

## EPIDEMIOLOGY OF ALZHEIMER'S DISEASE AND DEMENTIA IN INDIA: A SYSTEMATIC LITERATURE REVIEW

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**Aim:** this study aims to estimate the epidemiology and prevalence of Alzheimer's disease and other dementias in India.

**Materials and methods.** To ascertain the prevalence of dementia in India, we conducted a comprehensive review of existing research, utilizing databases from various sources, including EBSCOhost, PubMed, PsycINFO, and Google Scholar. We employed R software (version 3.5.3) along with the "metaphor" package to perform a meta-analysis.

**Results:** our meta-analysis incorporated data from 18 epidemiological studies. According to the findings of our meta-analysis, there are 20 individuals with dementia among every 1000 individuals in the population (95% confidence interval: 0.02-0.03). The prevalence was notably higher in the older age groups (75 years and above) compared to those under 75. However, prevalence rates did not significantly differ between males and females or between rural and urban populations.

**Conclusion:** this study reveals that dementia, especially among the elderly population in India, is a significant public health concern. A comprehensive national survey supported by robust evidence is essential to accurately determine the prevalence of this condition in the nation.

**Keywords:** epidemiology, dementia, Alzheimer's disease, India, meta-analysis, prevalence.

**Background.** As the world population ages at an unprecedented rate, Alzheimer's disease (AD) and other dementias are becoming a public health issue, especially in developing nations [1]. Emerging nations will house 14.2% of the world's 60%-plus population by 2020, roughly 70% of the elderly. In particular, India's life expectancy nearly doubled from 36.98 years in 1950-1960 to 69.27 years in 2015-2020. The 2011 census found 103.9 million elder Indians, up from 5.63 million in 1961 [1,2,3].

The senior population in India grew 35.5% between 2001 and 2011, compared to 23.9% between 1951 and 1961. Mortality rates, healthcare infrastructure, economic growth, and literacy rates all contributed to this demographic transition. Mental illness in the elderly affects their health and longevity [4]. Of all neuropsychiatric disorders, dementia causes the most impairment in the elderly.

These major social shifts may affect dementia incidence in India. Several studies have examined dementia prevalence across the nation.

Dementia was 1.9% in South Asia in 2005 and expected to rise to 3.6 million by 2020 and 7.5 million by 2040. Epidemiological studies in India have shown dementia prevalence rates from 2 to 35 per 1000 [5]. There is no clear national assessment of dementia trends in India, despite the significant public health consequences and emotional and financial strain on carers [6,7].

## MATERIALS AND METHODS

Up to June 2023, comprehensive searches were conducted on databases including EBSCOhost, PubMed, PsycINFO, and Google Scholar. The search strategy employed Boolean operators to combine keywords such as "India" and "dementia," encompassing Alzheimer's disease, vascular dementia, cognitive impairment, neurodegenerative disorder, and terms related to study design, including epidemiology, prevalence, observational study, cross-sectional study, cohort study, and disease frequency. Furthermore, supplementary publications were identified by manually examining the bibliographies, references, and cross-references of previously discovered research articles. Additionally, we conducted manual searches in Neurology India, as well as other Indian journals available

online, including the Indian Journal of Psychiatry and the Indian Journal of Gerontology. Both authors independently conducted a comprehensive review of the full-text articles in accordance with pre-defined inclusion and exclusion criteria.

### Inclusion and Exclusion Criteria

As of June 2023, we included all manuscripts published in the English language that provided quantitative data on either the number or frequency, while reporting data for both genders in the general population, encompassing rural, urban, or mixed backgrounds. Excluded from consideration were review papers, single-case studies, studies conducted in hospital settings, and research focused on specific racial or religious groups.

Out of a total of 719 articles initially identified, 623 were eliminated because their titles or abstracts did not align with the established inclusion and exclusion criteria. Subsequently, the full texts of the remaining 44 articles were meticulously examined. After thorough deliberation and assessment of their methodologies and conclusions, 18 studies were selected for inclusion in the meta-analysis.

### Data Extraction

Articles were included based on the predefined inclusion criteria and subjected to a thorough review. A customized data extraction form was employed to extract pertinent information from each article, including the author's name, publication year, study location, sample size, diagnostic criteria, and the number of individuals screened for dementia.

