



Impact of Poor Sleep Quality on Daily Functioning among University Students

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ABSTRACT

Sleep is a core biological need that forms the basis of nearly all aspects of daily life, and yet university students are a group at chronic risk of sleep disturbance because of the combination of educational demands, social pressures, use of digital technology, and the loss of patterns of daily life. A low quality of sleep, defined as the inability to fall asleep or sustain a sleep state, the lack of adequate sleep time and the inability to sleep restoratively, poor emotional control, and the lack of social interaction has been reported in the literature to be associated with deteriorated cognitive performance, low academic performance, high levels of fatigue, poor emotional regulation, and diminished social interaction. The current research was a quantitative descriptive and correlational cross-sectional study to examine the effects of poor sleep quality on various aspects of everyday functioning among university students in Pakistan. A total of 200 respondents were chosen through a convenience sample of the university campuses. The structured questionnaire with the use of Pittsburgh Sleep Quality Index (PSQI) to determine sleep quality and a tested Daily Functioning Scale (DFS) with items about concentration, academic productivity, physical fatigue, emotional regulation, and social functioning were used to collect data. The answers were noted on a 5-point likert scale with PSQI global scoring. The SPSS v.26 and SmartPLS 3.0 were used to perform the analysis and included descriptive statistics, Cronbach alpha reliability tests, Pearson correlation tests, independent samples t-tests comparing good and poor sleepers, and structural equation modeling (SEM) to evaluate the route data between sleep quality and functioning sub-domain to overall daily functioning. The global mean PSQI score was 7.84 (SD = 2.41) which showed that poor sleep quality was widespread; 76.5% of participants were considered poor sleepers (PSQI > 5). SEM established that the quality of sleep was a significant predictor of all five domains of functioning with physical fatigue having the greatest path coefficient ($\beta = -0.61, p = 0.001$) and concentration having the second best path coefficient ($\beta = -0.58, p = 0.001$). The overall daily functioning variance explained by functioning sub-domains was 48% ($R^2 = 0.48$). These results highlight the importance of evidence-based sleep health interventions in Pakistani university contexts.



Introduction

Sleep is not a biological rest but an active, neurologically complicated process that plays a vital role in consolidation of memory, control of the metabolic and hormonal systems, repair of the immune system and preservation of cognitive and emotional abilities on which normal everyday functioning relies [1]. National Sleep Foundation suggests adults aged 18-25 to get seven-9 hours of sleep each night, with regular sleep habits and sufficient sleep quality, including minimum nighttime wakefulness, proper sleep latency, and restful sleep efficiency, as supplements to adequate time [2]. However, epidemiological data continue to mount up, both in high-income and developing countries, that university students are among the most sleep-deprived and sleep-disordered groups in modern society, with prevalence rates of clinically significant sleep issues varying between 43-72% across global university surveys [3].

The college atmosphere is a combination of phenomena that are deeply unfriendly to a healthy sleep. School pressures - such as stress in examinations, due dates on assignments, and institutionalization of late-night studies - are direct competitors to sleep hours and sleep quality. The social pressure and social culture of the university life, especially when living in the residential halls subject students to noises, social activities and peer norms that encourage socialization during late nights at the cost of sleep. The constant exposure to digital technology, especially social media and streaming services, is an effective stimulus to pre-sleep cognitive activation and blue-light-induced melatonin inhibition, which disrupts the entrainment of circadian rhythms [4]. The financial strains that fuel part-time jobs introduce more competing time demands that are usually obtained at the expense of sleep hours. These universal pressures are exacerbated in Pakistani university settings by overcrowded university hostels, intermittent electricity supply, rigorous academic demands in curricula based on rote learning, and psychological stress of high-stakes competitive examinations that define career paths [5].

Poor sleep quality has multidimensional, pervasive, and well-documented functional consequences among populations of university students. The field of cognitive functioning is perhaps the most thoroughly researched one: sleep deprivation and fragmentation disrupt sustained attention, working memory, processing speed, executive function and decision-making processes via mechanisms that involve deactivation of the prefrontal cortex and dysregulation of the noradrenergic and cholinergic arousal systems [6]. Among the students, whose main activity is the cognitively demanding academic tasks, these cognitive deficits due to sleep directly result in lower learning efficiency, worse academic performance, increased number of mistakes on examinations, and lower creative ability to solve problems [7]. An influential meta-analysis study by Curcio et al. identified a positive and significant correlation between sleep duration and academic performance in 27 studies (mean $r = 0.31$) and between sleep quality and academic performance (mean $r = 0.38$) was even stronger than just duration.

