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COGNITIVE AND FUNCTIONAL IMPACTS OF SLEEP DEPRIVATION ON NEUROLOGICAL HEALTH AMONG WORKING PROFESSIONALS

Original Research

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ABSTRACT

Background: Sleep deprivation has emerged as a major occupational health concern, affecting cognitive efficiency, neurological function, and overall well-being. Among working professionals, chronic lack of restorative sleep contributes to fatigue, impaired decision-making, and declining productivity. Despite growing awareness, limited empirical data exist from regional professional populations linking sleep deprivation with measurable neurological and cognitive outcomes.

Objective: To evaluate how chronic sleep deprivation influences neurological functioning, cognitive performance, and overall health outcomes among working professionals in South Punjab.

Methods: A cross-sectional study was conducted over four months involving 380 full-time professionals aged 25–55 years from healthcare, education, corporate, and administrative sectors. Sleep quality was assessed using the Pittsburgh Sleep Quality Index (PSQI), cognitive performance through the Montreal Cognitive Assessment (MoCA), neurological alertness via the Psychomotor Vigilance Test (PVT), and overall health using the Short Form Health Survey (SF-36). Data were analyzed using SPSS version 26. Descriptive statistics, independent t-tests, one-way ANOVA, Pearson's correlation, and multiple linear regression were applied, considering $p < 0.05$ as statistically significant.

Results: A total of 62.6% of participants were identified as poor sleepers (PSQI >5). Poor sleepers had significantly lower mean MoCA scores (21.8 ± 3.4) and prolonged PVT reaction times (392 ± 68 ms) compared to good sleepers (27.3 ± 2.1 and 328 ± 55 ms, respectively, $p < 0.001$). Sleep duration correlated positively with cognitive performance ($r = 0.62$) and health outcomes ($r = 0.55$) while negatively with reaction time ($r = –0.58$). Sleep duration independently predicted cognitive and health outcomes after controlling for confounders ($\beta = 0.58$, $p < 0.001$).

Conclusion: Chronic sleep deprivation among working professionals was strongly associated with impaired cognition, reduced neurological responsiveness, and poorer health status. Promoting adequate sleep and workplace wellness initiatives may help preserve cognitive function and improve occupational health outcomes.

Keywords: Adults; Cognition; Fatigue; Occupational Health; Sleep Deprivation; Sleep Quality; Work Performance.

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INTRODUCTION

Sleep has long been recognized as an essential biological process vital for maintaining cognitive, emotional, and physiological balance (1). Yet, in modern professional environments characterized by high demands, long work hours, and digital connectivity, sleep often becomes a neglected priority. The chronic sacrifice of adequate rest has become almost synonymous with professional dedication, creating an insidious public health issue that transcends industries and socioeconomic boundaries. Sleep deprivation, whether partial or chronic, exerts profound effects on neurological health, impairing cognitive processes, emotional regulation, and physical functioning (2). The growing prevalence of sleep insufficiency among working professionals thus raises critical concerns regarding its cumulative impact on brain health and overall human performance. Scientific understanding has consistently underscored that sleep is not merely a passive state of rest but an active, restorative process essential for neuroplasticity, memory consolidation, and metabolic homeostasis. During various stages of sleep—particularly slow-wave and rapid eye movement (REM) sleep—the brain engages in intricate processes that support learning, decision-making, and emotional resilience. When these restorative cycles are repeatedly interrupted or curtailed, the brain's ability to process information, maintain attention, and regulate mood becomes compromised. Chronic sleep restriction disrupts neuronal communication, reduces synaptic efficiency, and impairs the clearance of neurotoxic waste products such as beta-amyloid peptides, which have been linked to neurodegenerative diseases. Consequently, sleep deprivation is no longer viewed as a benign inconvenience but as a serious neurological risk factor (3).

