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The Impact Of Sleep Disorders On Cognitive Function In Elderly Populations: A Cross-Sectional Analysis

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Abstract

Background:
Sleep disorders are prevalent among elderly individuals and may significantly impact cognitive health. However, the association between sleep disturbances and cognitive impairment in aging populations, particularly within Middle Eastern contexts, remains underexplored.

Aim:
This study aimed to investigate the impact of sleep disorders on cognitive function among elderly individuals attending healthcare facilities at King Khaled University, Saudi Arabia.

Methods:
A cross-sectional study was conducted involving 1,330 elderly participants aged 60 years and above. Sleep quality was assessed using the Pittsburgh Sleep Quality Index (PSQI), and cognitive function was evaluated with the Montreal Cognitive Assessment (MoCA). Sociodemographic and clinical data were collected. Statistical analyses included t-tests, chi-square tests, and multivariate regression models to identify predictors of cognitive impairment.

Results:
Poor sleep quality (PSQI >5) was prevalent in 65.6% of participants. Cognitive impairment (MoCA <26) was observed in 77.7% of the sample. Participants with poor sleep quality exhibited significantly lower cognitive scores compared to good sleepers (mean MoCA 21.3 vs. 24.8, $p<0.001$). After adjusting for age, gender, education, and chronic diseases, poor sleep quality remained an independent predictor of cognitive impairment ($\beta = -2.6$, $p<0.001$).

Conclusion:
Sleep disturbances are highly prevalent among elderly individuals and are significantly associated with cognitive decline. Routine screening and management of sleep disorders

may offer a critical opportunity to preserve cognitive function in aging populations. Future longitudinal and interventional studies are warranted to confirm these findings and guide preventive strategies.

Keywords:
Sleepdisorders; Cognitive function; Elderly; Sleep quality; Cognitive impairment; Aging; Cross-sectional study

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Introduction

The aging process is often accompanied by a progressive decline in physiological, psychological, and cognitive functions, posing significant challenges to health systems globally. Among the myriad factors influencing cognitive aging, sleep disorders have emerged as a critical yet underexplored determinant. Sleep disturbances, encompassing insomnia, obstructive sleep apnea, restless legs syndrome, and circadian rhythm disruptions, are notably prevalent in older populations, with estimates suggesting that up to 50% of community-dwelling elderly individuals experience some form of sleep disorder (1). As global demographics shift towards an increasingly aging society, understanding the implications of sleep disturbances on cognitive function has become an urgent public health priority.

Sleep plays a fundamental role in maintaining cognitive health through processes such as memory consolidation, synaptic plasticity, and the clearance of neurotoxic waste products from the brain (2). Disruptions in sleep architecture, particularly reductions in slow-wave and rapid eye movement (REM) sleep, have been implicated in impairments across various cognitive domains, including attention, executive function, and memory (3). Furthermore, chronic sleep disorders have been associated with neuropathological changes characteristic of dementia, including amyloid-β accumulation and tau pathology (4). Consequently, sleep disturbances are increasingly recognized not merely as comorbidities but as modifiable risk factors for cognitive decline and dementia.

Several epidemiological studies have examined the relationship between sleep disorders and cognitive impairment among older adults, yet findings remain heterogeneous. While some studies demonstrate a strong association between poor sleep quality and cognitive deficits (5), others report minimal or inconsistent effects after adjusting for confounding variables such as depression, comorbid illnesses, and medication use (6). These discrepancies underscore the need for further research employing rigorous designs, standardized measures, and culturally diverse samples to elucidate the complex interplay between sleep and cognition in aging populations.

In particular, insomnia—characterized by difficulties initiating or maintaining sleep—has been linked to impaired attention, working memory, and executive function in older adults (7). Similarly, obstructive sleep apnea (OSA), a condition marked by intermittent upper airway obstruction during sleep leading to hypoxia and fragmented sleep, has been associated with declines in verbal memory, psychomotor speed, and visuospatial skills (8). Notably, untreated moderate to severe OSA has been proposed as an independent risk factor for mild cognitive impairment (MCI) and Alzheimer's disease (9). These findings highlight the importance of early detection and management of sleep disorders to potentially mitigate or delay cognitive deterioration.

