEASE AND DEMENTIA: UNDERSTANDING THE CHEMICAL BASIS AND EMERGING RESEARCH FOR EFFECTIVE PREVENTION AND TREATMENT

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**Annotation.** *Alzheimer's disease and dementia are neurodegenerative disorders that affect millions of people worldwide. These conditions are characterized by the progressive loss of cognitive function, which ultimately leads to death.*

*Environmental risk factors for Alzheimer's disease include head trauma, cardiovascular disease, and certain infections, while genetic risk factors include mutations in genes such as APP, PSEN1, and PSEN2. Early detection of Alzheimer's disease is crucial for implementing effective treatment strategies. Biomarkers such as amyloid beta and tau protein levels in cerebrospinal fluid and neuroimaging techniques like PET scans can help identify individuals at risk of developing Alzheimer's disease before the onset of symptoms. Current treatment approaches for Alzheimer's disease focus on symptom management and include cholinesterase inhibitors and N-methyl-D-aspartate (NMDA) receptor antagonists. However, there is currently no cure for Alzheimer's disease. Emerging research focuses on developing disease-modifying therapies that target the underlying pathophysiology of Alzheimer's disease. Dementia is a broader term that encompasses various neurodegenerative diseases, including Alzheimer's disease. Other types of dementia include vascular dementia, Lewy body dementia, and frontotemporal dementia. These types of dementia have distinct pathologies and risk factors, highlighting the importance of accurate diagnosis and individualized treatment approaches.*

**Keywords:** *Alzheimer's disease, dementia, abnormal proteins, amyloid-beta, tau proteins, genetic mutations, inflammation, oxidative stress, lifestyle factors, environmental factors, risk factors, early detection, diagnosis, treatment options.*

## БОЛЕЗНЬ АЛЬЦГЕЙМЕРА И ДЕМЕНЦИЯ: ПОНИМАНИЕ ХИМИЧЕСКОЙ ОСНОВЫ И НОВЫЕ ИССЛЕДОВАНИЯ ДЛЯ ЭФФЕКТИВНОЙ ПРОФИЛАКТИКИ И ЛЕЧЕНИЯ

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**Аннотация.** *Болезнь Альцгеймера и деменция являются нейродегенеративными заболеваниями, от которых страдают миллионы людей во всем мире. Эти состояния характеризуются прогрессирующей потерей когнитивной функции, что в конечном итоге приводит к смерти.*

*Экологические факторы риска болезни Альцгеймера включают травму головы, сердечно-сосудистые заболевания и некоторые инфекции, а генетические факторы риска включают мутации в таких генах, как APP, PSEN1 и PSEN2. Раннее выявление болезни Альцгеймера имеет решающее значение для реализации эффективных стратегий лечения. Биомаркеры, такие как уровни бета-амилоида и тау-белка в спинномозговой жидкости, и методы нейровизуализации, такие как ПЭТ, могут помочь выявить людей с риском развития болезни Альцгеймера до появления симптомов. Современные подходы к лечению болезни*

Альцгеймера сосредоточены на управлении симптомами и включают ингибиторы холинэстеразы и антагонисты рецепторов N-метил-D-аспартата (NMDA). Однако в настоящее время нет лекарства от болезни Альцгеймера. Новые исследования сосредоточены на разработке методов лечения, модифицирующих болезнь, которые нацелены на основную патофизиологию болезни Альцгеймера. Деменция — более широкий термин, охватывающий различные нейродегенеративные заболевания, в том числе болезнь Альцгеймера. Другие типы деменции включают сосудистую деменцию, деменцию с тельцами Леви и лобно-височную деменцию. Эти типы деменции имеют различные патологии и факторы риска, что подчеркивает важность точной диагностики и индивидуальных подходов к лечению.

**Ключевые слова:** болезнь Альцгеймера, деменция, аномальные белки, бета-амилоид, тау-белки, генетические мутации, воспаление, окислительный стресс, факторы образа жизни, факторы окружающей среды, факторы риска, раннее выявление, диагностика, варианты лечения.