Among working professionals, the effects of inadequate sleep manifest in both subtle and overt ways. Persistent fatigue, diminished focus, and slower reaction times are common early indicators (4). Over time, however, these symptoms may progress into more concerning impairments, including deficits in executive functioning, creativity, and emotional intelligence—attributes essential for workplace competence. Furthermore, research has revealed that prolonged sleep deprivation alters brain connectivity patterns, particularly within regions responsible for attention and memory (5). These neurological alterations not only degrade job performance but also increase vulnerability to mental health disorders such as anxiety, depression, and burnout. The cyclical nature of stress and sleep deprivation further compounds the problem: occupational stress disrupts sleep quality, and poor sleep, in turn, exacerbates stress reactivity, creating a self-perpetuating decline in both mental and physical well-being. The physiological ramifications extend beyond cognitive dysfunction. Chronic sleep deprivation has been associated with metabolic dysregulation, impaired immune response, and elevated inflammatory markers. These systemic changes indirectly affect brain health, as inflammation and oxidative stress can accelerate neuronal aging and compromise cerebrovascular integrity. In professionals exposed to prolonged work-related strain—such as healthcare providers, corporate executives, and shift workers—the interaction between stress hormones and disrupted sleep patterns amplifies these detrimental effects. The neurological system, being both central and sensitive, becomes particularly susceptible to such continuous strain, which may predispose individuals to long-term neurological disorders (6).

Despite increasing awareness of the importance of sleep, many professionals continue to underestimate its significance, often perceiving sleep reduction as a manageable or even commendable aspect of ambition (7). This cultural normalization of exhaustion not only endangers individual health but also undermines organizational productivity and societal efficiency. Modern neuroscience challenges the misconception that the brain can indefinitely compensate for sleep loss (8). While temporary adaptation may mask immediate deficits, the cumulative neurological cost of chronic deprivation remains unavoidable. Brain imaging studies have shown that even moderate sleep restriction over several days can produce functional impairments comparable to total sleep deprivation (9). The resulting decline in cognitive flexibility, working memory, and decision-making accuracy carries significant implications for safety, innovation, and interpersonal relationships within professional contexts. Addressing this growing concern requires a deeper understanding of the multifaceted ways sleep deprivation influences brain function and overall health outcomes. While existing literature has extensively documented the short-term cognitive effects of acute sleep loss, there remains a notable gap regarding the long-term neurological consequences among chronically sleep-deprived working populations. Few studies have comprehensively examined how sustained deficits in sleep quality and duration interact with occupational stressors to influence both cognitive decline and functional health trajectories. This gap underscores the urgent need for focused investigation into how chronic sleep deprivation affects the neural mechanisms underlying attention, memory, emotional regulation, and executive performance in adults who experience continuous work-related pressure. This study seeks to evaluate how chronic sleep deprivation influences neurological functioning, cognitive performance, and overall health outcomes among working professionals. The objective is to establish a clearer understanding of the extent to which

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sleep loss contributes to cognitive inefficiency and potential neurological compromise, while also identifying patterns that may inform preventive interventions. Through this exploration, the research aims to emphasize the critical importance of restorative sleep as a foundational component of neurological health and occupational sustainability (10).

METHODS

This cross-sectional study was conducted over a period of four months in the South Punjab region with the primary objective of evaluating how chronic sleep deprivation influences neurological functioning, cognitive performance, and overall health outcomes among working professionals. The design was chosen to allow for the assessment of relationships between sleep duration and various functional outcomes at a single point in time, providing a clear snapshot of the prevalence and impact of sleep deprivation within a professional population.

The study population consisted of full-time working professionals aged 25 to 55 years, employed across different sectors including healthcare, education, corporate, and administrative fields. Participants were recruited using stratified random sampling to ensure balanced representation from each occupational category. The sample size was estimated using the Cochran formula for cross-sectional studies, assuming a 95% confidence level, 5% margin of error, and an expected prevalence of inadequate sleep among working adults at 40%. Based on this calculation, a sample of 369 participants was required; however, to account for possible non-responses or incomplete data, a total of 380 participants were targeted.