Despite growing recognition of the sleep–cognition relationship, much of the existing literature is limited by cross-cultural variability, selection biases, and a lack of focus on subclinical cognitive changes preceding overt dementia diagnoses. Most studies have predominantly involved Western populations, limiting the generalizability of findings to other sociocultural contexts, such as those in the Middle East and Asia, where aging trajectories and sleep practices may differ (10). Moreover, the majority of studies have concentrated on clinically diagnosed sleep disorders, with less attention to subjective sleep quality measures that may be equally predictive of cognitive outcomes (11). Addressing these gaps is crucial for the development of effective preventive and therapeutic strategies tailored to diverse elderly populations.

In Saudi Arabia and other Gulf countries, where the proportion of elderly individuals is rapidly increasing, data on the prevalence and consequences of sleep disorders among older adults remain sparse. Cultural factors, healthcare access disparities, and unique lifestyle patterns may modulate both sleep behaviors and cognitive health outcomes in these settings (12). Furthermore, social determinants such as educational attainment, physical inactivity, and chronic disease burden—which are prevalent among elderly populations in the region—may confound or mediate the relationship between sleep and cognition (13). There is, therefore, a compelling need for population-specific studies that account for these contextual factors.

Cross-sectional studies, despite their inherent limitations in inferring causality, offer a valuable approach to explore associations between sleep characteristics and cognitive function within large, diverse samples. By capturing a snapshot of the sleep–cognition relationship across different sociodemographic strata, cross-sectional analyses can identify high-risk groups and generate hypotheses for longitudinal research. Additionally, the use of validated instruments such as the Pittsburgh Sleep Quality Index (PSQI) for sleep assessment and the Montreal Cognitive Assessment (MoCA) for cognitive screening enhances the reliability and validity of findings (14,15).

Given these considerations, the present study aims to investigate the impact of sleep disorders on cognitive function among elderly individuals attending primary healthcare facilities. Specifically, it seeks to assess the prevalence of sleep disturbances, examine their associations with cognitive performance, and explore potential sociodemographic and clinical correlates. By focusing on an elderly population within a non-Western context, this research endeavors to contribute novel insights to the global understanding of sleep and cognitive aging and inform culturally sensitive interventions aimed at preserving cognitive health in later life.

In summary, sleep disturbances represent a prevalent and potentially modifiable risk factor for cognitive decline among older adults. Unraveling the nature and strength of this association is critical for early identification of at-risk individuals and for informing preventive strategies against dementia and related disorders. Through a cross-sectional analysis of elderly populations, this study aspires to bridge existing knowledge gaps and foster the development of targeted, contextually relevant health policies and clinical practices. Addressing sleep health may offer a promising avenue not only for enhancing cognitive resilience but also for improving overall quality of life in aging societies.

Aim of the Study

The aim of this study is to investigate the association between sleep disorders and cognitive function among elderly individuals. Specifically, the study seeks to assess the prevalence of sleep disturbances, evaluate cognitive performance, and explore the relationship between sleep quality and cognitive impairment, while considering relevant sociodemographic and clinical factors.

Research Questions

1. What is the prevalence of sleep disorders among elderly individuals attending primary healthcare facilities?
2. What is the level of cognitive function among elderly individuals with and without sleep disorders?
3. Is there a significant association between sleep disorder severity and the degree of cognitive impairment in elderly populations?

Methods

Study Design

This study employed a cross-sectional design to explore the association between sleep disorders and cognitive function among elderly individuals. The cross-sectional approach was deemed appropriate given the study's objective to assess the prevalence and correlation of variables at a single point in time without manipulating any conditions. This design allows for the efficient collection of large amounts of data across diverse sociodemographic groups, offering a valuable snapshot of sleep and cognitive health among older adults in a non-Western context.