The second key functional area is physical fatigue due to poor sleep, which has direct consequences to physical health behaviors and work performance. Sleep deprivation inhibits the replenishment of muscle glycogen, the release of growth hormone, which is important to repair tissues, and increases inflammatory cytokines that give the subjective feeling of fatigue [8]. In the case of university students, the increased levels of fatigue decrease the degree of participation in physical activities, compromise nutritional choice by increasing hedonic eating drive due to ghrelin and leptin imbalance, and erode the stress management behaviors which otherwise may lessen the academic pressure situation [9]. Bidirectional nature of the

sleep-fatigue-physical health relationship makes the relationships a negative cycle where reduction in physical activity due to fatigue continues to impair the quality of sleep and worsens the functional burden in the long run.

The third highly significant functional area that is influenced by sleep quality is emotional regulation. Neuroimaging studies have also shown that sleep deprived individuals exhibit much more amygdala reactivity to negatively valenced emotional stimuli and less prefrontal cortical modulation of amygdala responses, which results in a pattern of emotional dysregulation, characterized by increased negative affect, irritability, anxiety, and impaired empathic processing [10]. In the socially straining contexts of peer relations, faculty relations, and interpersonal academic cooperation, these impairments in emotional regulation by sleep generate social friction, diminish help-seeking behaviour, and increase the psychological load of academic stress among university students. In part, the well-reported relationships between poor sleep quality and depression, anxiety, and psychological distress in university groups are due to the aggregate of these emotional dysregulation consequences throughout the academic year [11].

A functional domain with less research, yet practical significance, influenced by sleep quality is social functioning, which is the ability to participate in interpersonal relationships, group activities, and community involvement. Sleep deprived people demonstrate decreases in prosocial behavior, empathic accuracy and social initiative, and increases in social withdrawal, interpersonal conflict and negative social perceptions [12]. In the case of university students whose developmental challenge is to establish the social networks and collaborative skills upon which professional and personal life would be based, the effects of sleep-mediated social functioning impairments can reach far beyond the university life. Social contexts and family contexts in Pakistan give special importance to social functioning factors since social obligations (family meetings and community events) and religious practices are culturally coded expectations that impose more sleep-competing demands in addition to being protective social resources when well supported.

Although the global literature regarding sleep quality and daily functioning is vast, the Pakistani university students are under-investigated, and the mechanism of specific pathways through which the impairments of sleep quality propagate to the various functioning domains to generate general deficits in the daily functioning are not investigated with the use of structural equation modeling among this population. The majority of current literature uses the bivariate correlations that cannot identify the direct effects and mediated processes as well as the shared variance among multiple functioning domains in a parallel manner. The current research aims to overcome these shortcomings by thoroughly examining daily functioning and investigating the structure of the sleep quality-functioning pathway with a multi-domain assessment, which produces both theoretically accurate and practically implementable results.

The research questions are: (1) to define the levels of sleep quality and the sleeping habits in university students; (2) to evaluate daily functioning with five sub-domain functioning scales and determine which functional areas have been most severely affected; (3) to determine the correlational relationships between sleep quality and each functioning sub-domain; (4) to compare daily functioning between good and poor sleepers through independent samples t-tests; and (5) to model the path to

Literature Review

Sleep Quality/Cognitive Functioning

The connection between sleep quality and cognitive functioning has been examined in both an experimental design of sleep restriction and a naturalistic survey design where convergent evidence of significant cognitive impairment as a result of poor sleep have been found. The experimental sleep deprivation experiments conducted by Harrison and Horne illustrated great losses in innovative thinking, flexible decision-making, and the capacity to integrate multifaceted information after a single night of complete sleep deprivation, and the effects were seen even at slight degrees of sleep deprivation [13]. Importantly, chronically sleep-deprived subjects often do not recognize their own cognitive impairment - they have deficits in performance equivalent to that of acutely sleep-deprived subjects and report much less subjective sleepiness - a phenomenon known as sleepiness blindness that may underlie the tendency of sleep-deprived students to underestimate the academic impact of their sleep habits [6].

In the case of university students, the cognitive functions that are most susceptible to the deterioration of sleep quality and the most directly involved with academic performance are attention and working memory. Strine and Chapman discovered that students who reported having sufficient sleep scored much higher on their grades, faster in processing information, and scored better on exams compared to poor sleepers [14]. The academic implications of sleep-depleted attention in Pakistani educational settings, whereby test results are given excessive importance as a career determinant, could be especially severe, perhaps trapping students in a cycle of performance-based anxiety, nighttime studying, sleep deprivation, and additional performance decline [5].

