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Research Article

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# Sleep Disorders and Their Effects on Cognitive Health, Mental Well-being, and Life Quality: A Cross-Sectional Study in Lahore Pakistan

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## Abstract

**Background:** Sleep quality has been identified as a modifiable risk factor for cognitive impairment, which is becoming a major issue among aging populations. High-income nations have seen a great deal of study, while communities in South Asia, especially Pakistan, have less data accessible.

**Objective:** This study aimed to investigate the link between sleep quality and cognitive impairment in people residing in Lahore, Pakistan.

**Methods:** Five hundred adult Lahore residents participated in a community-based cross-sectional survey. The Mini-Mental State Examination (MMSE) was used to evaluate the participants' cognitive abilities after they finished a structured questionnaire measuring sleep characteristics. Standardized MMSE cut-off values were used to define cognitive impairment. Sleep factors and cognitive impairment were examined using univariate and multivariate logistic regression analysis.

**Results:** 75 (15%) of the subjects reported cognitive impairment. People with a sleep latency of 16–30 minutes (OR = 0.33, 95% CI: 0.23–0.47, $p < 0.001$) and those who reported sleeping 6–7.9 hours (OR = 0.57, 95% CI: 0.40–0.80, $p = 0.001$) were considerably less likely to experience cognitive impairment. On the other hand, cognitive impairment was more likely to occur in those who used sleep aids, remained up late more than ten times in the previous three months, or had numerous nightly awakenings. Moreover, stratified analysis showed that the associations between sleep and cognitive performance were altered by age, BMI, and smoking history.

**Conclusion:** In Lahore, Pakistan, individuals' cognitive impairment is substantially correlated with poor sleep quality. Enhancing sleep patterns might be a workable way to slow down cognitive aging in public places.

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## Introduction

Cognitive dysfunction is described as a noticeable decline in important mental functions as memory, attention, executive function, language, and visuospatial processing [1]. It can be caused by a variety of reasons, including neurodegenerative diseases, neurological damage, psychological illnesses, and pharmacological side effects. Clinically, it might manifest as forgetfulness, poor attention, sluggish thinking, and language difficulties—symptoms that severely affect everyday functioning [2]. Individuals with cognitive impairment have an increased chance of developing dementia, making it a significant public health problem. Thus, identifying modifiable risk factors is crucial for early intervention and prevention.

Sleep is an essential biological requirement that promotes physical health, immunological function, emotional management, and cognitive functioning [3]. Sleep is one of the body's primary restorative activities, and it is essential for memory consolidation, attention control, and executive functioning. Poor sleep quality can affect these functions and has been linked to long-term neurological effects [4] (Broad Context).

Despite the known significance of sleep, sleep problems are nonetheless common and undertreated. Over 300 million individuals in Pakistan are believed to have sleep difficulties, with a nationwide prevalence incidence of 38.2% [5]. At the same time, the prevalence of cognitive impairment is rising, particularly among middle-aged and older persons. While previous research has suggested a link between sleep quality and cognitive performance, the results have been inconsistent [6]. Some studies indicate a considerable link between sleep disruptions and cognitive deterioration, while others show little or no prognostic significance [7] (Specific Problem).

Several research have looked into the link between insufficient sleep and poorer cognition. A comprehensive analysis found that sleep problems, such as insomnia, sleep fragmentation, and obstructive sleep apnea, are frequently related with cognitive impairment [8]. These disorders can cause neuroinflammatory reactions, neuronal network disruption, and impaired neuroplasticity, all of which are established pathways for cognitive decline. Poor sleep quality, as defined by short duration, nocturnal awakenings, delayed onset, and use of sleep drugs, was shown to be strongly associated with cognitive deficiencies, even after correcting for confounding variables [9]. However, contradictions persist in the research; for example, no significant association was observed between sleep disruptions and eventual cognitive impairment in a sample of older persons. These disparities might be attributed to variances in sample characteristics, sleep measures, or the existence of unaccounted for moderating factors like age, education level, or health condition. Furthermore, most research have focused on clinical or occupational groups, limiting their applicability to the general public [10] (Review of Relevant Literature).

