Dean&Francis
ISSN 2959-409X

Epidemiological Patterns and Risk Determinants of Neurodegenerative Diseases in the Context of Global Population Aging

Zefei Mu[1, *]

[1]King's College School, Soto de Viñuelas, Madrid, 28760, Spain
*Corresponding author: zefei.mu@gmail.com

Abstract:

With the acceleration of global population ageing, neurodegenerative diseases (NDDs) have emerged as a major challenge threatening the health of the elderly and societal development. This paper reviews the epidemiological characteristics and risk factors of major NDDs such as Alzheimer's disease and Parkinson's disease, focusing on their variations across different regions, age groups, genders, socioeconomic statuses, and the combined effects from lifestyle, psychosocial and environmental factors. Research indicates that the prevalence of NDDs increases significantly with age. Women are more susceptible to Alzheimer's disease, while men face a higher risk of Parkinson's disease. Individuals from lower socioeconomic backgrounds experience markedly elevated incidence rates due to constrained access to healthcare and poorer living conditions. NDDs not only cause cognitive and motor impairments but also impose substantial economic and social burdens. We have also explored the basic mechanisms of different risk factors that increase the risk of NDDs, including physical exercise, alcohol consumption, sleep disturbances, depression and stress, social engagement and overall environmental factors. Understanding the epidemiological patterns and risk factors facilitates the development of targeted public health policies and interventions to mitigate the future disease burden. This study not only provides data support for epidemiological research but also offers reference for global health governance and the optimisation of healthcare resource allocation.

Keywords: Neurodegenerative diseases; Population ageing; Epidemiology; Risk factors.

ISSN 2959-409X

1. Introduction

Due to rapid advances in medical science, public health and socioeconomic development, global population aging and increase in life expectancy have become two of the most significant social changes in the twenty-first century [1]. According to the 2024 World Health Organization (WHO) report, the pace of population aging worldwide is much faster than in the past, and the number and proportion of elderly people are rising rapidly. From 2015 to 2050, the proportion of the world's population over 60 years old will nearly double from 12% to 22% [2]. In 2019 the number of people aged 60 years and older was 1 billion. This number will increase to 1.4 billion by 2030 and 2.1 billion by 2050 [3]. Although the rapid development of medical care has led to a continuous increase in human lifespan and life expectancy worldwide, this improvement has not been matched with a corresponding extension of the healthspan. The difference between lifespan and healthspan means there are large numbers of older people who are living with age-related diseases for long periods, which has a substantial impact on quality of life, mortality, healthcare costs, the burden on the health system and the economy. Especially for those neurodegenerative diseases (NDDs), one of the greatest concerns for both clinical medicine and public health, including Alzheimer's disease (AD), Parkinson's disease (PD), Huntington's disease (HD), and others.

Neurodegenerative diseases are chronic, progressive disorders characterized by irreversible neuronal dysfunction and loss, which significantly affect the quality of life in the elderly population, which have a pronounced impact on patients' occupational, social and family aspects, and may lead to complete loss of any ability to perform daily activities. For example, patients may experience movement disorders, difficulty in breathing, cognitive problems or gradual memory loss (which may even lose all the memories) [4]. Moreover, NDDs are the main causes of dementia, however currently these diseases affect over 55.2 million people worldwide. According to the "World Alzheimer's Report 2021", this number is expected to reach 78 million by 2030. Among which AD is the most common type of dementia, accounting for 60-80% of cases [5]. AD had also been recorded as the cause of death in 119,339 cases in 2021, ranking as the seventh leading cause of death in the US and fifth leading cause of death among people aged 65 and above [6]. Concurrently, NDDs impose a considerable financial burden on healthcare systems, particularly due to treatment and long-term care costs.These costs include not only direct medical expenses, such as hospitalization, medication, and clinical services, but also indirect expenditures related to informal caregiving, institutionalization, and loss of productivity. Dementia, as a major consequence of these diseases, exemplifies this burden. According to the World Health Organization (2025), Since 2019 dementia has cost the global economy US$1.3 trillion, with approximately 50% of these costs are attributable to care provided by informal caregivers (e.g. family members and friends), who provide an average 5 hours of care and supervision every day [7].

In this context, aging can be conceptualized both as an extraordinary social achievement and can be seen as a profound challenge to the global healthcare systems. Although the extended life expectancy contributes to improved longevity and quality of life. However, the rapidly rising mortality rates of NDDs represents a considerable challenge. This demographic trend requires greater allocation of medical resources and contributes to higher mortality rates and social burdens. In this light, having a comprehensive investigation into the epidemiological patterns and risk factors are of critical importance. This paper therefore aims to provide a conclusive overview of the epidemiological patterns and risk factors of NDDs in elderly people.