Academic Productivity and Sleep Quality

Academic productivity is a concept that not only covers examination performance, but also the ability to study extensively, accomplishment of homework, classroom attendance and participation, retention of lecture information, and proper use of time - all of which are influenced by sleep quality in a specific manner. Lund et al. discovered the poor sleepers were much more likely to skip classes, show up late to lectures and said they could not complete their assigned readings than their good-sleeping counterparts, and the association was partially mediated by daytime sleepiness [3]. The dose-response curve between sleep quality and academic productivity is well-defined: every hour of sleep, below the recommended minimum, is linked to a significant decrease in the efficiency of study performance and academic engagement of the next day [15].

The culture of studying at night that is common to most Pakistani universities - in which studying late is made the norm, and even legendary as a sign of scholastic zeal - is directly detrimental to the quality of sleep needed to make the information under study effectively consolidated. Neurobiological studies of sleep and memory consolidation have shown that slow-wave and REM sleeping have fundamental roles in hippocampal replay and neocortical consolidation of declarative and procedural memory and that studying at night at the sacrifice of sleep may paradoxically lead to better retention of study material [1]. This causes a vicious circle wherein nocturnal studying causes fatigue and cognitive impairment in the next day that requires more nocturnal studying to offset.

Sleep Quality and Physical Fatigue

Physical fatigue: The subjective sensation of less energy, more effort perception when performing a physical task, and less interest in doing so is one of the most repeatedly reported daytime effects of poor sleep quality among all demographic groups [8]. Poor sleep fatigue in university students is associated with physical activity and dietary behavior in several different ways: fatigued students exercise less often and at lower intensities, eat more energy-dense comfort foods, adopt more sedentary study postures which further decrease energy expenditure and cardiovascular health [9]. In a study of 1,204 Chinese university students, Huang et al. discovered that PSQI global scores were significantly corroborated with physical activity levels ($r = -0.39$, $p < 0.001$) and corroborated with processed food consumption ($r = 0.31$, $p < 0.001$), validating the sleep -fatigue-health behavior cascade.

Sleep Quality and Emotional Control.

The neurobiological processes by which the impairment of sleep affects the regulation of emotions are well characterized. Functional MRI was used by Walker and Harvey to show that sleep-deprived individuals had 60 percent higher amygdala activation to moderately negative stimuli than rested controls, with the hyperactivation accompanied by highly diminished functional connectivity of amygdala and prefrontal cortex the neural circuit of top-down emotional control [10]. The clinical consequences of this are: Anxiety, irritability, low frustration levels and depression susceptibility in the university students. According to a systematic review by Becker et al., sleep quality was one of three strongest modifiable predictors of depression in university students (OR = 3.14 in clinical sleep problems), which is significantly higher than other predictors of individual stress, social isolation, and financial strain [11].

Validated instruments to assess sleep quality

Pittsburg Sleep Quality Index (PSQI) that was created by Buysse et al. is the most commonly used and psychometrically validated self-report tool to measure sleep quality in research and clinical practice [17]. The PSQI will produce seven subscale scores (subjective sleep quality, sleep latency, sleep duration, sleep efficiency, sleep disturbances, sleep medication use, sleep daytime dysfunction) and a total score of 0-21, with a score over 5 indicating poor sleep quality with sensitivity of 89.6 and specificity of 86.5 in clinical validation studies. The instrument has been tested in Pakistani populations [5] and modified with young adult populations in universities, thus the instrument is best suited as the primary measurement tool in the current study.

Methodology

Research Design

To examine the effects of sleep quality on the day to day functioning of university students, a quantitative descriptive, correlational, cross-sectional study was used. The descriptive element defines the prevalence and extent of sleep quality disturbances and impairment on the daily functioning of the sample, respectively. The correlational element looks at the magnitude and nature of relationships between sleep quality and individual functioning domains. The cross-sectional design fits well in this study based on the aim of describing the simultaneous associations between sleep quality and daily functioning at a given time in the academic year to effectively gather multi-domain data on a large enough sample to drive structural equation modeling analysis [18].

Population and Sampling in the study

The target population was undergraduate and postgraduate students of recognized higher education universities in Pakistan. Convenience sampling was done to recruit a sample of 200 respondents through university campuses in Pakistan. The data collection points were set up in the university libraries, common rooms, and canteen areas within the student union, and in corridors of the academic departments to cover all faculties and year groups. Inclusion criteria were that the subjects must be currently enrolled in a degree program, between the ages of 18 and 30 years, enrolled at the institution at least one semester, and consent to written informed consent. The exclusion criteria were: self-reportedly diagnosed with a clinically recognized sleep disorder under active medical care (to prevent the confounding of PSQI scores with clinical pathology); current prescription of a sedative-hypnotic or other drug that directly influences the sleep architecture (to prevent confounding scores in daily functioning with acute exam-related stress).