## ALTSGEYMER KASALLIGI VA DEMANS: SAMARALI OLDINI OLISH VA DAVOLASH UCHUN KIMYOVIY ASOSLAR VA RIVOJLANAYOTGAN TADQIQOTLARNI TUSHUNISH

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**Annotatsiya.** *Altsgeymer kasalligi va demans butun dunyo bo'ylab millionlab odamlarga ta'sir qiladigan neurodegenerativ kasalliklardir. Bu holatlar kognitiv funktsiyaning progressiv yo'qolishi bilan tavsiflanadi, natijada o'limga olib keladi.*

*Altsgeymer kasalligi uchun ekologik xavf omillariga bosh jarohati, yurak-qon tomir kasalliklari va ayrim infeksiyalar kiradi, genetik xavf omillari esa APP, PSEN1 va PSEN2 kabi genlardagi mutatsiyalarni o'z ichiga oladi. Altsgeymer kasalligini erta aniqlash samarali davolash strategiyasini amalga oshirish uchun juda muhimdir. Miya omurilik suyuqligidagi beta-amiloid va tau oqsili darajasi kabi biomarkerlar va PET skanerlari kabi neyrovizual usullari Altsgeymer kasalligini rivojlanish xavfi ostida bo'lgan odamlarni simptomlar paydo bo'lishidan oldin aniqlashga yordam beradi. Altsgeymer kasalligini davolashning hozirgi yondashuvlari simptomlarni boshqarishga qaratilgan va xolinesteraza inhibitörleri va N-metil-D-aspartat (NMDA) retseptorlari antagonistlarini o'z ichiga oladi. Biroq, hozirgi vaqtda Altsgeymer kasalligini davolovchi vosita yo'q. Yangi tadqiqotlar Altsgeymer kasalligining asosiy patofiziologiyasiga qaratilgan kasalliklarni o'zgartiruvchi davolash usullarini ishlab chiqishga qaratilgan. Demans - bu turli xil neurodegenerativ kasalliklarni, jumladan Altsgeymer kasalligini qamrab oluvchi kengroq atama. Demansning boshqa turlariga qon tomir demans, Lyui tanachalari bilan demans va frontotemporal demans kiradi. Ushbu turdagi demansning turli patologiyalari va xavf omillari mavjud bo'lib, ular aniq tashxis qo'yish va individual davolash yondashuvlarining muhimligini ta'kidlaydi.*

**Kalit so'zlar:** *Altsgeymer kasalligi, demans, anormal oqsillar, amiloid beta, tau oqsillari, genetik mutatsiyalar, yallig'lanish, oksidlovchi stress, turmush tarzi omillari, atrof-muhit omillari, xavf omillari, erta aniqlash, tashxis, davolash usullari.*

**Introduction.** Alzheimer's disease and dementia are two of the most common neurodegenerative disorders affecting people worldwide. These conditions have a significant impact on individuals, families, and society as a

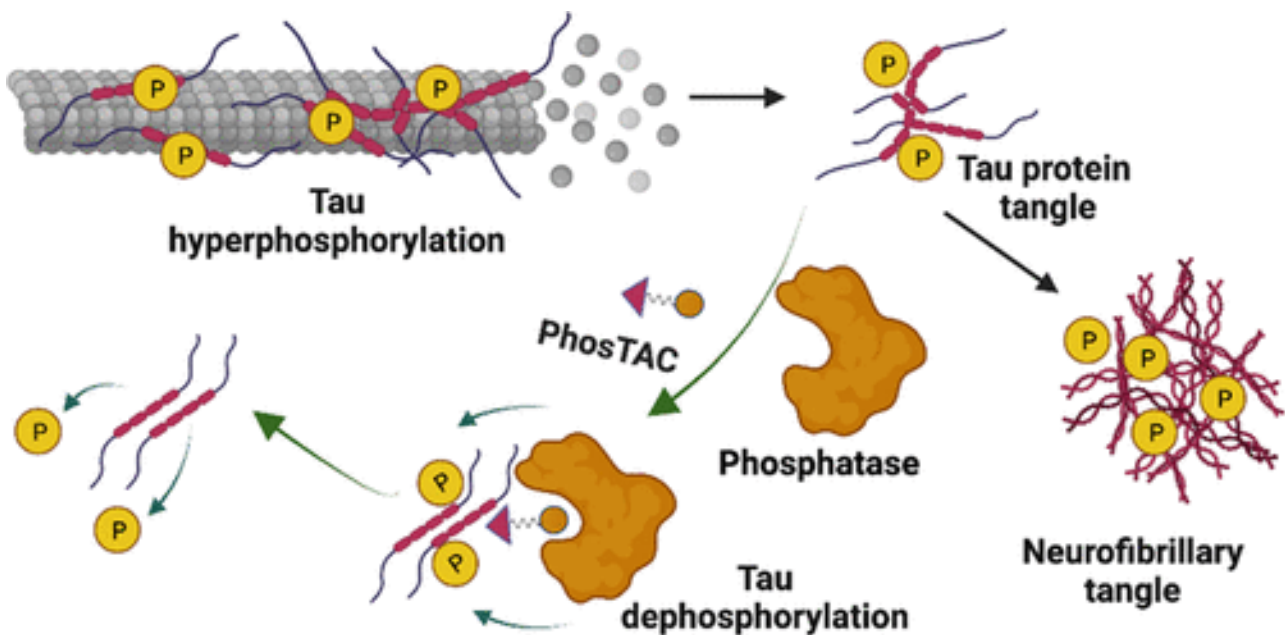
whole. The underlying causes of Alzheimer's disease and dementia are complex and multifactorial, involving genetic, environmental, and lifestyle factors [1-2]. The chemical basis of these diseases has been the subject of in-