Study Setting

The research was conducted at King Khaled University Hospital and affiliated primary healthcare centers in Abha, Saudi Arabia. These settings were selected to capture a representative sample of the elderly population receiving routine healthcare services. King Khaled University Hospital is one of the largest tertiary care institutions in the southern region of Saudi Arabia, providing specialized services for the aging population. The selected primary care centers cater to a wide catchment area, encompassing urban and semi-urban populations with varied socioeconomic backgrounds.

Sample and Sampling

A total of 1,330 elderly individuals aged 60 years and above were recruited for the study. Inclusion criteria included the ability to communicate verbally, willingness to provide informed consent, and attendance at the selected healthcare facilities during the data collection period. Exclusion criteria included diagnosed neurodegenerative diseases such as Alzheimer's disease, active psychiatric illness, recent major surgery or hospitalization within the past month, and severe sensory impairments that would interfere with cognitive assessment.

Participants were selected through stratified random sampling to ensure adequate representation across age groups (60–69, 70–79, 80+), gender, and educational levels. Within each stratum, random sampling was conducted using patient attendance logs at the healthcare centers. This sampling strategy enhanced the representativeness and minimized selection bias.

Data Collection Tools

Two primary instruments were used to collect data on sleep quality and cognitive function, in addition to a sociodemographic questionnaire.

Pittsburgh Sleep Quality Index (PSQI)

The Pittsburgh Sleep Quality Index (PSQI), developed by Buysse et al. in 1989, was used to assess sleep quality over the past month (16). The PSQI is a widely validated self-reported questionnaire designed to measure sleep disturbances and their severity. It consists of 19

items grouped into seven components: subjective sleep quality, sleep latency, sleep duration, habitual sleep efficiency, sleep disturbances, use of sleeping medications, and daytime dysfunction. Each component yields a score ranging from 0 to 3, with higher scores indicating worse sleep quality. The component scores are summed to produce a global score ranging from 0 to 21, where a score >5 signifies poor sleep quality. The PSQI has demonstrated strong psychometric properties, with a reported Cronbach's alpha of 0.83, indicating good internal consistency (16). For the purpose of this study, the PSQI was translated into Arabic following a forward-backward translation method by two independent bilingual translators. The Arabic version underwent content validation by a panel of five experts in sleep medicine and geriatrics, and a pilot study among 50 elderly individuals yielded a Cronbach's alpha of 0.81, confirming its reliability in the local context.

Montreal Cognitive Assessment (MoCA)

Cognitive function was assessed using the Montreal Cognitive Assessment (MoCA), originally developed by Nasreddine et al. in 2005 (17). The MoCA is a brief cognitive screening tool designed to detect mild cognitive impairment (MCI) and early dementia. It evaluates multiple cognitive domains, including visuospatial/executive functions, naming, memory, attention, language, abstraction, delayed recall, and orientation. The maximum score is 30, with a score below 26 generally indicating cognitive impairment. In this study, the Arabic version of the MoCA, validated by cultural and linguistic experts and tested in Arab elderly populations, was utilized. The Arabic MoCA demonstrated excellent reliability, with a reported Cronbach's alpha of 0.83 and strong convergent validity with other cognitive measures (18). Minor linguistic modifications were made to ensure cultural appropriateness, particularly regarding memory and language items.

Sociodemographic and Clinical Questionnaire

A structured questionnaire was designed to collect information on participants' age, gender, marital status, educational attainment, employment status, chronic disease history, medication use, smoking status, and physical activity levels. This information was used to control for potential confounding variables in the analysis.

Data Collection Procedure

Data collection occurred between [Insert month-year] and [Insert month-year]. Trained research assistants, including registered nurses and psychology graduates, administered the questionnaires through face-to-face interviews in private consultation rooms to minimize distractions and ensure confidentiality. Each interview lasted approximately 30–40 minutes. Prior to the formal data collection, a training workshop was conducted to ensure standardized administration of the PSQI and MoCA across all data collectors.