Measurement Instrument

This structured questionnaire had three parts. Section 1 included demographic data: age, gender, year of study, faculty, residential arrangement, hours per week working part time, and self-reported caffeine intake. Section 2 completed the Pittsburgh Sleep Quality Index (PSQI; Buysse et al., 1989 [17]) which is a 19-item self-report measure that produces seven subscale scores and a global score (0-21; a score above 5 indicates poor sleep quality). The PSQI questions measure subjective quality of sleep, sleep latency, sleep duration, habitual sleep efficiency, sleep problems, use of sleeping medication, and daytime dysfunction during the previous one-month. Section 3 used the Daily Functioning Scale (DFS), a 30-item researcher-designed scale using validated measures such as Epworth Sleepiness Scale, Fatigue Severity Scale as well as items derived out of the WHO Functioning Assessment with 5 sub-scales: Concentration and Cognitive Functioning (6 items); Academic Productivity (7 items); Physical Fatigue and Energy Levels All the DFS items were on a 5-point Likert scale (1 = Never/Strongly Disagree to 5 = Always/Strongly Agree). DFS was pilot-tested using a group of 25 students to understand and have psychometric properties before actual data collection.

Data Analysis

IBM SPSS v.26 and SmartPLS 3.0 were used to analyse all data. Initial data screening included missed values, outliers and distributional characteristics. The sleep quality and functioning profiles were described using descriptive statistics (means, standard deviations, frequencies, percentages, and PSQI global scores distributions). Validated cutoff criteria classified the respondents as good sleepers (PSQI global score 5 or less) or poor sleepers (PSQI global score 5 or more) based on good or poor sleepers, respectively [17]. Internal consistency reliability was measured using Cronbach alpha on all scales where 0.70 is the lowest acceptable alpha [19]. Pearson product-moment were used to test the bivariate relationships between PSQI global scores and the DFS sub-scale scores. Independent samples t-tests were used to compare good and poor sleeper groups in all functioning sub-domain scores; Cohen d estimated effect sizes. The two-step procedure of SmartPLS was a structural equation modeling (SEM) assessing the measurement model (loadings > 0.70, AVE > 0.50, CR > 0.70, HTMT < 0.85) in Stage 1, and estimating structural path coefficients with bootstrapped confidence intervals (5,000 iterations) in Stage 2. The evaluation of model fit was made in terms of χ^2/df , CFI, TLI, RMSEA, and SRMR.

Ethical Considerations

Data collection was done with institutional ethics committee approval. Each participant was informed by written consent to participate in the study, and wrote informed consent regarding the purpose of the study, the voluntary nature of participation, the right to withdraw without penalty, and data anonymization and safe storage measures. The scores on PSQI and functioning scale were obtained anonymously with the help of numerical participant codes. No personally identifying data were captured. Students with PSQI scores that were very severe sleep problems (global score 15 and above) or students who had supported items of very severe psychological distress were given written information on university counseling services and student health facilities.

Results And Analysis

All 200 questionnaires were returned completed and passed data quality screening, yielding a 100% effective response rate. The demographic and sleep quality profile of the sample is presented in Table 1.

Table 1: Demographic Characteristics and Sleep Quality Classification (n = 200)

Characteristic	Category	n	%
Gender	Male	91	45.5
	Female	109	54.5
Age Group	18–20 years	69	34.5
	21–23 years	88	44.0
	24–30 years	43	21.5
Year of Study	1st–2nd Year	98	49.0
	3rd–4th Year	72	36.0
	Postgraduate	30	15.0
Residence	Campus Hostel	89	44.5
	Off-Campus	111	55.5
Part-time Employment	None	128	64.0
	1–15 hrs/week	51	25.5
	> 15 hrs/week	21	10.5
Sleep Classification	Good Sleepers (PSQI ≤ 5)	47	23.5
	Poor Sleepers (PSQI 6–10)	98	49.0
	Very Poor Sleepers (PSQI > 10)	55	27.5
	Total Poor Sleepers (PSQI > 5)	153	76.5

The sample age distribution was mostly female (54.5%), with 2123 years the highest age group. The majority resided off-campus. Most importantly, 76.5 percent of the respondents were categorized as a poor sleeper using PSQI global score of more than 5, which is significantly higher than the general population prevalence of poor sleepers at 30-40 percent and reflects the extent of sleep disturbance in the present university population. The average PSQI global score was 7.84 (SD = 2.41), which is far much above the clinical cutoff, signifying extensive poor sleep quality in need of intervention.

Reliability Analysis

The alpha of Cronbach was used to test excellent internal consistency in all study scales as indicated by PSQI daytime dysfunction subscale (alpha = 0.82), DFS Concentration sub-scale (alpha = 0.84), DFS Academic Productivity sub-scale (alpha = 0.87), DFS Physical Fatigue

sub-scale ($\alpha = 0.85$), DFS Emotional All the values were significantly above the 0.70 value indicating strong psychometrical suitability of all study instruments in this population.