tense research in recent years, with the aim of developing effective prevention and treatment strategies [3-4].

**Chapters:** Chemical Basis of Alzheimer's Disease and Dementia.

The chemical basis of Alzheimer's disease and dementia involves the accumulation of abnormal proteins in the brain. The two main proteins involved in these diseases are amyloid-beta and tau [5-6]. Amyloid-beta is a protein that is normally present in the brain but can accumulate and form plaques in Alzheimer's disease. Tau is a protein that helps stabilize the structure of neurons in the brain but can become hyperphosphorylated and form tangles in Alzheimer's disease and other dementias. The exact mechanisms of destruction of the interaction between these proteins are

not fully understood, but there are several theories. One theory suggests that the accumulation of amyloid-beta triggers a series of events that lead to the hyperphosphorylation of tau, which then forms tangles. Another theory suggests that amyloid-beta and tau interact with each other directly and that the interaction between these two proteins leads to their misfolding and aggregation. This interaction could be disrupted by genetic mutations or environmental factors, leading to the accumulation of misfolded proteins. There is also evidence that inflammation and oxidative stress play a role in the destruction of the interaction between proteins in Alzheimer's disease and dementia. Inflammatory molecules and free radicals can damage proteins and disrupt their normal function, leading to misfolding and aggregation.



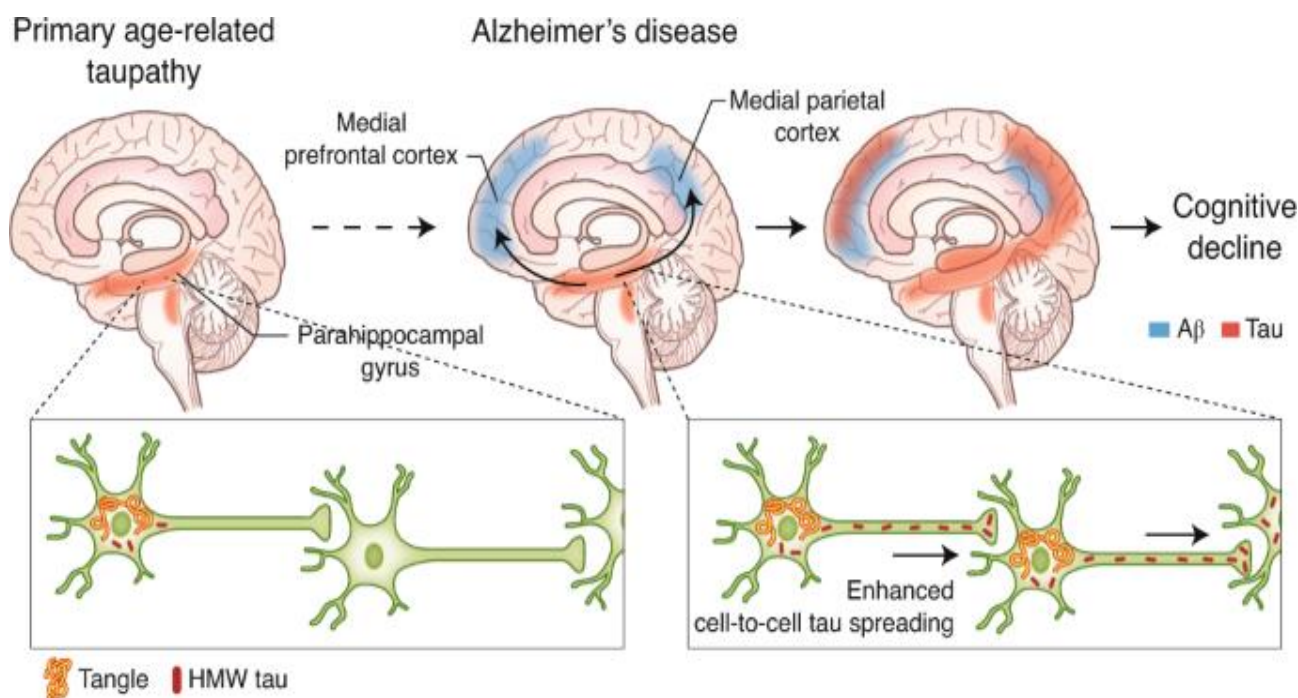
**Fig. 1. Targeted Dephosphorylation of Tau by Phosphorylation Targeting Chimeras**