2. The Epidemiological Patterns of Neurodegenerative Diseases

With the continued growth of the global burden of NDDs, it exerts profound clinical, social and economic impacts and poses significant challenges to healthcare systems. Therefore, it becomes essential to understand the epidemiological patterns of these diseases. which reveals how NDDs are distributed across populations worldwide. This includes the differences and occurrence of these diseases in terms of region, age, gender and socioeconomic states. Having a deep understanding of these patterns is crucial for public health planning, to help prevent the spread and control the impact.

2.1 Regional and National Differences

According to previous epidemiological data, the incidence and prevalence of NDDs distributed markedly across different geographic regions. Higher prevalence rates of AD are reported in high-income and more developed regions such as Europe and North America, which is largely due to longer life expectancy, an aging population structure, and improved diagnostic capabilities [8]. For instance, the estimated prevalence of AD in Europe is 5.05%, and the prevalence increases with age [9]. However, although the number of patients in middle-and low-income countries is smaller compared to high-income and developed

countries, due to population aging and the rapid increase in life expectancy, the number of AD patients in middle - and low-income countries has grown the most rapidly [10]. The prevalence of NDDs varies widely across regions and countries. High-income countries and developed regions have a relatively high prevalence of AD due to the longer life expectancy, high aging population, and improved diagnostic capacity. Although the number of patients in low- and middle-income countries is relatively small, the number of AD patients in these regions is growing at the fastest rate as life expectancy increases and aging accelerates. The geographical distribution of NDDs globally is not only affected by the level of economic development, but also closely related to demographic structure and medical resources. This puts forward higher requirements for public health policy formulation and resource allocation, and it is necessary to formulate differentiated prevention and control strategies for different countries and regions.

2.2 Age Differences

Most NDDs are age-related, and it is one of the most important risk factors for most NDDs, which means the prevalence and incidence rates increase markedly with age, and the risk of developing the disease can increase by more than 15 times in people aged 65 to 85. After the age of 65, the prevalence of AD almost doubles every five years. And the annual risk for people aged 65 to 69 is 0.5%, and for those over 85, it is 6% [11]. PD also shows a strong age dependence. Although it often occurs earlier than AD, many patients are diagnosed in their fifties or sixties, and the average duration of the disease from diagnosis to death is only 15 years [12, 13]. This suggests that the burden of NDDs in the elderly population will increase significantly as the population ages. Therefore, early intervention, health surveillance, and disease management strategies for the elderly population are of great public health significance.

2.3 Gender Differences

Epidemiological studies have shown that there are significant gender differences in the prevalence and incidence of NDDs. Interestingly, most of the clinical differences reported by NDDs seem to be closely related to gender. AD disproportionately affects women, who have a higher risk and prevalence of AD than men (about 2:1), experience more severe cognitive and physical decline, also with a longer duration of the disease. Contrary, PD is more common in men, the age of onset in men is earlier than that of women, and gender is an important independent risk factor for PD. Besides aging, male sex has become one of the most profound risk factors for developing PD at all ages and for all nationalities [14]. For instance, the age of onset in females (53.4 years) was 2.1 years later than that in males (51.3 years) [15]. And males have 1.4 to 3.7 times the risk of developing PD, compared to females [16]. There are significant gender differences in NDDs. AD is more likely to occur in women, and female patients have more significant cognitive and physical function declines, and the duration of the disease is longer. This shows that in disease prevention and control and clinical management, gender differences should be considered and targeted intervention strategies should be formulated.

2.4 Socioeconomic Status

Socioeconomic status (SES) also exerts a significant influence on NNDs. Patients with dementia generally have lower scores in the cognitive reserve index, lower educational attainment, lower job rankings, and less wealth [17]. According to investigation, higher SES are sometimes associated with a lower risk of dementia, and lower SES always relate to higher prevalence and mortality rates [18]. SES not only affects the risk of developing NDDs, but also causes significant differences in the diagnosis and treatment process. People with higher SES usually gain earlier access to medical examinations and interventions, thereby delaying disease progression. Conversely, groups with lower SES often delay seeking medical treatment due to financial difficulties, limited healthcare resources or in sufficient health awareness, and resulting in diagnosis at an advanced stage. Concurrently,individuals with lower SES are more likely to be exposed to toxic substances such as heavy metals, formaldehyde and pesticides due to their working condition [19]. Overall, lower SES leads to higher prevalence and mortality rates, SES has a crucial impact on the mobility and mortality of NDDs. SES not only affects the occurrence of diseases, but also exacerbates health inequalities in the diagnosis and caring process, emphasizing the need to focus on the role of socioeconomic structure in public health prevention and control of NDDs.