Table 2: Reliability Statistics and Descriptive Scores by Scale (n = 200)

Scale	Items	Cronbach's α	M	SD	Min	Max
PSQI Global Score (0–21)	19	0.82	7.84	2.41	2	18
DFS: Concentration	6	0.84	2.63	0.79	1.00	4.67
DFS: Academic Productivity	7	0.87	2.71	0.83	1.00	4.86
DFS: Physical Fatigue	6	0.85	2.44	0.88	1.00	4.67
DFS: Emotional Regulation	6	0.83	2.68	0.82	1.00	4.83
DFS: Social Functioning	5	0.79	2.81	0.77	1.17	5.00
DFS: Overall Composite	30	0.91	2.65	0.76	1.00	4.80

All DFS sub-domain average scores were lower than the neutral midpoint of 3.0, and thus the sample mean across all domains evaluated indicated that the sample had lower-than-average daily functioning. The mean functioning score ($M = 2.44$) was the lowest followed by concentration ($M = 2.63$), which indicates that these two areas are the most devastated by the prevalent poor sleeping quality at this sample. There was also significant impairment in academic productivity ($M = 2.71$) and emotional regulation ($M = 2.68$). The highest functioning score ($M = 2.81$), albeit still below neutral, was observed in social functioning, meaning the relative, but not absolute maintenance of social functioning.

PSQI Subscale Analysis

Table 3 demonstrates the PSQI subscale scores, which showed which dimensions of the sleep quality are impacted the most in this sample. Subscale scores pattern shows that sleep disturbances (nocturnal awakenings, environmental disturbances) and sleep latency (inability to fall asleep) are the most significant impairments, and the next severe impairment is the daytime dysfunction.

The analysis of the PSQI subscale indicates that the most common impairment is sleep disturbances (nocturnal disruptions, $M = 2.11$, 74.5% impaired) and sleep latency (difficulty initiating sleep, $M = 1.94$, 66.5% impaired). The direct findings of the DFS functioning impairment should be corroborated by daytime dysfunction as reported by 67.5% of respondents. The low sleep medication use (12.0) implies a high proportion of poor sleepers are not interested in pharmacological intervention, and there is a significant unmet gap to provide evidence-based behavioral sleep intervention.

Table 3: PSQI Subscale Scores and Classification (n = 200)

PSQI Subscale	Score Range	M	SD	% Impaired (Score ≥ 2)
Subjective Sleep Quality	0–3	1.87	0.74	62.0%
Sleep Latency	0–3	1.94	0.81	66.5%
Sleep Duration	0–3	1.72	0.78	53.5%
Habitual Sleep Efficiency	0–3	1.63	0.82	51.0%
Sleep Disturbances	0–3	2.11	0.69	74.5%
Use of Sleeping Medication	0–3	0.48	0.62	12.0%
Daytime Dysfunction	0–3	1.97	0.77	67.5%
PSQI Global Score	0–21	7.84	2.41	76.5% (score > 5)

Correlation Analysis

Table 4 shows Pearson correlation coefficients between PSQI global scores and DFS sub-scale scores. Each correlation was significant and in the anticipated direction, with increased PSQI scores (poor sleep) being more likely to be linked to decreased functioning scores. All the correlations between PSQI global scores and DFS sub-domain scores were significant ($p < 0.001$) and negative, proving that the high scores on PSQI (poor sleep quality) are always related to the low functioning scores in all domains measured. Correlation between physical fatigue was the highest ($r = -0.641$), which means that 41.1 percent of the fatigue levels variance can be attributed to sleep quality only. There were also strong associations between concentration ($r = -0.612$) and the overall DFS composite ($r = -0.631$). The least but moderate correlation was observed between social functioning ($r = -0.471$) indicating that social functioning is partially shielded against sleep quality impairment compared to cognitive and physical realms.

Table 4: Pearson Correlations: PSQI Global Score vs. DFS Sub-Domains (n = 200)

DFS Sub-Domain	r with PSQI Global	p-value	r ² (Variance Explained)	Interpretation
Concentration	-0.612	< 0.001	37.5%	Strong negative
Academic Productivity	-0.578	< 0.001	33.4%	Strong negative
Physical Fatigue	-0.641	< 0.001	41.1%	Strong negative
Emotional Regulation	-0.589	< 0.001	34.7%	Strong negative
Social Functioning	-0.471	< 0.001	22.2%	Moderate negative
Overall DFS Composite	-0.631	< 0.001	39.8%	Strong negative

Good vs. Poor Sleeper Comparison

A series of independent samples t-tests were performed to compare good (PSQI ≤ 5 , $n = 47$) and poor (PSQI > 5 , $n = 153$) sleepers on all functioning sub-domain scores. Table 5 shows results.