To address these research gaps, the present study will employ a cross-sectional design to investigate the relationship between sleep quality and cognitive function in a normal adult population [11]. The specific objectives are to:

a. Identify the frequency and patterns of sleep disorders among different demographic groups.

b. Study the relationship between sleep metrics (duration, fragmentation, latency, and sleep aid usage) and cognitive function.;

c. Investigate how demographic and lifestyle variables influence the link between sleep and cognition [12] (Research Objective)

This study's emphasis on a wide population sample provides a deeper knowledge of how sleep quality affects cognitive health outside of clinical settings. The findings are intended to help improve public health initiatives and therapeutic practices by identifying major sleep-related risk factors for cognitive impairment [13]. Finally, this study emphasizes the importance of sleep as a vital component of cognitive health and general well-being, with implications for early detection measures, preventative care, and lifestyle interventions [14] (Significance of the Study).

## Methodology

### Study Design

This community-based cross-sectional study sought to determine the relationship between sleep quality and cognitive impairment in the general adult population. Participants were recruited from community settings and evaluated using standardized questionnaires and validated clinical tools [15]. The Mini-Mental State Examination (MMSE) was utilized to assess cognitive functioning. Additional demographic and health-related data were gathered to account for potential confounding variables such as age, gender, education level, and medical history. Statistical studies were carried out using descriptive statistics, t-tests, chi-square tests, Analysis of Variance (ANOVA), and multivariable regression models, depending on the variables and study aims. The primary goal was to investigate the link between sleep disruptions and cognitive results, as well as to discover variables that may impact this connection in the overall adult population [16].

### Study Setting

The study included adult volunteers recruited from a variety of professional contexts requiring non-standard shift employment (e.g., healthcare, manufacturing, transportation), as well as community health centers. Data were gathered using a combination of online and in-person techniques to guarantee variety among working populations [17]. For the community population component (addressing cognitive outcomes), individuals aged 40 and up were recruited from urban residential areas using convenience and snowball sampling approaches. Prior to data collection, ethical permission was obtained, and each subject provided informed consent [18].

### Study Population and Sample

The research population included community-dwelling per-

sons aged 40 and above, predominantly middle-aged and elderly inhabitants from urban and semi-urban locations. A total of 500 people were recruited using convenience sampling during community health checkups and outreach activities [19]. Individuals were chosen for the study based on their availability, desire to participate, and competence to complete standardized exams measuring sleep quality, cognitive function, and overall quality of life. Participants had to be free of serious neurological or mental diseases including stroke, Parkinson's disease, or schizophrenia, as well as cognitively and physically capable of completing the questionnaires on their own [20]. Individuals with incomplete or missing data on critical factors, as well as those with severe medical issues that may influence sleep or cognitive tests, were eliminated from the final analysis. This community-based sample provided a diversified representative of the overall adult population, allowing for a thorough examination of how sleep disruptions affect cognitive performance and quality of life outcomes in a real-world situation [21].

**Intervention**

This intervention combines evidence-based insomnia treatments, such as digital Cognitive Behavioral Therapy (CBT), neuromodulation techniques like Transcranial Direct Current Stimulation (tDCS) or Transcranial Magnetic Stimulation (TMS), wearable biofeedback systems, mindfulness training, structured sleep hygiene education, and stress management techniques [22]. The 4-6-week program is designed for individuals who are experiencing sleep problems, cognitive decline, or anxiety and depression symptoms. Its goal is to improve overall sleep quality, boost cognitive function, and promote mental well-being. This integrative and technology-supported strategy encourages long-term lifestyle improvements while also addressing modifiable risk factors associated with poor sleep and cognitive impairment [23].

**Data Collection**

This study's data were collected from the general public using a structured, self-administered questionnaire. The test was created to gather thorough data on sleep quality, medication adherence, cognitive performance, and related demographic factors [24]. To measure medication adherence, the questionnaire used the 8-item Morisky Medication Adherence Scale (MMAS-8), a widely used and validated tool in health research. This scale assesses behaviors such as forgetfulness, discontinuing prescriptions without medical guidance, and difficulties adhering to a medication schedule. Responses are often binary (yes/no), and overall scores classify adherence as low, medium, or high. The MMAS-8 has high dependability, with a reported Cronbach's alpha of 0.83. The sleep assessment questionnaire contained chosen items derived from established measures such as the Holland Sleep Disorders Questionnaire (HSDQ), which captured critical elements such as sleep length, sleep latency, nighttime awakenings, and usage of sleep drugs [25]. Given the previously established link between sleep quality and cognitive health, these sleep-related characteristics were crucial to the investigation. To facilitate subgroup analysis, demographic data such as age, gender, education level, and housing circumstances were obtained. The questionnaire was distributed online and in person using convenience sampling. Participation was entirely voluntary, and all subjects provided informed consent prior to data collection. The poll was carried out over a certain time period to maintain uniformity and reduce timing-related biases. This technique facilitated the collecting of reliable, community-based data relevant to the study's objectives [26].