### Statistical Analysis

The statistical analysis was conducted using the R software (version 3.5.3), developed by the R Core Team at the University of Auckland, New Zealand. The analysis utilized a significance threshold of 5% (two-tailed tests) and involved the use of three R packages: "metafor," "meta," and "xlsx."

Data from the manuscript were imported from a Microsoft Excel spreadsheet into the R console with the "xlsx" library command. The "escalc" function was employed to compute the effect size, utilizing the "xi" and "ni" commands for event and sample size, respectively, within the "metafor" package. The analysis employed the Free-

man-Tukey transformation, commonly referred to as the "Freeman-Tukey double arcsine transformation," via the `escalc()` and `rma()` routines.

The effect size using the random effects model was calculated using the `rma()` function. The overall summary proportion was determined with the "predict" function, and converted proportions from various studies were combined to ascertain the overall prevalence of dementia using the "metaprop" function. To revert the summary effect size back into proportion, the "transf()" function was utilized.

The `metaprop()` function directed the transformation process to translate the initial proportions into prevalence, with the "sm" input guiding the transformation technique. A forest plot was created using the "forest" tool. Finally, publication bias was estimated using a funnel plot, and Egger's unweighted regression test results were generated using the `regtest()` function to confirm the presence of publication bias.

### **Etiology**

The loss of neurons in Alzheimer's disease is progressive. The hippocampus nucleus' entorhinal cortex usually causes it. Both early-onset and late-onset Alzheimer's are hereditary. Early-onset dementia is linked to trisomy 21 [8]. Age is the main risk factor for Alzheimer's disease. Other risk factors include traumatic brain injury, depression, cardiovascular and cerebrovascular disorders, older parental age, smoking, a family history of dementia, high homocysteine levels, and the APOE e4 allele. Educational achievement, oestrogen usage in women, anti-inflammatory medicine use, leisure activities like reading or performing music, a balanced diet, and regular aerobic exercise minimise Alzheimer's disease risk. Having a first-degree relative with Alzheimer's raises risk by 10% to 30%, while having two or more siblings triples risk [9,10].

### **Epidemiology**

Alzheimer's mostly affects the elderly. The global dementia population is anticipated to triple by 2050 from 24 million. Alzheimer's disease costs the US healthcare system \$172 billion annually [11,12]. About 4.5 million Americans 65 and older were diagnosed with Alzheimer's in 2011. After 65, Alzheimer's disease doubles every five years

[5]. Rarely more than 1% each year before 65, the frequency rises to 6% beyond 85. From 10% to 40% beyond 65, prevalence rates grow after 85 [2]. Women have a somewhat greater Alzheimer's disease risk, especially after 85 [13].

### **Dementia**

Dementia causes a broad deterioration in memory and other cognitive processes that hampers everyday tasks. A steady and sustained decline in cognitive function generally causes memory loss and a limited comprehension of one's inadequacies [14]. This conversation emphasises the role of a multidisciplinary team in dementia evaluation and management. The aetiology, risk factors, and difficulties in diagnosing and treating this range of cognitive impairments are also examined.

### **Etiology**

Many illnesses can induce neurocognitive problems, but Alzheimer's dementia (AD) accounts for 70%. Major Neurocognitive disorders have 13 etiological subcategories in the DSM-5. Alzheimer's, vascular, frontotemporal lobar degeneration, Lewy body, Parkinson's, HIV infection, Huntington's, prion, drug and alcohol abuse, traumatic brain injury, another medical condition, multiple aetiologies, and unspecified cases are subtypes. Patients often have many causes of serious neurocognitive disorders [15]. A patient may have vascular and Alzheimer's disease.

### **Epidemiology**

Most dementia cases—70%–80%—are caused by Alzheimer's disease. Hereditary or sporadic. Vascular dementia accounts for 15% of dementia cases and doubles every 5.3 years [16]. Smoking, diabetes, hypertension, and hypercholesterolemia increase vascular dementia risk. Lewy body dementia accounts for 5% of dementia cases, however misdiagnosis skews epidemiological statistics [17]. Parkinson's disease causes 10% of dementia cases, whereas frontotemporal dementia affects 25% of seniors.