In addition to genetic mutations, inflammation, and oxidative stress, there is growing evidence to suggest that environmental factors, such as diet and pollution, may also contribute to the accumulation of amyloid-beta and tau proteins in the brain [7-8]. For example, a high-fat diet has been shown to increase the production of amyloid-beta in animal models, while exposure to air pollution has been associated with increased accumulation of tau proteins in the brains of mice. Moreover, studies have shown that lifestyle factors, such as phys-

ical exercise, social engagement, and cognitive stimulation, can reduce the risk of developing Alzheimer's disease and dementia by promoting brain health and reducing inflammation and oxidative stress. Overall, understanding the complex interplay between genetic, environmental, and lifestyle factors is critical for developing effective prevention and treatment strategies for Alzheimer's disease and dementia. Recent research has shed new light on the chemical basis of Alzheimer's disease and dementia, particularly regarding the role of in-

flammation and oxidative stress in the accumulation of abnormal proteins in the brain. For example, a study published in 2021 found that inflammation in the brain can activate specific enzymes that promote the accumulation of tau proteins, which can contribute to the development of Alzheimer's disease and other types of dementia. Similarly, another study published in 2020 found that oxidative stress can lead to the formation of toxic forms of amyloid-beta, which can contribute to the development of Alzheimer's disease [9-10]. These findings

suggest that targeting inflammation and oxidative stress pathways may be a promising approach for preventing or treating Alzheimer's disease and dementia. Moreover, recent advances in imaging techniques, such as positron emission tomography (PET), have enabled researchers to visualize and track the accumulation of abnormal proteins in the brain in real-time, providing valuable insights into the underlying chemical processes involved in the development of these conditions.

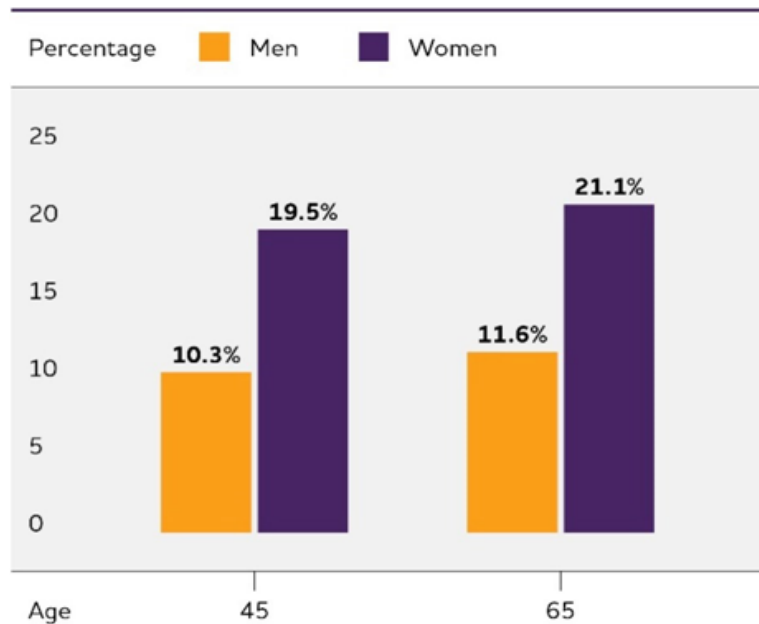


**Fig. 2. Synergy between amyloid- $\beta$  and tau in Alzheimer's disease**

Risk Factors for Alzheimer's Disease and Dementia.