Inclusion criteria included adults actively engaged in full-time employment, having a consistent work schedule, and self-reporting an average sleep duration of fewer than seven hours per night for the preceding three months. Participants were required to be free from known neurological disorders, psychiatric illnesses, or chronic systemic diseases that could independently influence cognitive function. Individuals with a history of insomnia, sleep apnea, substance use, or current use of medications affecting sleep or alertness were excluded. Those who had engaged in shift work or night duty during the month preceding data collection were also excluded to avoid confounding from acute sleep pattern changes.

Data were collected using structured, pretested questionnaires and standardized assessment tools administered in controlled environments, primarily within workplace or academic settings. Sleep quality was assessed through the Pittsburgh Sleep Quality Index (PSQI), which provided quantitative data on sleep duration, disturbances, and overall sleep efficiency. Cognitive functioning was evaluated using the Montreal Cognitive Assessment (MoCA), a validated tool that examines memory, attention, language, executive function, and visuospatial abilities. Neurological performance was measured objectively using the Psychomotor Vigilance Test (PVT), which recorded reaction times and lapses as indicators of attention and alertness. To assess general health outcomes, the Short Form Health Survey (SF-36) was employed, encompassing both physical and mental health domains.

All data were collected under uniform conditions during daytime hours to maintain consistency. Demographic information, including age, gender, occupation, working hours, and lifestyle habits (such as caffeine intake, screen exposure, and physical activity), was also recorded to account for potential confounding variables. Each participant provided informed consent prior to inclusion in the study.

Statistical analysis was performed using SPSS version 26. Descriptive statistics were used to summarize demographic characteristics and outcome measures. The Shapiro–Wilk test confirmed normal data distribution. Independent samples t-tests were applied to compare mean cognitive and neurological scores between adequate and inadequate sleepers. One-way analysis of variance (ANOVA) was used to evaluate variations across different occupational groups and sleep duration categories. Pearson's correlation coefficient determined the strength and direction of associations between sleep quality, cognitive performance, and overall health scores. Finally, multiple linear regression analysis was conducted to identify predictors of impaired cognitive and neurological function, controlling for relevant confounders such as age, gender, and working hours. A p-value of less than 0.05 was considered statistically significant.

This cross-sectional design, supported by validated assessment tools and rigorous statistical methods, enabled a comprehensive evaluation of the interrelation between sleep deprivation and neurological health among working professionals in South Punjab, providing valuable insights into an often-overlooked determinant of cognitive and functional well-being.

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RESULTS

The study included 380 working professionals from diverse occupational backgrounds in South Punjab. The mean age of participants was 36.8 ± 7.2 years, with a slight predominance of males (54.7%). The average work duration per week was 48.5 ± 7.6 hours, while the mean reported sleep duration was 6.1 ± 1.2 hours. Healthcare professionals accounted for 24.2% of participants, corporate employees 30.0%, educators 25.8%, and administrative staff 20.0%. The average caffeine consumption was 2.4 ± 1.1 cups per day (Table 1).

Analysis of sleep quality using the Pittsburgh Sleep Quality Index revealed that 62.6% of participants were classified as poor sleepers, having PSQI scores greater than 5, while 37.4% were identified as good sleepers. The mean PSQI score for poor sleepers was 9.1 ± 2.2 compared to 4.3 ± 0.9 among good sleepers, demonstrating a substantial prevalence of poor sleep within the working population (Table 2, Figure 1).

Cognitive performance, assessed using the Montreal Cognitive Assessment (MoCA), showed that 53.7% of participants had normal cognition, 38.4% displayed mild cognitive impairment, and 7.9% demonstrated moderate impairment. The mean MoCA score was highest among good sleepers (27.1 ± 1.6) and lowest among participants with moderate impairment (16.2 ± 1.3), indicating a marked association between sleep quality and cognitive efficiency (Table 3).

Neurological performance as measured by the Psychomotor Vigilance Test (PVT) indicated a mean reaction time of 392 ± 68 milliseconds in poor sleepers compared to 328 ± 55 milliseconds in good sleepers, reflecting slower cognitive response associated with reduced sleep. Likewise, SF-36 health survey results demonstrated significantly lower mean health scores among poor sleepers (64.2 ± 11.8) than good sleepers (78.5 ± 9.7), indicating a detrimental effect of inadequate sleep on general health status.