### **Psychiatric Disorders and Dementia**

Early descriptions of primary dementias comprised cognitive, functional, and psychiatric symptoms. Alois Alzheimer, who discovered Alzheimer's disease, noted anxiety, hallucinations, delusions, agitation, and memory, orientation, and knowledge problems in patients. His colleagues

Arnold Pick, Paul Sérieux, and Joseph Dejerine first defined midlife behaviour and language degeneration as frontotemporal dementia. Although recognised early, basic dementias were subsequently called cognitive diseases [18]. Psychiatric issues, including mood, behaviour, perception, and mental content, have been shown to be frequent in dementia for 35 years.

This figure illustrates an algorithm for the identification of different neurodegenerative types of dementia. It demonstrates how clusters of symptoms and the corresponding syndromes play a pivotal role in guiding the process of differential

diagnosis for dementia. The diagram depicts how cognitive and motor syndromes define distinct pathways, and when combined with psychiatric states (indicated in red text), they can lead to the specific diagnosis of various dementia subtypes, such as the behavioural variant of frontotemporal dementia (bvFTD), frontotemporal dementia with amyotrophic lateral sclerosis (FTD-ALS), and dementia with Lewy bodies (DLB) [19].

This figure is reprinted with permission from Devineni B and Onyike CU, sourced from Psychiatr Clin North Am (2015) [DOI: (www.sciencedirect.com/science/article/pii/S0193953X15000271)].

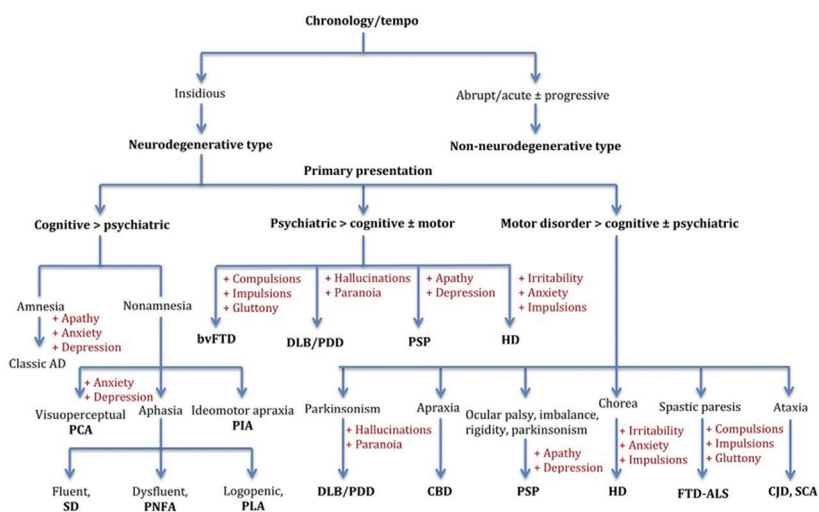


Fig. 1. Algorithm for Identifying Neurodegenerative Types of Dementia

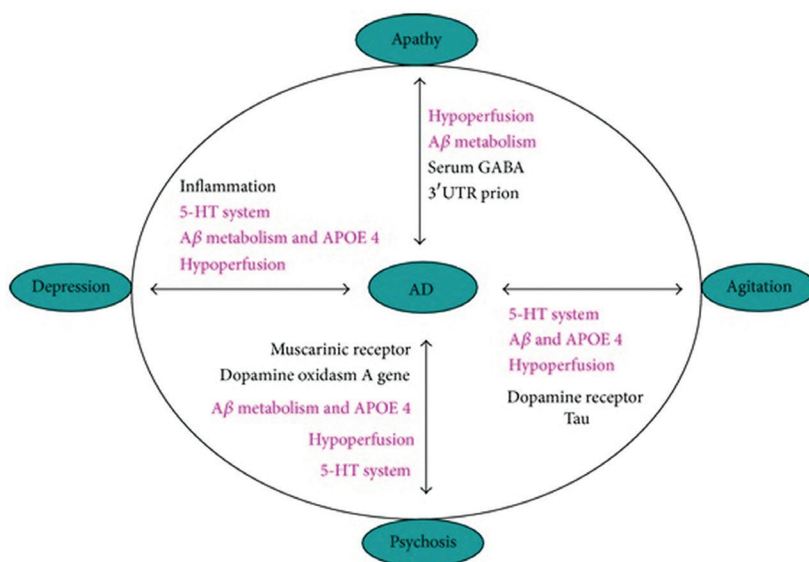


Fig. 2. Impact of Neuropsychiatric Symptoms and Behavioural Anomalies in Alzheimer's disease (AD)

This figure highlights the profound impact of neuropsychiatric symptoms and behavioural anomalies in AD on the quality of life (QOL) of patients. These symptoms are believed to be predictive of eventual or more severe dementia, extensive neurodegeneration, loss of functional independence, institutionalization, and early mortality. As such, there is a general consensus that these neuropsychiatric symptoms and behavioural anomalies are indicative of poor outcomes.