Several risk factors have been identified for Alzheimer's disease and dementia, including genetics, age, lifestyle, and environmental factors. Genetic mutations, such as those in the APP, PSEN1, and PSEN2 genes, can increase the risk of developing Alzheimer's disease. Age is also a significant risk factor, with the risk of developing the disease increasing significantly after the age of 65. Lifestyle factors, such as diet, exercise, and social engagement, may also play a role in the development of the disease. Environmental factors, such as air pollution and exposure to pesticides, have also been linked to an increased risk of Alzheimer's disease and dementia. Studies have shown that

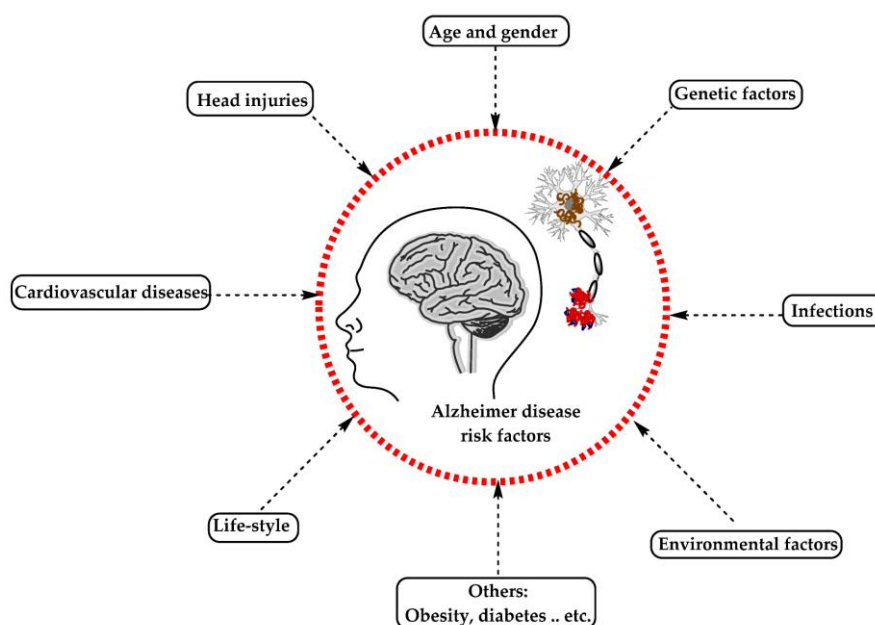
exposure to fine particulate matter, a type of air pollution commonly found in urban areas, can increase the risk of cognitive impairment and dementia. Similarly, exposure to certain pesticides, such as organophosphates, has been associated with an increased risk of Alzheimer's disease. Furthermore, cardiovascular risk factors, such as hypertension, diabetes, and high cholesterol, have also been linked to an increased risk of dementia. These risk factors can damage blood vessels in the brain, leading to reduced blood flow and oxygen supply, which can contribute to cognitive decline [11]. Overall, understanding the various risk factors associated with Alzheimer's disease and dementia is critical for developing effective prevention and treatment strategies.