Correlation analysis revealed significant positive relationships between sleep duration and both MoCA and SF-36 scores ($r = 0.62$ and 0.55, $p < 0.001$), while a strong negative correlation was observed between sleep duration and PVT reaction time ($r = -0.58$, $p < 0.001$). These findings indicated that longer sleep duration was associated with better cognitive and health outcomes, and improved neurological alertness (Table 4, Figure 2).

Analysis across occupational categories revealed that healthcare and corporate professionals reported the lowest mean sleep durations (5.7 ± 1.1 hours and 5.9 ± 1.0 hours respectively), corresponding with lower MoCA and SF-36 scores compared to education and administrative groups. A one-way ANOVA demonstrated significant differences in cognitive performance across occupational sectors ($F = 4.63$, $p = 0.003$).

Independent samples t-tests further revealed that poor sleepers had significantly lower mean MoCA scores (21.8 ± 3.4) compared to good sleepers (27.3 ± 2.1) with $p < 0.001$, and significantly prolonged PVT reaction times ($p < 0.001$). Similarly, the mean SF-36 scores of poor sleepers were significantly lower than those of good sleepers ($p < 0.001$).

Multiple linear regression analysis identified sleep duration as an independent predictor of both cognitive and health outcomes after controlling for age, gender, and work hours ($\beta = 0.58$, $p < 0.001$). These findings collectively highlight the high prevalence of sleep deprivation among working professionals and its measurable impact on neurological, cognitive, and functional health performance within this cohort.

Table 1: Demographic Characteristics of Participants

Variable	Mean ± SD / n (%)
Age (years)	36.8 ± 7.2
Gender (Male/Female)	208 (54.7%) / 172 (45.3%)
Occupation (Healthcare/Corporate/Education/Admin)	92 (24.2%) / 114 (30.0%) / 98 (25.8%) / 76 (20.0%)
Average Work Hours per Week	48.5 ± 7.6
Average Sleep Duration (hours)	6.1 ± 1.2
Caffeine Consumption (cups/day)	2.4 ± 1.1

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Table 2: Sleep Quality Distribution (PSQI Scores)

Sleep Quality Category	Frequency (n)	Percentage (%)	Mean PSQI Score ± SD
Good Sleepers (≤5)	142	37.4	4.3 ± 0.9
Poor Sleepers (>5)	238	62.6	9.1 ± 2.2

Table 3: Cognitive Performance Distribution (MoCA Scores)

Cognitive Category	Frequency (n)	Percentage (%)	Mean MoCA Score ± SD
Normal (≥26)	204	53.7	27.1 ± 1.6
Mild Impairment (18–25)	146	38.4	22.4 ± 2.1
Moderate Impairment (<18)	30	7.9	16.2 ± 1.3

Table 4: Correlation between Sleep Duration and Outcome Measures

Variable	Pearson's r	p-value
Sleep Duration vs MoCA Score	0.62	<0.001
Sleep Duration vs PVT Reaction Time	-0.58	<0.001
Sleep Duration vs SF-36 Health Score	0.55	<0.001