#### **Depression in Alzheimer Disease (AD)**

Recent research suggests that 25%–74.9% of AD patients have depression. The incidence varies according to the use of different diagnostic techniques, such as the DSM, NPI-D, and Geriatric Depression Scale [19]. One research found 10.5% NPI-D (significant), 56.4% NPI-D (any), 30% Geriatric Depression Scale (GDS), and 16% antidepressant usage in the same population. The French Network on AD (REAL.FR) found 17.45% each year in several hundred AD patients without depression or medications over four years [20,21]. Clinical depressive symptoms are predicted in 40% of AD patients within 5 years.

#### **Diagnostic Criteria for Alzheimer's Disease**

The diagnostic criteria for Alzheimer's disease involve a series of tests and assessments for individuals suspected of having the condition. These tests include a neurological examination, MRI scans to assess neurons, blood tests, such as vitamin B<sub>12</sub> levels, and a comprehensive review of the patient's medical and family histories [22]. Research has established a link between vitamin B<sub>12</sub> deficiency and neurological issues, as well as an increased risk of AD. Elevated homocysteine levels, which can result from vitamin B<sub>12</sub> deficiency, are a unique indicator and can lead to brain damage through oxidative stress, increased calcium influx, and apoptosis. Diagnosis of vitamin B<sub>12</sub> insufficiency can be made by measuring serum vitamin B<sub>12</sub> levels, along with tests for serum homocysteine levels and complete blood counts [23,24].

#### **Treatment**

As of the present moment, it is estimated that around 24 million people worldwide suffer from Alzheimer's disease (AD), and experts predict that by 2050, this number may quadruple. Despite being a significant public health concern, there are

currently only two types of medications approved for the treatment of AD: cholinesterase enzyme inhibitors and N-methyl D-aspartate (NMDA) antagonists [25,26,27].

The decline in cholinergic transmission in the brain is a consequence of the destruction of acetylcholine-producing cells due to various physiological mechanisms in AD. Acetylcholinesterase inhibitors (AChEIs), which can be classified as irreversible, reversible, and pseudo-reversible, function by preventing cholinesterase enzymes (AChE and BChE) from degrading acetylcholine (ACh). This action increases the concentration of ACh in the synaptic cleft [28].

Conversely, excessive NMDA receptor (NMDAR) activity leads to an increased influx of calcium ions (Ca<sup>2+</sup>), promoting synaptic dysfunction and cell death. NMDA antagonists restore the normal activity of NMDAR glutamate receptors by preventing overactivation, subsequently reducing Ca<sup>2+</sup> influx. While these two drug classes have therapeutic effects in alleviating AD symptoms, they do not have the ability to reverse or halt the progression of the disease [29].

Unfortunately, there have been relatively few successful clinical trials in AD treatment in the past decade. To alter the pathogenesis of AD and develop effective treatments, various pathways have been proposed, including the aberrant metabolism of tau proteins, beta-amyloid accumulation, the inflammatory response, cholinergic dysfunction, and oxidative damage [30].

#### **Symptomatic Treatment for Alzheimer's Disease**

**Cholinesterase Inhibitors:** The cholinergic hypothesis posits that Alzheimer's Disease (AD) results from a reduction in acetylcholine (ACh) biosynthesis. One therapeutic approach to enhance cognitive and neural cell function involves increasing cholinergic levels by inhibiting acetylcholinesterase (AChE) [31,32,33].

**Approved Drugs for Symptomatic Treatment of AD:** Tacrine, Donepezil, Rivastigmine, Galantamine, Memantine.

**Disease-Modifying Compounds That Entered Clinical Trials:** Semagacestat, Avagacestat, Tarenflurbil, Lanabecestat, Verubecestat, Atabecestat.