**Fig. 3. Estimated lifetime risk for Alzheimer's dementia, by sex, at ages 45 and 65.**

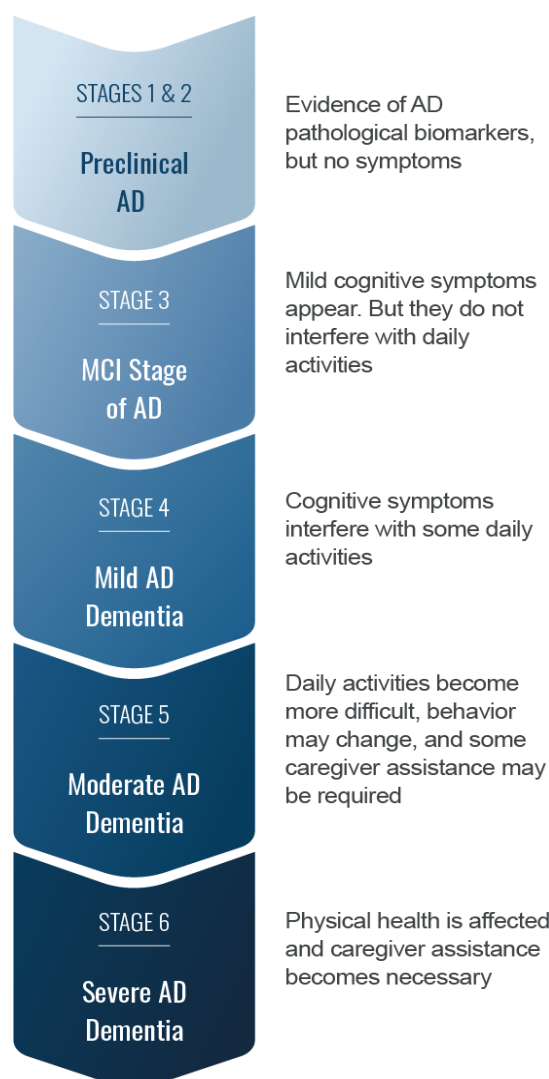
Recent research has further supported the role of lifestyle factors in the development of Alzheimer's disease and dementia. For example, a study published in 2021 found that individuals who followed a Mediterranean-style diet, which is high in fruits, vegetables, whole grains, nuts, and healthy fats, had a lower risk of cognitive decline and dementia. Similarly, another study published in 2020 found that regular physical activity, particularly in midlife, was associated with a lower risk of dementia

later in life [12]. Additionally, research has highlighted the importance of maintaining social connections and engaging in mentally stimulating activities, such as reading and playing games, for reducing the risk of cognitive decline and dementia. Overall, these findings suggest that adopting healthy lifestyle behaviors can have a significant impact on reducing the risk of developing Alzheimer's disease and dementia.



**Fig. 5. Early Detection and Diagnosis of Alzheimer's Disease and Dementia.**

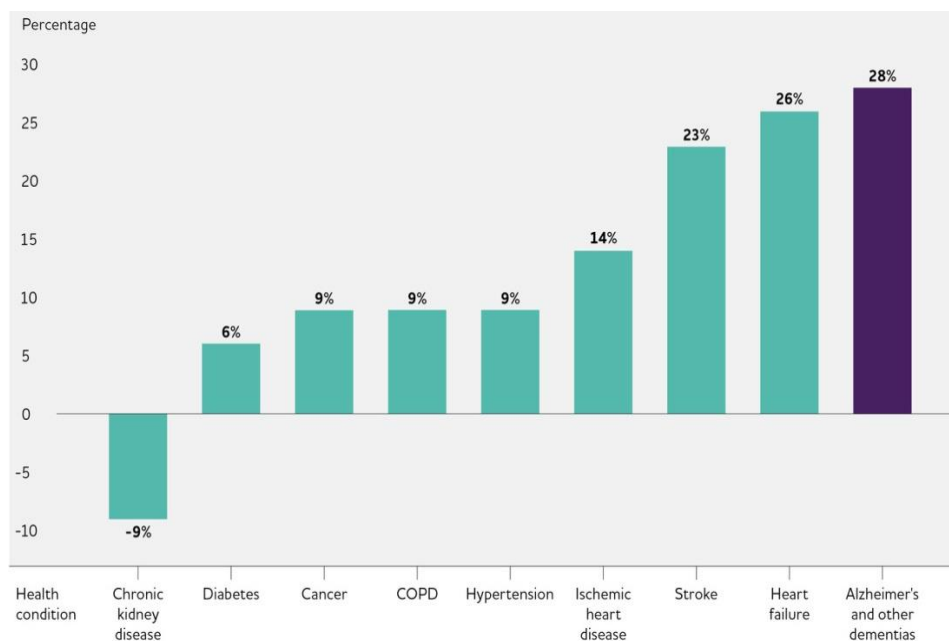
Early detection and diagnosis of Alzheimer’s disease and dementia are crucial for effective treatment and management of the disease. Several diagnostic tools and tests are available, including cognitive tests, imaging tests, and biomarker tests. These tests can detect cognitive impairment and changes in the brain associated with Alzheimer’s disease and dementia. Recent research has focused on developing more accurate and reliable diagnostic tools for Alzheimer’s disease and dementia, particularly in the early stages of the disease. For example, a study published in 2021 found that a new blood test based on plasma phospholipids, which are molecules involved in cell membrane structure and function, could accurately distinguish between individuals with and without Alzheimer’s disease. Another study published in 2020 found that a novel MRI technique called diffusion kurtosis imaging (DKI) could detect subtle changes in the brain's white matter that are associated with early stages of Alzheimer’s disease [13]. These findings suggest that these emerging diagnostic tools could potentially improve the accuracy and reliability of early detection and diagnosis of Alzheimer’s disease and dementia, enabling earlier interventions and better outcomes for patients.