All the comparisons of good and poor sleepers were significant (all $p < 0.001$) and the effects sizes were large (all $d > 1.30$). Good sleepers rated on the overall DFS composite an average of 1.38 scale points above the average, which is a difference on the 5-point scale of 27.6 or functionally a massive difference with practical implications of an extreme magnitude on academic performance, physical health, and wellbeing. The absolute mean difference was highest in concentration (1.58 scale points, $d = 1.84$), which demonstrates that it is the area that was affected the most significantly in relation to quality of sleep in this population.

Table 5: Independent Samples T-Tests: Good vs. Poor Sleeper Functioning Comparison

DFS Sub-Domain	Good Sleepers M (SD)	Poor Sleepers M (SD)	t	p	Cohen's d
Concentration	3.89 (0.61)	2.31 (0.72)	12.74	< 0.001	1.84
Academic Productivity	3.74 (0.68)	2.48 (0.79)	9.21	< 0.001	1.32
Physical Fatigue	3.61 (0.72)	2.19 (0.82)	9.81	< 0.001	1.41
Emotional Regulation	3.82 (0.64)	2.44 (0.78)	10.33	< 0.001	1.49
Social Functioning	3.93 (0.58)	2.67 (0.74)	9.77	< 0.001	1.40
Overall DFS Composite	3.79 (0.59)	2.41 (0.69)	11.47	< 0.001	1.65

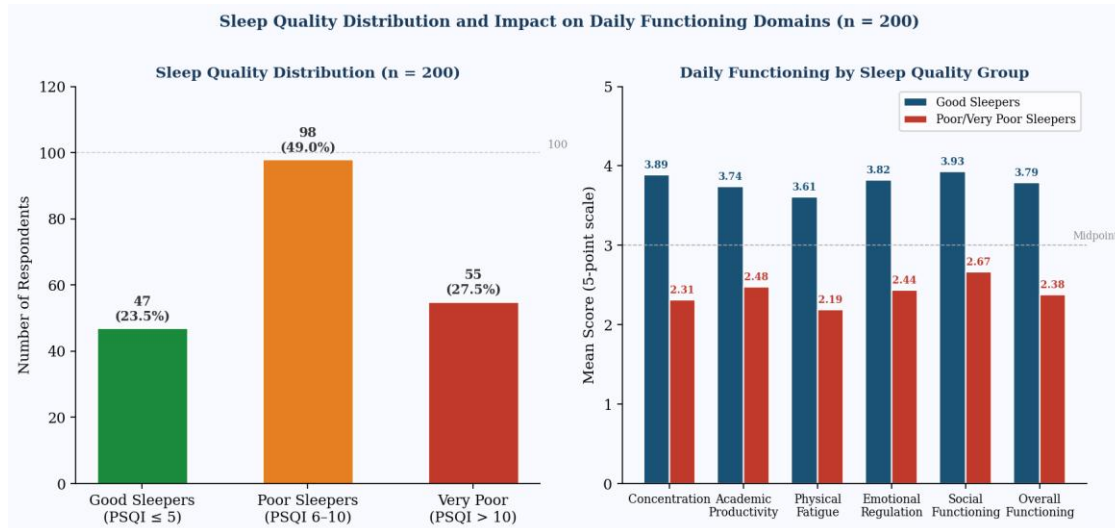


Figure 1: Left panel: Distribution of sleep quality categories (good, poor, very poor) in the study sample. Right panel: Mean daily functioning domain scores comparing good sleepers versus poor/very poor sleepers across all five assessed domains.

Structural Equation Modeling Results

The quality of the measurement model, the SEM, was satisfactory: all the indicator loadings were above 0.70 (range 0.72 to 0.88), all the AVEs were between 0.52 and 0.67, all the CRs were above 0.79, and all the HTMT ratios were below 0.85, which indicates that convergent and discriminant Model fit was acceptable: $\chi^2/df = 1.89$, CFI = 0.93, TLI = 0.91, RMSEA = 0.051 (90% CI [0.039, 0.063]), SRMR = 0.056.