**Data Analysis**

All collected replies were input and analyzed with SPSS Version 25. Descriptive statistics (frequencies, percentages, means, and standard deviations) were employed to describe demographic and sleep-related data. Bivariate analyses, such as chi-square tests and independent t-tests, were used to investigate the relationship between sleep practices and cognitive and mental health outcomes [27]. Inferential analysis was performed using logistic regression models to assess the strength of associations between sleep quality indicators (such as short or long sleep duration, sleep latency, and night-time awakenings) and key health outcomes, such as suspected cognitive dysfunction and sleep disorder symptoms. This analytical technique successfully identified sleep-related risk variables for cognitive impairment in older persons [28]. Adjustments were done for sociodemographic factors such as age, gender, and education level to account for any confounding impacts. A p-value of $<0.05$ indicated statistical significance. The findings were evaluated in light of previous research and explored in terms of the biology and public health implications of sleep health in the general population [29].

**Ethical Considerations**

Both reference studies revealed a strong commitment to ethical research procedures, with methodologies that ensured participant safety, autonomy, and data confidentiality. Participants in the study were recruited willingly through a public newspaper advertising and supplied informed consent online [30]. To preserve personal information, data was collected via non-invasive, self-administered questionnaires with complete anonymity. Although official ethics committee permission was not expressly stated, the work followed conventional ethical norms for peer-reviewed research. The participation of a varied and sizable general population increased fairness and representativeness. Methodological transparency and the use of approved assessment instruments demonstrated a high degree of scientific and ethical integrity. In contrast, the study was done with specific ethical permission from institutional review boards and in compliance with the Declaration of Helsinki [31]. Written informed permission was gained by direct, face-to-face interviews, assuring clear communication and willing involvement. The study used validated tools to measure sleep quality and cognitive performance, with low risk to participants. Anonymization of data, fair inclusion of middle-aged and older community members, and adherence to the STROBE principles for honest reporting all contributed to increased ethical rigor. Both research adhere to important ethical norms such as informed consent, confidentiality, nonmaleficence, equity, and scientific transparency, which reinforces the trustworthiness and integrity of their findings [32].

## Results

### General and Sleep Characteristics of Participants

The study comprised 500 people, with 425 (85%) showing no evidence of cognitive impairment and 75 (15%) classified as having cognitive dysfunction based on MMSE evaluation. Table 1 presents the participants' baseline general characteristics.

**Table 1:** Baseline characteristics of participants according to cognitive dysfunction.

| Characteristics | Total | Cognitive Dysfunction | | p-value |
|---|---|---|---|---|
| | (N=500) | No (85%) = 425 | Yes (15%) = 75 | |
| **Age (years)** | | | | <0.001 |
| 40–59 | 331 | 300 | 31 | |
| 60–69 | 134 | 88 | 46 | |
| ≥70 | 35 | 22 | 13 | |
| Sex | | | | 0.396 |
| Male | 245 | 207 | 38 | |
| Female | 255 | 218 | 37 | |
| **BMI (kg/m$^2$)** | | | | 0.001 |
| <24 | 205 | 191 | 14 | |
| ≥24 | 295 | 234 | 61 | |
| **Education Level** | | | | 0.131 |
| Illiteracy/primary | 7 | 6 | 1 | |
| Middle school | 27 | 23 | 4 | |
| College or above | 466 | 396 | 70 | |
| **Hypertension** | 208 | 180 | 28 | <0.001 |
| **Diabetes** | 72 | 62 | 10 | 0.024 |
| **Hyperlipidemia** | 290 | 233 | 57 | 0.009 |
| **Drinking** | 87 | 75 | 12 | 0.943 |
| **Smoking** | 102 | 86 | 16 | 0.823 |
| **Glucose (mmol/L)** | 5.8 ±1.6 | 5.8 ±1.5 | 6.0 ±1.7 | 0.026 |
| **Hemoglobin (g/L)** | 145.2 ±16.1 | 145.1 ±16.4 | 146.1 ±14.3 | 0.215 |
| **Neutrophil/lymphocyte** | 1.9 ±0.7 | 1.9 ±0.8 | 1.8 ±0.7 | 0.264 |
| **Exercise Habit** | | | | <0.001 |
| <1 per week | 97 | 89 | 8 | |
| 1–2 per week | 45 | 43 | 2 | |
| 3–4 per week | 35 | 34 | 1 | |
| >4 per week | 323 | 259 | 64 | |

The majority of participants were aged 40 to 59, with men accounting for 48.9%. Cognitive impairment was more prevalent in older individuals ($p < 0.001$), those with higher BMI ($p = 0.001$), and those with hypertension ($p < 0.001$), diabetes ($p = 0.024$), or hyperlipidemia ($p = 0.009$). Higher fasting glucose levels ($p = 0.026$) and less physical activity ($p < 0.001$) were associated with cognitive impairment. There were no significant differences in gender, education level, hemoglobin concentration, smoking, drinking, or neutrophil-to-lymphocyte ratios.