3. Different Risk Factor of Neurodegenerative Diseases

The epidemiological patterns of NDDs reveal significant influences among different modifiable determinants. Meanwhile growing evidence highlights the critical role of lifestyle, psychosocial,and environmental exposure which operate independently but instead interact together. Therefore, lead to an increase in the incidence of NDDs and fasten the progression of NDDs.

ISSN 2959-409X

3.1 Lifestyle

Physical exercise is closely related to NDDs. A lifestyle that lacks regular physical activity may increase the risk of stroke, Alzheimer's disease, and Parkinson's disease [20]. Physical exercise promotes the expression of brain-derived neurotrophic factor (BDNF), an important mechanism that triggers beneficial processes in NDDs, and a variety of molecules are involved. In people with PD, physical exercise improves gait and balance, enhances cognitive function, and delays disease progression by inhibiting protein aggregation in the brain. In patients with AD, regular exercise can also delay the progression of the disease, improve cognitive ability and memory level, and delay the onset of neuropsychiatric symptoms such as depression and apathy [20]. Alcohol consumption is a widespread behavior worldwide. Epidemiological studies have shown that moderate alcohol consumption is associated with a reduced prevalence of AD. Low to moderate concentrations of ethanol can combat β amyloid toxicity in hippocampal neurons, while excessive alcohol consumption promotes β amyloid accumulation and tau phosphorylation, leading to neuronal death and neurodegenerative disease [21].

Sleep disorders are an important risk factor for NDDs, especially with a significant impact on AD. Sleep disorders could decrease the scavenging capacity of neorometabolites and increase the accumulation of neurotoxic substances and may have a bidirectional relationship with the pathological process of AD. Sleep disorders could promote the accumulation of β amyloid and tau proteins, which in turn may aggravate the severity of sleep disorders. In addition, short sleep less than 6 hours or long sleep more than 8 hours are both detrimental to cognitive function, and the daily sleep duration is closely related to cognitive decline and the subsequent dementia risk [22].

Physical exercise, alcohol consumption and sleeping patterns all have an important impact on development of NDDs. Regular exercise and alcohol intake both have a potential effect on cognitive protection, while sleep disorders and irrational sleep duration can accelerate cognitive decline. These lifestyle factors are of great significance in the prevention and intervention of NDDs, suggesting that individual behavioral interventions have potential application value in disease management.

3.2 Psychosocial factors

Depression and stress have a significant impact on NDDs, particularly on common symptoms of PD such as stiffness and tremors. In patients with PD and other neurodegenerative disorders, the key neural circuits that regulate stress responses and hypothalamic-pituitary-adrenal axis function undergo degeneration, making the effects of stress and depression on symptom expression and disease progression particularly pronounced [23].

Social participation has a positive effect on the maintenance of cognitive function. Studies have shown that higher levels of social interaction enhance mental stimulation and improve the maintenance, efficiency, and capacity of neural networks, thereby supporting cognitive preservation [24]. Long-term high levels of social participation can slow β-amyloid-related cognitive decline, whereas individuals with lower cognitive function often exhibit reduced social engagement [25].

Environmental factors also play a critical role in the development of NDDs. Wild dogs living in severely polluted urban environments show obvious oxidative damage and early formation of diffuse amyloid plaques, as well as DNA damage in brain regions such as the olfactory bulb, frontal cortex and hippocampus. Exposure to high concentrations of urban pollution can also lead to tissue degeneration and accumulation of heavy metals such as nickel and vanadium in the brain through the nasal pathway [26].

Psychosocial factors and environmental exposure significantly affect the pathological progression of NDDs. Depression and stress can aggravate symptoms and accelerate disease progression. Active social participation helps maintain cognition. Environmental pollution can accelerate nerve damage through oxidation and toxic accumulation. These observations indicate that psychosocial support and environmental interventions should be integrated into disease prevention and management strategies to delay progression and protect neurological function.

