

Lifestyle Behaviors and Cognitive Outcomes in Physiotherapy Students: Cross-Sectional Study

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Abstract

Background: The pervasive use of digital devices, coupled with irregular sleep and low physical activity, poses potential risks to cognitive outcomes in university students. Physiotherapy students, whose education demands both mental and physical engagement, may be particularly vulnerable. *Objective:* This study aimed to investigate the integrated effects of smartphone use, physical activity, and sleep quality on cognitive outcomes among undergraduate physiotherapy students. *Methods:* A cross-sectional design was applied involving 100 first- and second-year physiotherapy students at Universitas Pembangunan Nasional Veteran Jakarta. Data were collected through validated self-administered questionnaires, including the Cognitive Failures Questionnaire (CFQ), International Physical Activity Questionnaire – Short Form (IPAQ-SF), and a Likert-based assessment of smartphone-related lifestyle impact. Descriptive statistics, Pearson correlation, and multiple regression analyses were performed using SPSS version 26.0. *Results:* The findings showed a significant relationship between excessive digital device use and increased cognitive failures. Poor sleep quality was also associated with greater cognitive lapses, while higher physical activity levels correlated positively with better cognitive performance. Regression analysis indicated that the three lifestyle variables jointly explained a substantial proportion of the variance in cognitive outcomes. *Conclusion:* Digital habits, sleep patterns, and physical activity levels interactively influence cognitive outcomes in physiotherapy students. Interventions promoting digital hygiene, adequate sleep, and physical activity may enhance cognitive resilience and academic performance in this population.

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INTRODUCTION

The widespread use of technology has significantly transformed lifestyle habits among university students. Increased reliance on smartphones, laptops, and other digital devices has altered the way students communicate, learn, and rest. Physiotherapy students, whose academic journey requires both cognitive sharpness and physical stamina, are experiencing these shifts as part of their daily routine. The normalization of excessive screen time, reduced physical activity, and disrupted sleep patterns has become increasingly common in academic settings. Although often treated as separate concerns, these lifestyle factors may interact and jointly influence cognitive outcomes, overall well-being, and learning efficiency.

Using digital devices, particularly in the evening, has been linked to delayed melatonin production, resulting in poorer sleep quality. This can lead to difficulty concentrating, memory lapses, and impaired decision-making the next day (1). Alhola and Polo-Kantola (2) reported that cognitive outcomes such as attention and alertness are highly

vulnerable to even moderate levels of sleep loss. Moreover, Exelmans and Van den Bulck found that bedtime smartphone use reduces sleep efficiency and contributes to daytime cognitive fatigue in university students (3).

At the same time, reduced physical activity a common trade-off for sedentary digital engagement has also been shown to negatively affect cognitive outcomes. Physical inactivity limits oxygen and nutrient flow to the brain and may hinder neuroplasticity, a key mechanism for learning and adaptation (4). Regular exercise, on the other hand, is consistently linked to improved mood, attention, and executive function. Mahindru et al. emphasized that students who maintain an active lifestyle experience fewer symptoms of stress and cognitive overload (5).

These lifestyle habits are not isolated; they often reinforce each other in cyclical patterns. For example, poor sleep can increase dependence on digital devices to stay alert, which further reduces opportunities for physical movement and encourages nighttime screen exposure. When repeated continuously, such behaviors can develop into entrenched habits that ultimately shape lifestyle patterns. Over time, these cycles may gradually diminish executive functioning, increase fatigue, and negatively influence cognitive outcomes. For physiotherapy students, who are expected to integrate both mental and physical performance in their learning, these effects may interfere with academic preparation and future clinical competence. Importantly, these interactions highlight the need to conceptualize the problem through an integrated model, where digital behaviors, physical activity, and sleep are examined together as interrelated lifestyle factors shaping cognitive outcomes.

Recent findings suggest that these lifestyle factors are most impactful when considered together rather than in isolation. A study by Carpi et al (5) found that poor sleep quality among university students correlates with reduced mental health-related quality of life. Similarly, Stillman et al (6) highlighted the positive role of physical activity in promoting resilience in cognitive outcomes. Yet, few studies have examined the combined influence of these factors on health science students, especially in an integrated model that includes digital behavior, physical activity, and sleep.

This study aims to fill that gap by exploring how digital lifestyle patterns, physical activity levels, and sleep quality jointly affect cognitive outcomes in physiotherapy students. By understanding these relationships in a targeted academic population, the research hopes to inform both individual health strategies and institutional efforts in supporting student well-being and cognitive readiness.

METHODS

This study employed a quantitative, cross-sectional design to examine the relationship between integrated lifestyle factors namely digital device usage, sleep quality, and physical activity and cognitive health among undergraduate physiotherapy students. The study population consisted of 130 students enrolled in the physiotherapy program, and a total of 100 participants were selected through purposive sampling based on the inclusion criteria: being an active student, willing to provide informed consent, and having no self-reported history of neurological or psychiatric disorders.