Table 2 shows sleep-related features. Significant differences were found between groups with and without cognitive impairment in terms of total sleep time ($p < 0.001$), sleep latency ($p < 0.001$), number of awakenings during the night ($p < 0.001$), and use of sleep medication ($p < 0.001$). Cognitive impairment was linked to lower sleep duration (<6 hours), longer sleep latency (>1 hour), frequent night awakenings (≥2 times), and increased usage of sleep medication. There was no significant link between cognitive impairments and late-night behavior ($p = 0.466$) (Tables 1,2).

**Table 2:** Sleep quality of participants according to cognitive dysfunction.

| Characteristics | Total | Cognitive Dysfunction | Cognitive Dysfunction | p-value |
|---|---|---|---|---|
| | (N=500) | No (425) | Yes (75) | |
| **Total sleep duration** | | | | <0.001 |
| <6 h | 84 | 64 | 20 | |
| 6–7.9 h | 372 | 321 | 51 | |
| >8 h | 44 | 40 | 4 | |
| **Sleep latency** | | | | <0.001 |
| 0–15 min | 272 | 233 | 39 | |
| 16–30 min | 188 | 182 | 6 | |
| 30–60 min | 26 | 22 | 4 | |
| >1 h | 14 | 9 | 5 | |
| **Number of awakenings** | | | | <0.001 |
| 0 | 210 | 186 | 24 | |
| 1 | 226 | 204 | 22 | |
| 2 | 45 | 38 | 7 | |
| ≥3 | 19 | 15 | 4 | |
| **Frequency of staying up** | | | | 0.466 |
| 0 | 412 | 369 | 43 | |
| 1–5 | 33 | 30 | 3 | |
| 6–10 | 10 | 9 | 1 | |
| ≥11 | 45 | 17 | 28 | |
| Sleep medication | | | | <0.001 |
| No | 495 | 445 | 50 | |
| Yes | 5 | 4 | 1 | |

**Associations Between Sleep Quality and Cognitive Dysfunction**

The relationship between sleep quality and cognitive impairment was investigated further using logistic regression analysis (Table 3). In the fully adjusted model (Model 2), participants who slept 6-7.9 hours per night had a substantially reduced risk of cognitive impairment than those who slept fewer than 6 hours (OR = 0.57, 95% CI: 0.40-0.80, p = 0.001). Similarly, individuals who slept more than 8 hours had a lower risk (OR = 0.58, 95% CI: 0.33-1.00, p = 0.052).

Shorter sleep latency (16-30 minutes) was more protective than longer latency periods. Participants with sleep latency of 16-30 minutes showed substantially decreased risk of cognitive impairment (OR = 0.33, 95% CI: 0.23-0.47, p < 0.001). Longer sleep latency (>1 h) was linked with an elevated risk, but it did not achieve statistical significance in the fully adjusted model (OR = 1.30, 95% confidence interval: 0.62-2.72, p = 0.490).

Night awakenings were also substantially linked to cognitive impairment. Waking up once throughout the night increased the risks of cognitive impairment (OR = 1.65, 95% CI: 1.19-2.30, p = 0.003), as did waking up three or more times (OR = 2.34, 95% CI: 1.25-4.36, p = 0.008) as compared to no awakenings. In Model 2, frequent late-night activity (≥11 occasions over 3 months) was found to increase the risk of cognitive impairment (OR = 1.90, 95% CI: 1.20-3.00, p = 0.006). Finally, sleep drug usage was shown to be strongly linked with cognitive impairment in all models. Participants who took sleep medicine had approximately three times the risk of cognitive impairment as those who did not (OR = 2.97, 95% CI: 1.19-7.45, p = 0.020) (Table 3).

