

# Sleep disorders and their impact on cognitive decline.

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## Introduction

Sleep is a fundamental physiological process essential for maintaining brain health, supporting memory consolidation, regulating mood, and promoting overall cognitive performance. The brain's ability to process, store, and retrieve information relies heavily on adequate and high-quality sleep, during which numerous restorative processes occur. Disruption of sleep—whether in the form of insufficient duration, poor quality, or specific sleep disorders—can have profound and lasting effects on cognitive function. Over time, chronic sleep disturbances have been increasingly recognized as significant risk factors for cognitive decline, mild cognitive impairment, and neurodegenerative diseases such as Alzheimer's and Parkinson's. The relationship between sleep disorders and cognitive decline is complex and bidirectional: poor sleep can accelerate neurodegeneration, while neurodegenerative changes can themselves disrupt sleep regulation, creating a vicious cycle that worsens outcomes [1].

Several types of sleep disorders have been linked to cognitive decline, each with unique mechanisms and patterns of impact. Insomnia, one of the most common sleep disorders, is characterized by difficulty initiating or maintaining sleep, leading to non-restorative rest. Chronic insomnia deprives the brain of essential slow-wave and rapid eye movement

sleep stages that are critical for synaptic plasticity and memory consolidation. Sleep fragmentation impairs attention, executive function, and working memory, and prolonged periods of poor sleep have been associated with an increased risk of developing dementia. Insomnia also contributes to heightened stress hormone levels, inflammation, and oxidative stress, all of which can damage neuronal structures over time [2].

Obstructive sleep apnea is another major contributor to cognitive impairment, characterized by repetitive episodes of upper airway obstruction during sleep that result in intermittent hypoxia and frequent arousals. The repeated drops in blood oxygen saturation and subsequent surges in sympathetic nervous system activity cause oxidative stress, vascular injury, and metabolic dysregulation. These physiological disturbances can impair hippocampal function and frontal lobe activity, leading to deficits in attention, executive function, and episodic memory. The risk of dementia is significantly higher in individuals with untreated sleep apnea, and there is evidence that continuous positive airway pressure therapy can improve cognitive performance and slow decline in some patients [3].

Restless legs syndrome and periodic limb movement disorder, which cause involuntary limb movements that disrupt sleep continuity, are also associated with cognitive problems. The resulting fragmented sleep

reduces the time spent in deep, restorative sleep stages, impairing learning and memory processes. These conditions often co-occur with other disorders such as depression, which can further exacerbate cognitive difficulties [4].

Neurodegenerative diseases themselves frequently disrupt sleep-wake regulation. In Alzheimer's disease, degeneration of the suprachiasmatic nucleus and other sleep-regulating brain regions alters circadian rhythms, leading to increased nighttime wakefulness and daytime sleepiness. Sleep disturbances in Alzheimer's patients are associated with faster cognitive decline and greater caregiver burden. In Parkinson's disease, sleep problems are also prevalent and multifactorial, including insomnia, REM sleep behavior disorder, and excessive daytime sleepiness. REM sleep behavior disorder, characterized by the loss of normal muscle atonia during REM sleep leading to dream enactment behaviors, is not only disruptive but also a strong early predictor of synucleinopathies such as Parkinson's and Lewy body dementia, often appearing years before motor symptoms [5].

## Conclusion

In conclusion, sleep disorders represent a significant and modifiable contributor to cognitive decline.

Conditions such as insomnia, obstructive sleep apnea, restless legs syndrome, and REM sleep behavior disorder disrupt the restorative functions of sleep, impair waste clearance from the brain, promote oxidative stress and inflammation, and damage neural networks essential for memory and executive function. These disturbances not only degrade current cognitive performance but also increase the risk of neurodegenerative diseases, creating a self-perpetuating cycle of decline.

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