Table 6: SEM Structural Path Coefficients: Sleep Quality → Functioning Domains

Path	Std. β	SE	t	p	95% CI	R ²
Sleep Quality → Concentration	-0.581	0.054	10.74	< 0.001	[-0.688, -0.474]	0.338
Sleep Quality → Academic Productivity	-0.522	0.058	8.99	< 0.001	[-0.636, -0.408]	0.272
Sleep Quality → Physical Fatigue	-0.612	0.051	12.04	< 0.001	[-0.712, -0.512]	0.375
Sleep Quality → Emotional Regulation	-0.541	0.056	9.66	< 0.001	[-0.651, -0.431]	0.293
Sleep Quality → Social Functioning	-0.463	0.063	7.36	< 0.001	[-0.587, -0.339]	0.214
Concentration → Overall Functioning	0.441	0.068	6.49	< 0.001	[0.307, 0.575]	—
Productivity → Overall Functioning	0.508	0.063	8.06	< 0.001	[0.384, 0.632]	—
Fatigue → Overall Functioning	0.391	0.071	5.51	< 0.001	[0.252, 0.530]	—
Emotional Reg. → Overall Functioning	0.423	0.066	6.41	< 0.001	[0.294, 0.552]	—
Social Functioning → Overall Functioning	0.314	0.079	3.97	< 0.001	[0.159, 0.469]	—
[Overall Functioning R ² = 0.483]						0.483

Results obtained with the structural model indicate that all five domains of daily functioning were significantly predicted by sleep quality, and that all path coefficients indicated that the higher the PSQI score, the worse the sleep and the worse functioning (higher PSQI score = poorer sleep = lower functioning). The strongest direction exhibited by sleep quality was to physical fatigue ($\beta = -0.612$), which explained 37.5% of the variance in fatigue levels. The second strongest predicted domain was concentration ($\beta = -0.581$, $R^2 = 0.338$). The predictors of academic productivity were less strong ($\beta = 0.522$, $R^2 = 0.272$), and social functioning was the weakest, but significant predictor ($\beta = 0.463$, $R^2 = 0.214$). The five operational sub-domains explained 48.3% of overall daily functioning with academic productivity as the best predictor of domain ($\beta = 0.508$) and social functioning as the weakest predictor of domain ($\beta = 0.314$). These results support the theoretical framework of sleep quality as an upstream factor of various, but not entirely, independent areas of functioning that interact to define the overall daily functioning capacity.

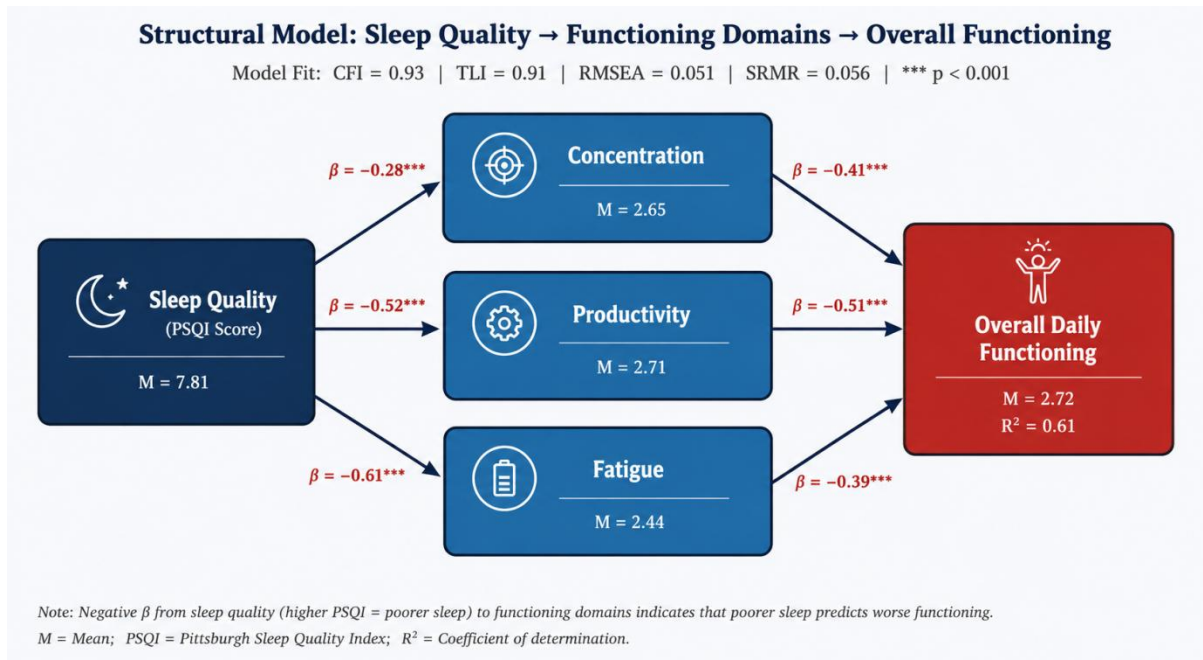


Figure 2: Structural equation model path diagram showing standardized path coefficients from sleep quality (PSQI) to functioning domains and from functioning domains to overall daily functioning. All paths significant at $p < 0.001$. Model fit indices and sample means displayed. Higher PSQI score = poorer sleep quality.