4. Conclusion

In conclusion, the epidemiological pattern of neurodegenerative diseases are formed by the interaction of complex factors such as age, gender and socioeconomic status, while lifestyle, psychosocial, and environmental risk factors further influence disease occurrence and progression With the continuous aging of the global population, the prevalence of NDDs will continue to rise and cause more cases, placing increased pressure on healthcare systems, and the consequences will be particularly severe in low- and middle-income countries with limited medical infrastructure. The development of targeted interventions has therefore become imperative, encompassing improved early screening and diagnosis, mitigation of lifestyle, environment and other related risk factors, promotion of public health education, and increased investment in research and drug development. At the same time, interdisciplinary collaboration must be prioritised, integrating epidemiology, clinical medicine, neuroscience, and

public health policy to identify more effective prevention and treatment strategies. Only by fully recognising and addressing the complex epidemiological characteristics of NDDs can their growing burden on society and public health be effectively alleviated. Achieving this requires not only responses and resource allocation within health-care systems but also strong policy support and concerted efforts from society. Ultimately, only by recognizing and addressing the multi-faceted epidemiological situation of NDDs can society hope to alleviate its increasingly heavy burden.

References

[1] Gianfredi, V., Nucci, D., Pennisi, F. et al. Aging, longevity, and healthy aging: the public health approach. Aging Clin Exp Res 37, 125 (2025). https://doi.org/10.1007/s40520-025-03021-8

[2] WHO. Aging and health. World Health Organization. (2024) https://www.who.int/news-room/fact-sheets/detail/ageing-and-health

[3] WHO, Health topics: ageing. World Health Organization. https://www.who.int/health-topics/ageing#tab=

[4] Batista, P. S. P. (2016). Quality of life in patients with neurodegenerative diseases. Journal of Neurology and Neuroscience, 7(1), Article 74. https://doi.org/10.21767/2171-6625.100074

[5] Jiang, Q., Liu, J., Huang, S. et al. Antiageing strategy for neurodegenerative diseases: from mechanisms to clinical advances.Sig Transduct Target Ther 10, 76 (2025).https://doi.org/10.1038/s41392-025-02145-7

[6] Alzheimer's Association. 2024 Alzheimer's Disease Facts and Figures, (2024) pp.3708–3821.https://doi.org/10.1002/alz.13809.

[7] WHO.Dementia.World Health Organization. (2025)https://www.who.int/news-room/fact-sheets/detail/dementia

[8] Wang S, Jiang Y, Yang A, Meng F, Zhang J. The Expanding Burden of Neurodegenerative Diseases: An Unmet Medical and Social Need. Aging Dis. 2024 Nov 4;16(5):2937-2952. doi: 10.14336/AD.2024.1071. PMID: 39571158; PMCID: PMC12339136.

[9] Niu H, Álvarez-Álvarez I, Guillén-Grima F, Aguinaga-Ontoso I (2017). Prevalence and incidence of Alzheimer's disease in Europe: A meta-analysis. Neurologia, 32:523-532.

[10] Uwishema, Olivier MDa; Kassahun Bekele, Bezawit MDa,h,c; Nazir, Abubakar MBBSa,d,*; Filbert Luta, Erick MDa,e,f; Abdulnaser Al-Saab, Elaf MDa,g; Jacques Desire, Irakiza MDa,b; Franklin Ozioma, Chukwuma MDa,i; Wojtara, Magda MDa. Breaking barriers: addressing inequities in Alzheimer's disease diagnosis and treatment in Africa. Annals of Medicine & Surgery 86(9):p 5299-5303, September 2024. | DOI: 10.1097/MS9.0000000000002344

[11] Michael G. Erkkinen, Mee-Ohk Kim and Michael D. Geschwind. Clinical Neurology and Epidemiology of the Major Neurodegenerative DiseasesPublished in Advance July 17, 2017, doi:10.1101/cshperspect. a033118.

[12] Prof Andrew J Lees, MD · Prof John Hardy, PhD · Prof Tamas Revesz, FRCPath.Parkinson's disease. The Lancet, Volume 373, Issue 9680, 2055 - 2066, June 13, 2009

[13] Bianco A, Antonacci Y, Liguori M. Sex and Gender Differences in Neurodegenerative Diseases: Challenges for Therapeutic Opportunities. International Journal of Molecular Sciences. 2023; 24(7):6354. https://doi.org/10.3390/ijms24076354

[14] Glenda E. Gillies, Ilse S. Pienaar, Shiv Vohra, Zahi Qamhawi. Sex differences in Parkinson's disease.Volume 35, Issue 3, August 2014, Pages 370-384. https://doi.org/10.1016/j.yfrne.2014.02.002