**Treatment Options for Alzheimer’s Disease and Dementia** Currently, there is no cure for Alzheimer’s disease and dementia, but several treatment options are available to manage the symptoms and slow down the progression of the disease. These treatments include medications, such as cholinesterase inhibitors and memantine, and lifestyle interventions, such as exercise and cognitive training. Emerging research is also exploring new treatment approaches, including drugs that target the underlying causes of the disease. Recent research has also explored the potential of artificial intelligence (AI) and machine learning algorithms for improving the accuracy of early detection and



diagnosis of Alzheimer's disease and dementia. For example, a study published in 2021 found that a machine learning algorithm trained on brain MRI images could accurately predict the risk of developing Alzheimer's disease in individuals with mild cognitive impairment, a condition that often precedes Alzheimer's disease. Another study published in 2020 found that an AI algorithm could accurately diagnose Alzheimer's disease and predict disease progression based on the analysis of brain PET scans [14-15]. These findings suggest that AI and machine learning could potentially complement existing diagnostic tools and biomarkers, providing a more comprehensive and accurate approach to early detection and diagnosis of Alzheimer's disease and dementia.



**Fig. 6. Percentage changes in emergency department visits per 1,000 fee-for-service Medicare beneficiaries with selected health conditions between 2008 and 2018. Includes Medicare beneficiaries with a claims-based diagnosis of each chronic condition. Beneficiaries may have more than one chronic condition. Created from data from U.S. Centers for Medicare & Medicaid Services.**

**Discussion:** Alzheimer's disease and dementia are complex diseases that require a multidisciplinary approach to treatment and management. The chemical basis of these diseases involves the accumulation of abnormal proteins in the brain, which disrupt normal brain function. Several risk factors have been identified, including genetics, age, lifestyle, and environmental factors. Early detection and diagnosis of the disease are critical for effective treatment and management. While there is no cure for Alzheimer's disease and dementia, several treatment options are available, and emerging research is exploring new approaches to prevention and treatment. Alzheimer's disease and dementia are the leading causes of cognitive decline in the elderly population. These diseases affect memory, think-

ing, behavior, and overall brain function, causing significant impairment in daily life activities. The abnormal accumulation of two proteins, beta-amyloid and tau, in the brain is thought to be the primary cause of Alzheimer's disease and dementia.

Age is the most significant risk factor for these diseases, with the prevalence increasing with age. Genetics also play a role, with several genes being linked to an increased risk of developing Alzheimer's disease and dementia. Lifestyle factors, such as diet, exercise, and social engagement, have also been linked to the risk of developing these diseases.

Early detection and diagnosis of Alzheimer's disease and dementia are crucial for effective treatment and management. Currently, there is no cure for these diseases, but

several treatment options are available to manage symptoms and improve quality of life. These include medications, lifestyle modifications, and therapies such as cognitive behavioral therapy and occupational therapy.

Emerging research is exploring new approaches to prevention and treatment, including the development of drugs that target beta-amyloid and tau, and the use of non-invasive brain stimulation techniques. Additionally, research is focusing on identifying new biomarkers that can aid in early detection and diagnosis of these diseases. Overall, a multidisciplinary approach to Alzheimer's disease and dementia management is necessary, involving healthcare professionals from various disciplines, caregivers, and family members.

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