Data were collected using four validated instruments. Cognitive performance was measured using the Cognitive Failures Questionnaire (CFQ), which evaluates the frequency of cognitive lapses in daily life such as forgetfulness, attention errors, and distractibility. Physical activity was assessed using the International Physical Activity Questionnaire – Short Form (IPAQ-SF), which records vigorous, moderate, and light activities, as well as walking duration and sitting time. Sleep quality was evaluated using the Pittsburgh Sleep Quality Index (PSQI), a widely used tool that measures subjective sleep quality, latency, duration, disturbances, and daytime dysfunction over the past month.

The digital lifestyle domain was measured using a five-point Likert-scale questionnaire adapted from validated smartphone-use impact tools. The response options ranged from 1 (never/strongly disagree) to 5 (frequent/strongly agree).

The instrument consisted of five domains: usage frequency, emotional impact (e.g., irritability, anxiety, or mood changes related to device use), behavioral impact (e.g., frequent checking of devices during learning activities), physical impact (e.g., headaches, fatigue, or eye strain due to prolonged use), and social conflict (e.g., disruption of social interaction and peer relationships). Higher scores indicated greater frequency or stronger agreement with negative impacts in each domain.

The survey was administered online and remained open for two weeks. Prior to participation, students were required to read a digital information sheet and provide electronic informed consent. Participation was voluntary, and respondents had the right to withdraw at any stage without penalty. To ensure confidentiality, no personally identifying information was collected, and data access was restricted to the research team. After data cleaning, all valid responses were analyzed using IBM SPSS version 26.0.

Ethical clearance for this study was granted by the Research Ethics Committee of Universitas Pembangunan Nasional "Veteran" Jakarta (Approval number: 60/VI/2025/KEP). The study was conducted in accordance with ethical principles, ensuring informed consent, anonymity, confidentiality, and the protection of participants' rights.

RESULTS AND DISCUSSION

This study explored the associations between digital lifestyle habits, sleep quality, physical activity levels, and self-reported cognitive failures among physiotherapy students. The findings provide meaningful insight into how daily behavioral patterns may contribute to students' cognitive outcomes, especially in demanding academic and clinical settings.

Table 1. Distribution of Cognitive Failures Based on CFQ

<i>Cognitive Failure Level</i>	<i>Frequency (n)</i>	<i>Percentage (%)</i>
<i>Mild</i>	3	3.0%
<i>Moderate</i>	59	59.4%
<i>Severe</i>	38	37.6%
Total	100	100%

Table 1 presents the distribution of cognitive failures among 100 undergraduate physiotherapy students based on the Cognitive Failures Questionnaire (CFQ). A total of 59 students (59.4%) reported a moderate level of cognitive failure, while 38 students (37.6%) experienced severe failure. Only 3% of participants ($n = 3$) reported mild issues. This distribution suggests that cognitive failures are not uncommon in this academic population, with nearly all respondents experiencing at least moderate lapses in attention, memory, or action regulation.

These findings reflect growing concerns about cognitive outcomes in university environments, particularly among students balancing both academic and clinical demands. The predominance of moderate to severe failures may be linked to overlapping lifestyle behaviors such as irregular sleep, excessive digital exposure, and insufficient physical activity factors consistently reported among college populations.

Recent studies reinforce this concern and illustrate a common pattern: higher digital engagement and reduced restorative behaviors tend to impair attention, memory, and executive function. Hartanto et al. showed that frequent smartphone multitasking predicted higher cognitive failure scores in daily tasks, suggesting an overload on attentional resources.⁽⁷⁾ Building on this, Kaewpradit et al. reported that excessive digital screen time was strongly associated with poorer sleep quality and mental health outcomes, thereby indirectly impairing cognitive efficiency.⁽⁸⁾ In line with this,

Shalash et al. demonstrated that night-time screen use was directly associated with lower cognitive function in healthy young adults, reinforcing the disruptive role of evening digital exposure on circadian rhythms and daytime alertness.(9) Furthermore, Belluardo et al. highlighted in their narrative review that the combination of inadequate sleep and physical inactivity consistently predicts poorer executive function and slower processing speed among students.(10)

For physiotherapy students, whose future roles depend on rapid decision-making, clinical reasoning, and sustained focus, unresolved cognitive failures may pose serious challenges to academic performance and professional readiness.

Table 2. Physical Activity Patterns Based on IPAQ-SF

<i>Variable</i>	<i>Category</i>	<i>Frequency (n)</i>	<i>Percentage (%)</i>
<i>Vigorous Activity (weekly)</i>	Every day	41	41%
<i>Moderate Activity (weekly)</i>	Every day	23	23%
<i>Light Activity (weekly)</i>	Every day	67	67%
<i>Walking Duration (daily)</i>	15–30 minutes	34	34%
<i>Sitting Duration (daily)</i>	4–6 hours/day	29	29%

Table 2 presents the distribution of physical activity among the participants based on responses to the International Physical Activity Questionnaire-Short Form (IPAQ-SF). The data reveal that 41% of students engage in vigorous activity every day, while 23% report daily moderate activity. Notably, 67% perform light activities daily, indicating a preference or tendency toward lower-intensity physical engagements. Regarding walking behavior, 34% of participants walk between 15–30 minutes daily, while 29% spend between 4–6 hours sitting each day, reflecting a substantial sedentary component in daily routines.