**Table 3:** Association between sleep quality and cognitive dysfunction.

| | Crude model | | Model 1 | | Model 2 | |
|---|---|---|---|---|---|---|
| | **Unadjusted OR (95% CI)** | **P** | **Adjusted OR (95% CI)** | **P** | **Adjusted OR (95% CI)** | **P** |
| Total sleep duration (<6 h) | Ref. | | Ref. | | Ref. | |
| Total sleep duration (6–7.9 h) | 0.53(0.42–0.67) | <0.001 | 0.68 (0.53–0.88) | 0.003 | 0.57 (0.40–0.80) | 0.001 |
| Total sleep duration (>8 h) | 0.47 (0.31–0.71) | <0.001 | 0.66 (0.39–0.92) | 0.019 | 0.58 (0.33–1.00) | 0.052 |
| P for trend | | <0.001 | | 0.003 | | 0.007 |
| Sleep latency (0-15 min) | Ref. | | Ref. | | Ref. | |
| Sleep latency (16-30 min) | 0.28 (0.21–0.36) | <0.001 | 0.33 (0.25–0.43) | <0.001 | 0.33 (0.23–0.47) | <0.001 |
| Sleep latency (30-60 min) | 0.62 (0.38–0.99) | 0.046 | 0.63 (0.38–1.02) | 0.059 | 0.53 (0.27–1.06) | 0.074 |
| Sleep latency (>1 h) | 2.08 (1.32–3.28) | 0.002 | 1.69 (1.05–2.72) | 0.032 | 1.30 (0.62–2.72) | 0.49 |
| **P for trend** | | <0.001 | | 0.002 | | 0.001 |
| Number of awakenings (0) | Ref. | | Ref. | | Ref. | |
| Number of awakenings (1) | 1.21 (0.97–1.50) | 0.091 | 1.07 (0.85–1.34) | 0.578 | 1.65 (1.19–2.30) | 0.003 |
| Number of awakenings (2) | 1.65 (1.18–2.13) | 0.004 | 1.27 (0.89–1.80) | 0.184 | 1.64 (0.98–2.74) | 0.06 |
| Number of awakenings (≥3) | 2.27 (1.47–3.52) | <0.001 | 1.52 (0.96–2.40) | 0.074 | 2.34 (1.25–4.36) | 0.008 |
| **P for trend** | | <0.001 | | 0.052 | | 0.001 |
| Frequency of staying up | Ref. | | Ref. | | Ref. | |
| (None) | | | | | | |
| Frequency of staying up | 0.74 (0.47–1.15) | 0.179 | 1.09 (0.69–1.74) | 0.709 | 0.79 (0.37–1.67) | 0.53 |
| (1–5) | | | | | | |
| Frequency of staying up | 0.77 (0.35–1.72) | 0.526 | 1.29 (0.56–2.97) | 0.55 | 0.71 (0.17–3.11) | 0.656 |
| (6–10) | | | | | | |
| Frequency of staying up | 1.08 (0.78–1.51) | 0.633 | 1.69 (1.19–2.41) | 0.004 | 1.90 (1.20–3.00) | 0.006 |
| (≥11) | | | | | | |
| **P for trend** | | 0.96 | | 0.004 | | 0.016 |
| Sleep medication | | | | | | |
| No | Ref. | | Ref. | | Ref. | |
| Yes | 3.49 (1.69–7.19) | <0.001 | 2.70 (1.26–5.78) | 0.011 | 2.97 (1.19–7.45) | 0.02 |
| **P for trend** | | <0.001 | | 0.011 | | 0.02 |

**Stratified Analysis**

Stratified analyses were used to look at the connections between sleep characteristics and demographic or clinical risk factors in relation to cognitive impairment. First, we conducted stratified analyses of total sleep duration based on important risk variables (Supplementary Table S1). A significant interaction was seen between age and sleep duration of 6-7.9 hours (p = 0.042). In this subgroup, those aged 40-59 years (OR = 0.44, 95% CI: 0.25-0.78, p = 0.005) and 60-69 years (OR = 0.47, 95% CI: 0.29-0.76, p = 0.002) had a decreased risk of cognitive impairment. Furthermore, there was a significant interaction between BMI and sleep duration greater than 8 hours (p = 0.043). Participants who slept more than 8

hours and had a BMI ≥24 had a lower risk of cognitive impairment (OR = 0.39, 95% CI: 0.19-0.79, p = 0.010).