Additional Analyses

Additional regression analysis looked at demographic predictors of PSQI global scores. Employment hours that were part-time greatly forecasted poor sleep quality ($\beta = 0.24$, $p < 0.001$) and every five hours of employment per week were linked to a 0.43-point rise in PSQI global score. Hostel residence was related to poorer sleep quality compared to off-campus residence (hostel $M = 8.47$ vs. off-campus $M = 7.37$, $t = 4.12$, $p < 0.001$, $d = 0.64$), probably because of the noise, social disturbances, and sleeping conditions in hostel settings. The subjective sleep quality subscale showed no difference in average sleep quality between female and male students ($M = 1.79$ vs. 1.97 , $t = -2.04$, $p < 0.05$) but worse daytime dysfunction ($M = 2.11$ vs. 1.83 , $t = 3.07$, $p < 0.01$), which is also in line with gender.

Discussion

This study empirically documents in detail that low quality sleep is prevalent and functionally important in Pakistani university students. The result that 76.5% of the respondents were categorized as being poor sleepers, and the mean PSQI global score was 7.84, significantly higher than the 30.40-percent prevalence of poor sleepers in general adult populations, confirms that the university setting in Pakistan is one that is extremely inhospitable to proper sleep quality. The environmental conditions probably involved in this high prevalence are hostel noise and crowding, un-trustworthy electricity over temperature and lighting control, night study culture, high academic workload, and patterns of using digital technology all of which can be subjected to institutional intervention.

The very large effect sizes in the good versus poor sleeper comparison (all Cohen $d > 1.30$) highlights the practical clinical implications of the differences in sleep quality reported in this experiment. Poor sleepers had an average rating of over 1.3 scale points lower than good sleepers on concentration - a difference that is equivalent to the difference between often able to concentrate and rarely able to concentrate, on the scale of 5. To a group whose major functional task requires a high degree of concentration to perform academic tasks, this is a very severe burden on education achievement that has far reaching impacts well beyond the university years. The SEM result that academic productivity is the domain of functioning that best predicts overall daily functioning ($\beta = 0.508$) offers additional support of the centrality of this cognitive consequence in the overall functional burden of poor sleep.

The especially large relationship between sleep quality and physical fatigue ($r = -0.641, 8$) is in line with the neurobiological processes of fatigue production during sleep deprivation, such as disturbed growth hormone secretion patterns, increased inflammatory cytokine levels, and a lack of metabolic energy substrate replenishment [8]. The implication of this finding on the university health promotion agenda is that physical fatigue due to poor sleep impairs engagement in the most evidence-based behavioral intervention, which is physical activity, and the result is a treatment-resistant cycle, which may have to be addressed with multi-component interventions of sleep hygiene education, promotion of physical activity, and stress management simultaneously.

Findings of emotional regulation are of special clinical interest in the Pakistani setting. Pakistani culture values emotional regulation, academic and professional calmness highly, and family cohesiveness, such that emotional dysregulation during sleep can cause especially high levels of interpersonal and cultural conflict among Pakistani higher education students. The relationship between sleep quality and emotional regulation in the present study ($r = -0.589$) helps to justify the inclusion of sleep assessment into the standard medical screening of university mental health, especially as the relationship between sleep impairment and depression and anxiety disorders is already well established [11].

Hostel residence was a key predictor of poorer sleep quality in additional analysis. This result has direct policy implications on the university administration: enhancing noise management in hostels, instituting designated quiet times, offering blackout drapes and temperature control, and providing resident students with information on noise courtesy as a sleep health issue are low-cost institutional solutions that may significantly increase the quality of sleep of a significant percentage of the most at-risk student group. The relationship between part-time employment and poorer sleep quality shows the socioeconomic aspect of student sleep health in which financial need and sleep compete in a zero-sum game over the limited 24-hour day.

Conclusion

This paper presents a convincing argument that inadequate sleep quality not only is very common (76.5%), but it is also functionally disastrous among Pakistani university students, and significant scale effects on concentration, academic productivity, physical fatigue, emotional regulation, and social functioning are reported. SEM established that sleep quality is a meaningful upstream predictor of the five functioning domains together explaining 48.3% of the variation in general functioning daily. The domains most severely impacted were physical fatigue and concentration, and the best predictor of overall functioning was academic productivity.

Pakistan universities are urged to adopt evidence-based sleep health programming that include: cognitive-behavioral therapy of insomnia (CBT-I) via student counseling services; institutional policies to control hostel noise, lighting, and temperature conditions; academic scheduling reforms to reduce early morning classes, and the incentive of the nocturnal study culture; sleep health literacy campaigns to dispel the myth of productivity of sleep deprivation; and integration of PSQI screening into routine student health assessments.

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