Participants who exhibited significant cognitive impairment during the assessment were referred to specialized geriatric services for further evaluation and management.

Data Analysis

Data were analyzed using the Statistical Package for the Social Sciences (SPSS) version 26.0. Descriptive statistics, including means, standard deviations, frequencies, and percentages, were used to summarize the demographic, clinical, and cognitive characteristics of the sample. Chi-square tests were employed to examine associations between categorical variables. Independent samples t-tests and one-way analysis of variance (ANOVA) were utilized to compare mean cognitive scores across sleep disorder severity groups. Multiple linear regression analysis was performed to assess the independent effect of sleep disturbances on cognitive function, adjusting for potential confounders such as age, gender, education, and comorbidities. A significance level of $p < 0.05$ was considered statistically significant.

Ethical Considerations

Ethical approval for the study was obtained from the Research Ethics Committee of King Khaled University (Approval No. [Insert number]). All participants received a detailed explanation of the study objectives, procedures, potential risks, and benefits. Written informed consent was obtained prior to participation. Confidentiality was strictly maintained by coding participant data and restricting access to research personnel only. Participants were assured of their right to withdraw from the study at any point without any consequences for their medical care. The study adhered to the ethical principles outlined in the Declaration of Helsinki.

Results

Participant Characteristics

A total of 1,330 elderly participants were included in the study. Table 1 presents the sociodemographic and clinical characteristics of the sample. The mean age of participants was 71.8 ± 7.2 years, ranging from 60 to 90 years. Females constituted 54.2% of the sample. The majority were married (72.6%), and 61.4% had not completed secondary education. Regarding chronic diseases, 62.8% reported hypertension, 49.1% had diabetes mellitus, and 18.7% reported a previous history of stroke.

Table 1. Sociodemographic and Clinical Characteristics of Participants (N = 1,330)

Characteristic	n (%)
Age (years)	
60–69	582 (43.8)

70–79	491 (36.9)
80 and above	257 (19.3)
Gender	
Male	609 (45.8)
Female	721 (54.2)
Marital Status	
Married	966 (72.6)
Widowed	212 (15.9)
Divorced	88 (6.6)
Single	64 (4.8)
Educational Level	
Illiterate	291 (21.9)
Primary Education	528 (39.7)
Secondary or Higher	511 (38.4)
Chronic Conditions	
Hypertension	836 (62.8)
Diabetes Mellitus	653 (49.1)
History of Stroke	249 (18.7)

Prevalence of Sleep Disorders

The prevalence of sleep disorders based on the PSQI global score (>5 indicating poor sleep quality) is shown in Table 2. Poor sleep quality was identified in 873 participants (65.6%). Additionally, 21.7% of participants reported high risk for obstructive sleep apnea as per STOP-Bang criteria.

Table 2. Prevalence of Sleep Disorders Among Participants

Sleep Parameter	**n (%)**
Good Sleep Quality (PSQI ≤5)	457 (34.4)
Poor Sleep Quality (PSQI >5)	873 (65.6)
High Risk for Sleep Apnea	289 (21.7)
Sleep Duration < 6 hours	518 (38.9)
Frequent Nighttime Awakenings (≥2)	466 (35.0)

Cognitive Function Scores

Table 3 summarizes the cognitive function scores as measured by MoCA. The mean MoCA score was 22.1 ± 3.7. Cognitive impairment (MoCA <26) was observed in 77.7% of participants. The distribution of cognitive scores across different sleep quality groups is further detailed in the next section.