Second, we examined stratification according to sleep latency (Supplementary Table S2). A significant interaction was seen between age and sleep delay more than one hour (p = 0.031). Participants aged 40-59 years with sleep delay >1 hour had a substantially greater risk of cognitive impairment (OR = 4.02, 95% CI: 1.17-13.84, p = 0.028). Third, stratification based on the frequency of nightly awakenings indicated several interactions (Supplementary Table S3). There was a significant interaction between age and waking up once every night (p < 0.001). Individuals aged 40-59 years (OR = 3.14, 95% CI: 1.84-5.35, p < 0.001) and ≥70 years (OR = 4.14, 95% CI: 1.33-12.88, p = 0.014) had a higher risk of cognitive impairment. Participants who awoke once per night were more likely to develop cognitive impairment if they did not smoke (OR = 2.19, 95% CI: 1.48-3.25, p < 0.001). There was also a significant interaction between smoking and nighttime waking (p = 0.005).

These findings suggest that age, BMI, and smoking status may influence the relationship between sleep characteristics and cognitive impairment, highlighting the necessity of customized risk assessments in sleep-related cognitive health.

## Discussion

In this community-based cross-sectional study, we examined the relationship between sleep quality and cognitive impairment in 500 persons from Lahore, Pakistan. Our findings demonstrated that several sleep factors were significantly connected to cognitive state [33]. Participants who slept for 6-7.9 hours with sleep latencies ranging from 16 to 30 minutes were less likely to suffer cognitive impairment. In contrast, frequent overnight awakenings, staying up late, and using sleep medications have all been associated to an increased risk of cognitive impairment [34].

In recent years, sleep issues have emerged as a major public health concern in Pakistan. It is believed that a significant proportion of the population suffers from sleep disruption, and the tendency looks to be rising, particularly in metropolitan regions like Lahore. Sleep problems, such as insomnia, sleep apnea, and circadian rhythm disturbances, have been related to a variety of physical and mental health issues [35]. Chronic sleep disruption causes various system malfunction and raises the risk of metabolic syndrome, cardiovascular disease, and obesity. In terms of mental health, insufficient sleep has been linked to sadness, anxiety, emotional instability, and cognitive deterioration. Given that cognitive impairment can be an early indicator of neurodegenerative disorders such as Alzheimer's disease and vascular dementia, recognizing modifiable risk factors such as inadequate sleep is critical for early preventive methods [36] (Figure 1).

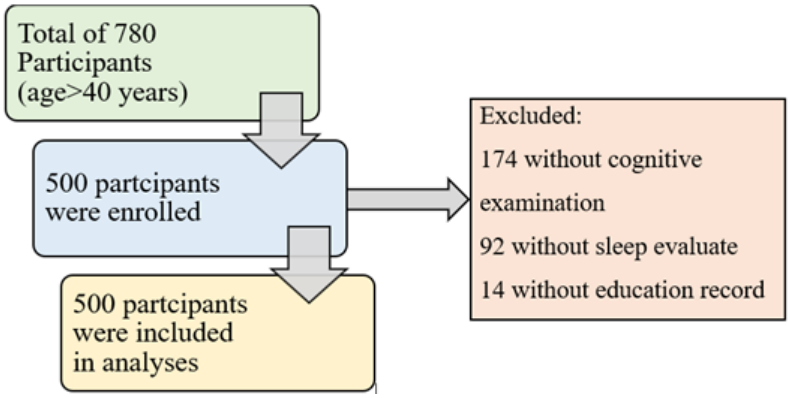


**Figure 1:**

Our study discovered that people who slept 6-7.9 hours each night had a considerably lower risk of cognitive impairment than those who slept fewer than 6 hours. This is consistent with prior research indicating that moderate sleep duration has a protective impact on cognitive function [37]. For example, it was shown that older people who slept fewer than 7 hours had a linear decrease in cognitive impairment risk with each extra hour of sleep. Nighttime sleep is critical for memory consolidation and synaptic balance. It promotes neuronal regeneration and modulates neurotransmitters like acetylcholine and dopamine, which are necessary for attention and learning [38]. Sleep disruption has been demonstrated to affect the glymphatic system, which is essential for removing neurotoxic waste products like as beta-amyloid and tau proteins, both of which are linked to Alzheimer's disease pathology. As a result, poor sleep may encourage neurotoxic buildup and cause cognitive impairment. Participants with a sleep delay of 16-30 minutes had a considerably decreased risk of cognitive impairment compared to those with a very short latency (<15 minutes) [39]. Although there is no clear consensus on how sleep delay affects cognition, numerous researches show that extended latency implies poor sleep efficiency. Sleep latency was found to be an average of 6.97 minutes longer in cognitively impaired older individuals. A polysomnography investigation revealed that Alzheimer's sufferers had much higher latency than controls [40]. Surprisingly, our data imply that both very short and lengthy sleep latencies may be harmful, and that a normal sleep start period may indicate improved sleep

control. However, because normal sleep latency is regarded up to 30 minutes, further research is needed to validate these findings in bigger and more varied groups [41].