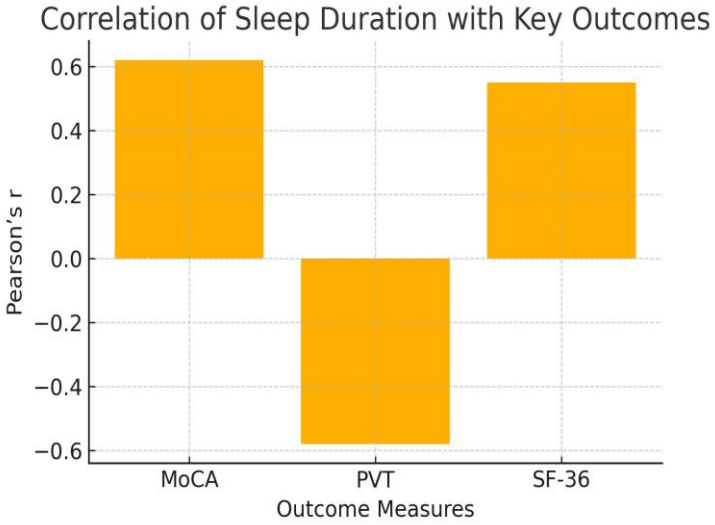

Figure 2 Correlation of Sleep Duration with Key Outcomes

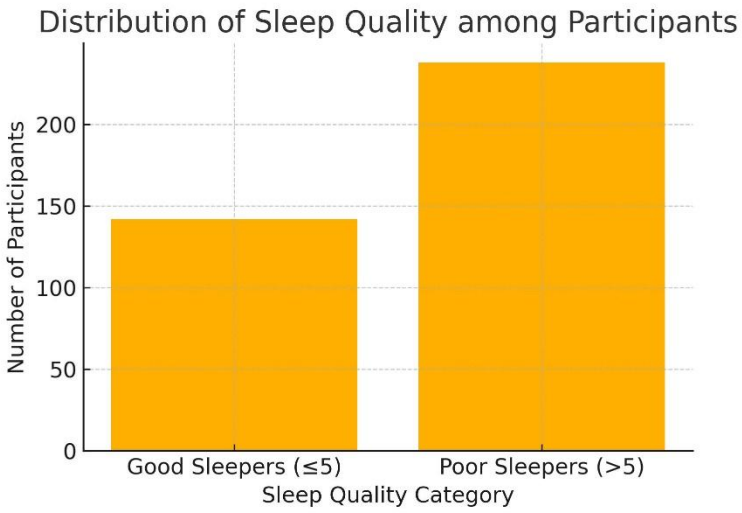

Figure 2 Distribution of Sleep Quality Among Participants

DISCUSSION

The findings of this study demonstrated a significant association between chronic sleep deprivation and impairments in cognitive performance, neurological alertness, and general health among working professionals in South Punjab (11). The results aligned with the growing evidence that insufficient sleep contributes to functional decline across multiple domains of brain activity and overall well-being. The high prevalence of poor sleep quality among professionals underscored the extent to which modern occupational pressures and lifestyle factors compromise restorative rest, ultimately affecting neurological efficiency and cognitive resilience (12). The observed

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correlation between reduced sleep duration and lower cognitive scores reflected the intricate dependence of higher-order cognitive functions on adequate sleep. Participants with shorter sleep duration exhibited marked deficits in attention, working memory, and executive functioning, as indicated by lower Montreal Cognitive Assessment scores. These findings reinforced the concept that sleep serves as a neurobiological foundation for optimal cognitive processing, particularly in domains requiring sustained attention and decision-making. The delayed reaction times recorded on the Psychomotor Vigilance Test further emphasized how insufficient sleep disrupts neural communication speed and attentional capacity, likely due to impaired prefrontal cortex activity and decreased cortical arousal. The strong negative correlation between sleep deprivation and reaction time provided objective evidence of compromised neurological alertness, even among otherwise healthy professionals. General health, as measured by the SF-36 survey, was also found to be significantly reduced among participants reporting inadequate sleep. Lower physical and mental health scores suggested that chronic sleep restriction exerts both physiological and psychological burdens. Fatigue, irritability, and reduced physical vitality were recurrent findings, consistent with the systemic effects of prolonged sleep insufficiency. The data suggested that sustained lack of restorative sleep may lead to metabolic and inflammatory alterations, contributing not only to cognitive fatigue but also to broader declines in perceived well-being (13).