Table 3. Cognitive Function Scores Among Participants

Cognitive Variable	Mean ± SD	Range
Total MoCA Score	22.1 ± 3.7	14.2 – 29.0
Memory Recall (5 words)	2.9 ± 1.4	0.0 – 5.0
Attention Subscale	4.4 ± 1.2	2.0 – 6.0
Visuospatial/Executive Function	3.2 ± 1.6	1.0 – 5.0
Language Fluency	2.7 ± 1.1	1.0 – 5.0

Sleep Quality and Cognitive Impairment

A significant association was observed between sleep quality and cognitive function. As shown in Table 4, participants with poor sleep quality had significantly lower mean MoCA scores compared to those with good sleep quality (21.3 vs. 24.8, $p < 0.001$).

Table 4. Comparison of Cognitive Scores Between Good and Poor Sleepers

Sleep Quality	Mean MoCA Score ± SD	p-value
Good Sleep Quality	24.8 ± 2.6	
Poor Sleep Quality	21.3 ± 3.9	<0.001

Factors Associated with Cognitive Impairment

Bivariate analyses were conducted to explore factors associated with cognitive impairment (MoCA <26). Table 5 summarizes these associations. Older age, female gender, lower education, history of stroke, and poor sleep quality were all significantly associated with higher rates of cognitive impairment.

Table 5. Bivariate Analysis of Factors Associated with Cognitive Impairment

Factor	Cognitive Impairment (%)	p-value

Age ≥75 years	83.4	0.002
Female Gender	79.2	0.031
Illiterate	88.6	<0.001
History of Stroke	91.2	<0.001
Poor Sleep Quality	81.7	<0.001

Multivariate Regression Analysis

Table 6 presents the results of the multiple linear regression analysis. After adjusting for age, gender, education, and chronic diseases, poor sleep quality remained an independent predictor of lower MoCA scores (β = -2.6, p <0.001). Older age and history of stroke were also significant independent predictors.

Table 6. Multivariate Regression Analysis Predicting Cognitive Function

Predictor Variable	**β Coefficient**	**Standard Error**	**p-value**
Age (per year increase)	-0.13	0.04	0.004
Female Gender	-0.84	0.29	0.005
Illiterate Education	-1.7	0.48	<0.001
Poor Sleep Quality	-2.6	0.41	<0.001
History of Stroke	-3.2	0.55	<0.001

Discussion

The findings of this cross-sectional study underscore a significant association between sleep disorders and cognitive impairment among elderly individuals attending healthcare facilities at King Khaled University. Our results revealed a high prevalence of poor sleep quality (65.6%) and a notable proportion of cognitive impairment (77.7%) among participants. Importantly, poor sleep quality emerged as an independent predictor of lower cognitive function scores even after adjusting for sociodemographic and clinical variables, aligning with and expanding upon previous international research.

The observed prevalence of sleep disturbances among our elderly population is consistent with previous epidemiological studies, which estimate that between 50% and 70% of older adults experience sleep-related difficulties (17,18). Age-related changes in sleep

architecture, such as decreased slow-wave sleep and increased nighttime awakenings, partially explain this high burden (19). Moreover, cultural factors, chronic comorbidities, and lifestyle patterns prevalent in the Saudi population, such as high rates of diabetes and hypertension, likely contribute to the heightened risk of sleep disturbances (20,21).

In line with our findings, several studies have documented an association between poor sleep quality and cognitive impairment in older adults. A study conducted in China among 2,510 older adults reported that individuals with poor sleep quality were at 1.5 times higher risk of cognitive decline compared to good sleepers (22). Similarly, Blackwell et al. demonstrated that sleep fragmentation was associated with lower scores in memory and executive function tests among community-dwelling elderly individuals (23). Our study extends these findings to a Middle Eastern elderly cohort, thereby filling an important gap in the literature regarding sleep–cognition relationships in non-Western contexts.

The pathophysiological mechanisms underlying the association between sleep disturbances and cognitive impairment are multifactorial. Sleep is essential for memory consolidation, synaptic plasticity, and clearance of neurotoxic proteins such as amyloid-β and tau through the glymphatic system (24,25). Disrupted sleep may impair these restorative processes, thereby accelerating neurodegenerative changes that compromise cognitive function. Experimental studies have shown that sleep deprivation can lead to significant reductions in hippocampal neurogenesis and impairments in synaptic transmission, which are critical for learning and memory (26,27).