Our findings demonstrated that participants who reported waking up one or more times throughout the night were more likely to develop cognitive impairment, with the risk increasing with each awakening. Frequent nocturnal awakenings contribute to sleep fragmentation, which has been linked to neuroinflammation via microglial activation and increased inflammatory cytokines, notably in the hippocampus [42]. Fragmented sleep has also been linked to poor endothelium function and blood-brain barrier disturbance, both of which may impair cognitive performance. These physiological changes emphasize the necessity of undisturbed sleep in preserving cognitive health, particularly in middle-aged and elderly people [43].

Participants who had regularly remained up late in the previous three months were considerably more likely to suffer from cognitive impairment. Staying up late frequently results in chronic sleep deprivation and circadian rhythm misalignment, both of which impair brain performance [44]. Sleep deprivation is linked to neurotransmitter imbalance (e.g., decreased acetylcholine), neuronal stress, and reduced synaptic plasticity, all of which lead to poor learning, attention, and memory. Furthermore, irregular sleep cycles might reduce the brain's capacity to consolidate memories and perform cognitive activities effectively [45].

Our study also discovered a strong link between sleep medicine usage and cognitive impairment. This most likely indicates the presence of underlying serious sleep difficulties, which may be risk factors for cognitive impairment. Sleep drugs, particularly those that operate on the GABAergic system (such as benzodiazepines), have been related to short-term memory problems and an increased risk of dementia in several studies [46]. While drugs can be useful in acute situations, their long-term usage should be approached with caution due to the possibility of cognitive negative effects [47].

The stratified analysis in our study indicated significant impact modifiers. Age was substantially linked to cognitive impairment across several sleep domains. As predicted, increasing age was a constant risk factor [48]. This is consistent with prior study, which found that age-related changes in brain structure, such as decreased gray and white matter volume and increased neuroinflammation, lead to cognitive decline [49].

Interestingly, persons with a lower BMI were more likely to have cognitive impairment. Although there is conflicting data on the BMI-cognition relationship, a low BMI may indicate malnutrition, which has been linked to brain shrinkage and impaired neurotransmission. High BMI has been associated to cognitive impairment via metabolic and vascular pathways, revealing a U-shaped connection that warrants more investigation [50].

Our result that nonsmokers who woke up once at night had a greater risk of cognitive impairment appears contradictory, but it might be due to unmeasured confounders or nicotine's possible neuro stimulatory effects [51]. While some research show that nicotine might improve acute attention and working memory, prolonged smoking is detrimental to brain health owing to oxidative stress, vascular damage, and neurotoxicity. As a result, the complicated association between smoking and cognition warrants more investigation [52].

In conclusion, our findings show that poor sleep quality—including short sleep duration, protracted latency, nightly awakenings, frequent late nights, and sleep medicine use—is strongly linked with cognitive impairment in individuals living in Lahore, Pakistan [53]. These findings highlight the necessity of early detection and management for sleep problems in community settings in order to lower the risk of cognitive deterioration [54]. Sleep health education and treatment should be included into Pakistan's public health plans and primary care practices to enhance cognitive outcomes and promote healthy aging, particularly in urban populations where sleep problems are under-recognized yet very prevalent [55].

## Limitations

The study has significant drawbacks. First, all sleep factors were self-reported using questionnaires, which might be prone to memory bias or subjective misunderstanding. Due to limited resources, objective evaluations like as actigraphy and polysomnography were not employed [56]. Second, the cross-sectional design does not allow for a causal relationship between sleep quality and cognitive impairment. Longitudinal investigations are needed to determine the direction and underlying mechanisms of these correlations [57].

Third, the sample was confined to a single metropolitan area (Lahore, Pakistan), which may limit the findings' applicability to rural people or other parts of the nation. Future research with bigger, multicenter samples from Pakistan might improve the external validity of these findings [58]. Finally, while major confounding variables were controlled for in the regression models, several characteristics, such as psychiatric history, stress levels, and detailed socioeconomic status, were not assessed and may have an impact on both sleep and cognitive results [56].