Occupational analysis revealed that healthcare and corporate professionals reported the poorest sleep quality and the most pronounced cognitive impairments (14). This pattern likely reflected the high workload, extended duty hours, and psychological stress inherent in these professions. The difference in sleep duration across occupational groups highlighted the influence of work culture and time demands on sleep behavior. Moreover, professionals in high-stress environments demonstrated lower MoCA and SF-36 scores, suggesting a compounded effect of occupational stress and sleep deprivation on brain function (15). These findings supported the hypothesis that chronic occupational strain and inadequate rest act synergistically to impair cognitive performance. The strength of this study lay in its multidimensional assessment of sleep deprivation's effects using validated and complementary tools. The integration of subjective and objective measures allowed for a comprehensive evaluation of both perceived and measurable impacts. The inclusion of diverse professional groups enhanced the generalizability of findings across occupational sectors. Moreover, the use of standardized instruments such as PSQI, MoCA, PVT, and SF-36 ensured the reliability of results and facilitated meaningful comparison across cognitive and health domains. However, several limitations were acknowledged. Being a cross-sectional study, causality between sleep deprivation and neurological or cognitive impairment could not be definitively established. Although statistical associations were strong, the temporal sequence of sleep loss leading to cognitive decline could not be confirmed. Additionally, the reliance on self-reported sleep data may have introduced recall bias, as participants might have over- or under-reported their sleep duration or quality. Despite efforts to exclude confounding factors, unmeasured variables such as diet, undiagnosed medical conditions, or psychological stress levels may have influenced outcomes. The study also did not include neuroimaging or biochemical markers that could provide deeper insight into the structural and metabolic correlates of sleep deprivation (16).

The duration of data collection and regional confinement to South Punjab limited the representativeness of results to other populations with differing socioeconomic and cultural contexts (17). Moreover, occupational subgroups such as shift workers and night duty personnel were excluded to minimize acute sleep disruptions, but this also limited understanding of populations most vulnerable to severe sleep deprivation. Future studies may benefit from longitudinal designs that track cognitive and neurological changes over time to clarify causation and progression. The inclusion of neuroimaging techniques, stress biomarkers, and circadian rhythm analyses could strengthen the understanding of the biological mechanisms linking sleep loss to cognitive impairment (18). Despite these limitations, the study contributed valuable regional data on a growing occupational health concern. It provided evidence that sleep deprivation among working professionals is not merely a lifestyle issue but a neurological and cognitive health hazard with measurable consequences. The findings underscored the necessity of workplace interventions promoting sleep hygiene, workload management, and mental health awareness. Employers and policymakers could consider strategies such as flexible scheduling, awareness campaigns, and occupational wellness programs to mitigate the widespread impact of sleep deprivation on workforce productivity and cognitive health (19). In conclusion, this study established that chronic sleep deprivation among working professionals in South Punjab was strongly associated with impaired cognitive performance, reduced neurological responsiveness, and diminished general health. The results emphasized that adequate sleep is not a passive luxury but a biological necessity integral to optimal cognitive and neurological functioning. Future research expanding on these findings may help inform targeted interventions aimed at preserving mental efficiency and promoting sustainable occupational health in an increasingly demanding professional landscape (20).

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CONCLUSION

The study concluded that chronic sleep deprivation significantly impairs cognitive performance, neurological alertness, and overall health among working professionals. Reduced sleep duration was strongly linked with diminished attention, memory, and executive functioning, alongside poorer physical and mental well-being. These findings highlight the urgent need to prioritize adequate sleep as a vital component of occupational health and productivity. Promoting healthy sleep practices within professional environments may serve as a critical strategy to enhance neurological efficiency, cognitive resilience, and long-term well-being in the modern workforce.

AUTHOR CONTRIBUTION

Author	Contribution
Usama Mansoor*	Substantial Contribution to study design, analysis, acquisition of Data Manuscript Writing Has given Final Approval of the version to be published
Muhammad Haroon	Substantial Contribution to study design, acquisition and interpretation of Data Critical Review and Manuscript Writing Has given Final Approval of the version to be published
Abdul Aziz*	Substantial Contribution to acquisition and interpretation of Data Has given Final Approval of the version to be published
Zia ur Rehman	Contributed to Data Collection and Analysis Has given Final Approval of the version to be published
Azhar Hussain Khoso	Contributed to Data Collection and Analysis Has given Final Approval of the version to be published
Shaikh Khalid Muhammad	Substantial Contribution to study design and Data Analysis Has given Final Approval of the version to be published

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