**The study's key findings revealed:**

- The overall prevalence of dementia was 5.1%, with a noticeable increase in prevalence with advancing age and a decrease with lower educational levels.
- Among females, the prevalence of dementia was 7.2%, which was twice as high as that observed in males at 3.8% [34].
- Widows, widowers, and unmarried individuals exhibited a doubled prevalence of 9.3% in contrast to the 4.3% prevalence in the married population.
- Age, gender, marital status, education, occupation, the number of family members in the household, and liquor addiction were all significantly associated with dementia.
- The relative risk for the aforementioned variables was found to be greater than 1.

The objective of this study was to investigate the frequency and patterns of psychiatric morbidity, as well as the associations between physical illness and psychiatric morbidity, in an elderly urban population [35]. The research involved enrolling all consenting elderly individuals in a specific municipal ward division (total n=202), following a comprehensive survey of the entire adult population, which comprised 7,239 people [36,37]. A door-to-door survey approach was adopted, involving interviews and physical examinations of the participants. Various assessment tools, including the General Health Questionnaire-12, Mini Mental State Examination, CAGE Questionnaire, and Geriatric Depression Scale, were employed during the interviews, alongside a review of available documents. To verify the information, interviews with other family members were also conducted [38,39,40].

**Key findings from the study included:**

- Psychiatric illnesses were identified in 26.7% of the population, while physical illnesses were present in 69.8%.
- The most prevalent psychiatric diagnoses were depressive disorders, dementia, generalized anxiety disorder, alcohol dependence, and bipolar disorder.
- The leading physical illnesses included visual impairment, cardiovascular disease, rheumatic illnesses, pulmonary conditions, hearing im-

pairment, genitourinary diseases, and neurological disorders.

- The presence of dementia was associated with factors such as advanced age, single/widowed/separated status, nuclear family setup, economic dependence, low education, and specific physical illnesses like cardiovascular disorders, rheumatic disorders, and neurological disorders.
- Depression was linked to female gender, single/widowed/separated status, residing in nuclear families, economic dependence, and co-existing physical illnesses, particularly cardiovascular disorders and visual impairment.

This study highlighted a higher prevalence of dementia and late-life depression in the studied population. The noteworthy associations with various sociodemographic factors and physical illnesses may have significant implications for healthcare planning.

**Conclusion**

In conclusion, this study presents the first reported AD incidence rates from southern India. These incidence rates appear to be notably higher than those reported in rural northern India, comparable to those reported in China, and slightly lower than those reported in Western countries. Dementia needs to be acknowledged as a significant mental health concern in nationwide surveys, and the diverse forms of dementia should be identified as a priority in geriatric care. Future research should focus on identifying potential risk factors, and healthcare organizations should work on developing preventive interventions to delay the onset of dementia. The results of this meta-analysis indicate that 20 per thousand individuals in India are affected by dementia. Given the methodological variations in different studies, it is imperative for The National Mental Health Survey of India to consider dementia as a key area of investigation.

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## ЕПІДЕМІОЛОГІЯ ХВОРОБИ АЛЬЦГЕЙМЕРА ТА ДЕМЕНЦІЇ В ІНДІЇ: СИСТЕМАТИЧНИЙ ОГЛЯД ЛІТЕРАТУРИ

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**Ціль:** це дослідження спрямоване на оцінку епідеміології та поширеності хвороби Альцгеймера та інших деменцій в Індії.

**Матеріали та методи.** Для визначення поширеності деменції в Індії ми провели комплексний огляд існуючих досліджень, використовуючи бази даних з різних джерел, включаючи EBSCOhost, PubMed, PsycINFO і Google Scholar. Для проведення мета-аналізу ми використовували програмне забезпечення R (версія 3.5.3) разом з пакетом "metaphor".

**Результати.** Наш мета-аналіз включав дані 18 епідеміологічних досліджень. Згідно з результатами мета-аналізу, на кожні 1000 осіб у популяції припадає 20 осіб з деменцією (95% довірчий інтервал: 0,02-0,03). Поширеність була помітно вищою у старших вікових групах (75 років і старше) порівняно з особами молодше 75 років. Однак показники поширеності суттєво не відрізнялися між чоловіками та жінками або між сільським та міським населенням.

**Висновок.** Це дослідження показує, що деменція, особливо серед людей похилого віку в Індії, є значною проблемою для громадського здоров'я. Для точного визначення поширеності цього захворювання в країні необхідно провести комплексне національне дослідження, підкріплене надійними доказами.

**Ключові слова:** епідеміологія, деменція, хвороба Альцгеймера, Індія, мета-аналіз, поширеність.