## Conclusion

This study presents fresh data from Lahore, Pakistan, emphasizing the link between poor sleep quality and cognitive impairment in middle-aged and older persons. Our data show that short sleep duration, extended sleep latency, numerous overnight awakenings, staying up late, and use of sleep medicine are all independently associated with an elevated risk of cognitive impairment. Sleeping for 6-7.9 hours and having a modest sleep latency of 16-30 minutes were related with a decreased risk of cognitive impairment. These data imply that keeping a good sleep schedule may help with cognitive resilience. Given Pakistan's expanding burden of neurodegenerative illnesses and the high incidence of sleep disorders in urban populations, sleep health promotion should be included into

primary care and community outreach programs. Older adults and people with metabolic risk factors like hypertension and obesity should receive special care since they are more sensitive to sleep disturbance and cognitive impairment.

## Future Recommendations

This study found a strong link between poor sleep quality and cognitive impairment in people in Lahore, Pakistan. Given the increased frequency of sleep-related health issues and their larger influence on cognitive and neurological well-being, the following evidence-based guidelines are recommended to guide future research, advise clinical practice, and raise community awareness:

**Strengthen Public Awareness of Sleep and Cognitive Health**

Sleep is often overlooked in everyday life, despite its importance in memory, focus, and emotional stability. Health authorities, non-governmental organizations, and media sources should work together to establish culturally relevant public health initiatives that promote sleep hygiene. Messaging should highlight the need of getting 6-8 hours of sleep every night, avoiding excessive screen time, limiting coffee and heavy meals before bedtime, and keeping regular sleep-wake cycles [59].

**Integrate Sleep Screening in Routine Healthcare**

Primary care physicians, mental health practitioners, and specialists should include basic sleep assessment instruments in routine check-ups, especially for middle-aged and elderly people. Identifying at-risk patients early, particularly those with hypertension, diabetes, or obesity, allows for prompt interventions to prevent or delay cognitive deterioration [60].

**Expand Access to Community-Based Sleep Services**

There is an urgent need for inexpensive, accessible sleep clinics inside public hospitals and urban primary health units in places such as Lahore. These programs should provide information, screening, and behavioral therapies, such as Cognitive Behavioral Therapy for Insomnia (CBT-I), which has been demonstrated to improve sleep without the need of medication [61].

**Encourage Healthy Sleep Practices at the Family and Community Level**

Families have an important influence in determining sleep patterns. Educational programs could help families support the elderly and fragile relatives by developing consistent and tranquil nightly routines. Community leaders, religious organizations, and local health workers should work together to spread clear, culturally relevant messages about how sleep quality affects brain function and general well-being [62].

**Conduct Longitudinal and Interventional Research in Pakistan**

Longitudinal cohort studies in various regions of Pakistan, including both urban and rural populations, are required to better understand the direction and degree of correlations between sleep and cognitive function. Future study should look at how lifestyle treatments, such as better sleep habits, exercise, and food, affect cognitive results over time [63].

**Address Sleep Medication Use with Caution**

This study found that using sleep drugs, particularly sedatives or benzodiazepines, increased the risk of cognitive impairment. Future studies should look on medicine use, dependency, and adverse effects among the Pakistani population. Clinicians should be taught to promote behavioral treatments before prescribing drugs, and patients should be warned on the hazards of long-term usage [32].

**Explore Sociocultural and Environmental Determinants**

Long evening social events, late-night screen exposure, prayer timings, and noise pollution are examples of cultural, occupational, and environmental variables that impact sleep behavior in Pakistan. Future study should investigate how these characteristics interact with sleep and cognition in order to design culturally appropriate therapies [64].

**Promote Sleep Health Through Schools and Workplaces**

Educational institutions and companies may play an important role in encouraging good sleep [65]. Schools can include sleep instruction into health science curriculum, and companies may help their employees by reducing night shifts, fostering work-life balance, and including wellness programs that address sleep as a critical component of mental and physical health [66].

**Train Healthcare Providers in Sleep and Geriatric Cognitive Care**

The Pakistani healthcare system requires more competence in sleep medicine and cognitive health [67]. Continuing Medical Education (CME) programs should include courses on identifying and managing sleep problems, particularly in older persons, as well as understanding their link to cognitive decline [68].

**Target High-Risk Groups for Early Intervention**

Sleep quality examinations should emphasize older persons, people with metabolic problems (e.g., diabetes, hypertension), and people who lead sedentary lives or have inconsistent sleep habits [69]. Tailored therapies depending on age, BMI, gender, and smoking status can help avoid early cognitive decline in these populations [70].

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## Conflict of Interest

None.

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