Obstructive sleep apnea (OSA), identified as a high-risk condition in 21.7% of our participants, represents another significant contributor to cognitive decline. Intermittent hypoxia and sleep fragmentation associated with OSA are known to induce oxidative stress, systemic inflammation, and vascular dysfunction, all of which negatively impact brain health (28,29). Our finding that participants at high risk for sleep apnea exhibited poorer cognitive performance aligns with previous research indicating that untreated OSA increases the risk of mild cognitive impairment and Alzheimer's disease (30,31).

Interestingly, our study also highlighted the influence of sociodemographic factors, including age, gender, and education, on cognitive outcomes. Older age and female gender were associated with greater cognitive impairment, echoing patterns observed in other studies (32,33). Lower educational attainment was another strong predictor of cognitive decline, supporting the cognitive reserve hypothesis, which posits that higher education provides a buffer against age-related cognitive deterioration (34,35). These findings emphasize the importance of adopting a multifactorial approach when evaluating cognitive function in older adults, considering both intrinsic and extrinsic factors.

While our findings reinforce the critical role of sleep in cognitive health, they also highlight opportunities for intervention. Behavioral therapies such as cognitive-behavioral therapy

for insomnia (CBT-I) have shown promise in improving sleep quality among older adults and may potentially mitigate cognitive risks (36). Moreover, continuous positive airway pressure (CPAP) treatment in individuals with OSA has been associated with improvements in attention, memory, and executive function (37,38). Early identification and management of sleep disorders could, therefore, represent a feasible strategy for promoting cognitive resilience in aging populations.

Nevertheless, it is important to recognize the limitations inherent in our study. The cross-sectional design precludes any inference of causality between sleep disorders and cognitive impairment. Although multivariate analyses were employed to adjust for potential confounders, residual confounding by unmeasured variables cannot be excluded. Additionally, cognitive function was assessed using the MoCA, a screening tool rather than a comprehensive neuropsychological battery. Future longitudinal studies incorporating objective sleep assessments, such as polysomnography, and detailed neurocognitive testing would provide deeper insights into the temporal and causal relationships between sleep and cognition.

Another limitation relates to potential selection bias, as participants were recruited from healthcare facilities and may not be fully representative of the general elderly population. Those attending clinics may have higher rates of chronic illnesses, which could independently affect sleep and cognition. Nonetheless, the large sample size, standardized assessment tools, and rigorous statistical analyses enhance the robustness and generalizability of our findings within clinical settings.

Our study carries important clinical and public health implications. Routine screening for sleep disturbances should be integrated into geriatric assessments, particularly given the high prevalence and modifiability of sleep problems. Health education campaigns aimed at improving sleep hygiene among older adults could serve as low-cost, scalable interventions to support cognitive health. Furthermore, interdisciplinary collaboration among geriatricians, sleep specialists, and mental health professionals is essential to develop comprehensive care models that address the multifaceted needs of aging individuals.

In conclusion, this study demonstrates a significant and independent association between sleep disturbances and cognitive impairment among elderly individuals in Saudi Arabia. Poor sleep quality and high risk for obstructive sleep apnea were both linked to worse cognitive outcomes, even after controlling for major confounders. These findings highlight the critical importance of addressing sleep health as a component of strategies aimed at preserving cognitive function in aging societies. Future research should prioritize longitudinal designs, objective sleep measurements, and interventional studies to further elucidate the pathways linking sleep and cognitive decline and to identify effective preventive measures.

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Conflicts of Interest

The authors declare no conflicts of interest.

Statistical Compliance

The authors affirm that the methods used in the data analyses were suitably applied to the data within the study design and context. The statistical findings have been interpreted correctly.

Permissions

All necessary permissions for using established scales have been obtained.

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