[15] Charlotte A Haaxma, Bastiaan R Bloem, George F Borm, Wim J G Oyen, Klaus L Leenders, Silvia Eshuis, Jan Booij, Dean E Dluzen, Martin W I M Horstink. Gender differences in Parkinson's disease. Journal of Neurology, Neurosurgery & Psychiatry 2007; 78 787-787 Published Online First: 16 Jul 2007. doi: 10.1136/jnnp.2006.109991

[16] Danielle S. Abraham a b, Ann L. Gruber-Baldini a, Laurence S. Magder a, Patrick F. McArdle, Sarah E. Tom, Erik Barr, Katrina Schrader, Lisa M. Shulman. Sex differences in Parkinson's disease presentation and progression. Parkinsonism & Related Disorders.Volume 69, December 2019, Pages 48-54. https://doi.org/10.1016/j.parkreldis.2019.10.01

[17] Almeida-Meza P, Steptoe A, Cadar D. Markers of cognitive reserve and dementia incidence in the English Longitudinal Study of Ageing. The British Journal of Psychiatry. 2021;218(5):243-251. doi:10.1192/bjp.2020.54

[18] Wang AY, Hu HY, Ou YN, Wang ZT, Ma YH, Tan L, Yu JT. Socioeconomic Status and Risks of Cognitive Impairment and Dementia: A Systematic Review and Meta-Analysis of 39 Prospective Studies. J Prev Alzheimers Dis. 2023;10(1):83-94. doi: 10.14283/jpad.2022.81. PMID: 36641612.

[19] Roberts AL, Johnson NJ, Chen JT, Cudkowicz ME, Weisskopf MG. Race/ethnicity, socioeconomic status, and ALS mortality in the United States. Neurology. 2016 Nov 29;87(22):2300-2308. doi: 10.1212/WNL.0000000000003298. Epub 2016 Oct 14. PMID: 27742817; PMCID: PMC5135021.

[20] Mahalakshmi B, Maurya N, Lee SD, Bharath Kumar V. Possible Neuroprotective Mechanisms of Physical Exercise in Neurodegeneration. Int J Mol Sci. 2020 Aug 16;21(16):5895. doi: 10.3390/ijms21165895. PMID: 32824367; PMCID: PMC7460620.

[21] Peng B, Yang Q, B Joshi R, Liu Y, Akbar M, Song BJ, Zhou S, Wang X. Role of Alcohol Drinking in Alzheimer's Disease, Parkinson's Disease, and Amyotrophic Lateral Sclerosis. Int J Mol Sci. 2020 Mar 27;21(7):2316. doi: 10.3390/ijms21072316. PMID: 32230811; PMCID: PMC7177420.

[22] Zhang XX, Tian Y, Wang ZT, Ma YH, Tan L, Yu JT.

ISSN 2959-409X

The Epidemiology of Alzheimer's Disease Modifiable Risk Factors and Prevention. J Prev Alzheimers Dis. 2021;8(3):313-321. doi: 10.14283/jpad.2021.15. PMID: 34101789; PMCID: PMC12280729.

[23] Justice NJ. The relationship between stress and Alzheimer's disease. Neurobiol Stress. 2018 Apr 21; 8:127-133. doi: 10.1016/j.ynstr.2018.04.002. PMID: 29888308; PMCID: PMC5991350.

[24] Influence of social network on occurrence of dementia: a community-based longitudinal study

Fratiglioni, Laura et al. The Lancet, Volume 355, Issue 9212, 1315 - 1319

[25] Biddle KD, d'Oleire Uquillas F, Jacobs HIL, Zide B, Kirn DR, Rentz DM, Johnson KA, Sperling RA, Donovan NJ. Social Engagement and Amyloid-β-Related Cognitive Decline in Cognitively Normal Older Adults. Am J Geriatr Psychiatry. 2019 Nov;27(11):1247-1256. doi: 10.1016/j.jagp.2019.05.005. Epub 2019 May 10. PMID: 31248770; PMCID: PMC6778491.

[26] Olloquequi J, Díaz-Peña R, Verdaguer E, Ettcheto M, Auladell C, Camins A. From Inhalation to Neurodegeneration: Air Pollution as a Modifiable Risk Factor for Alzheimer's Disease. Int J Mol Sci. 2024 Jun 25;25(13):6928. doi: 10.3390/ijms25136928. PMID: 39000036; PMCID: PMC11241587.