The dominance of light activity over moderate and vigorous exercise among physiotherapy students raises important concerns. While the curriculum in physiotherapy emphasizes the importance of physical fitness, the daily demands of lectures, academic responsibilities, and possibly urban lifestyle constraints may limit opportunities for more intense physical movement. Additionally, the significant proportion of sedentary time (sitting 4–6 hours daily) may contribute to long-term musculoskeletal stress and diminished cognitive function, which are often associated with prolonged inactivity (11).

Several recent studies support the need to address this imbalance. A longitudinal analysis by Liu et al. (2024) demonstrated that replacing 30 minutes of sedentary behavior with light physical activity improved processing speed, while substituting it with moderate-to-vigorous activity enhanced accuracy on executive function tasks in young adults.(12) Similarly, Zhang et al. (2022) showed that even normal-pace walking could significantly improve prefrontal cortex activation and Stroop test performance, supporting the cognitive benefits of short daily walking sessions comparable to the 15–30 minutes reported in this study (13). Complementing these findings, systematic reviews have consistently highlighted that excessive sedentary behavior is associated with poorer physical and cognitive outcomes among university populations, and that light activity alone is insufficient to offset these risks without the inclusion of more vigorous activities (14). In addition, Teuber, Leyhr, and Sudeck (2024) reported that higher levels of physical activity among university students were positively associated with improved stress recovery and academic performance, underscoring the broader cognitive and psychological benefits of maintaining regular exercise in student populations (15).

These insights collectively underscore the importance of promoting structured, higher-intensity physical activity in student populations. Given that physical activity influences neuroplasticity, circulation, and stress regulation, its

strategic incorporation into daily routines may mitigate the risk of cognitive dysfunction and physical fatigue among physiotherapy students.

Table 3. Smartphone Usage Impact Based on Likert Scale

<i>Domain</i>	<i>Most Frequent Category</i>	<i>Most Frequent (%)</i>
<i>Usage Frequency</i>	Frequent & Quite Frequent	66%
<i>Emotional Impact</i>	Mild	35%
<i>Behavioral Impact</i>	Mild	38%
<i>Physical Impact</i>	Mild	40%
<i>Social Conflict</i>	Mild	27%

Table 3 illustrates the perceived impact of smartphone usage across five domains as measured using a five-point Likert-scale questionnaire (1 = never/strongly disagree to 5 = frequent/strongly agree). The instrument covered the domains of usage frequency, emotional impact (e.g., anxiety or irritability when separated from devices), behavioral impact (e.g., frequent checking during academic activities), physical impact (e.g., headaches, eye strain, or fatigue due to prolonged use), and social conflict (e.g., disruption of peer interactions).

The results show that 66% of students reported frequent or quite frequent smartphone use, indicating a high level of digital engagement. In terms of perceived effects, the majority of students categorized their experiences as mild, with 35% reporting mild emotional impact, 38% mild behavioral impact, 40% mild physical impact, and 27% mild social conflict. These categorizations were based on the mean domain scores, where values between 1.0–2.4 were classified as mild, 2.5–3.4 as moderate, and 3.5–5.0 as severe. The predominance of mild impacts suggests that while smartphones are widely used, most students perceive only limited negative consequences across emotional, behavioral, physical, and social domains.

The pervasive use of smartphones among students is not unexpected given the academic and social demands of university life. However, even when the perceived effects are described as "mild," the cumulative burden of emotional dysregulation, behavioral changes, and physical strain such as neck discomfort or eye fatigue can have significant implications for cognitive performance and overall health (16).

Recent studies reinforce these observations. Maayah et al. (2023) found that prolonged smartphone use and specific postures were significantly associated with neck and shoulder pain among university students, highlighting that musculoskeletal effects are often underestimated when self-perceived impact is mild (17). Similarly, Elvan et al. (2024) reported that students using smartphones for more than four hours per day had greater neck pain and lower neck muscle endurance, underscoring the physiological toll of extended device use (18). From another perspective, a 2025 study in *BMC Public Health* demonstrated that excessive smartphone use was linked with eye strain, hand discomfort, and fatigue, showing that physical consequences are multidimensional and not limited to musculoskeletal complaints (19). Furthermore, research published in the *European Journal of Medical Research* (2025) confirmed a significant association between smartphone addiction and musculoskeletal disorders in young university students, reinforcing the broader health risks of high-frequency usage (20).

These findings emphasize that even mild smartphone-related effects should not be disregarded, as their long-term cumulative impact could compromise both psychological well-being and cognitive efficiency. The integration of smartphone hygiene education into university wellness programs may be an effective preventive measure for student populations heavily reliant on digital interaction.

Table 4. Distribution of Sleep Quality Based on PSQI Scores

<i>Sleep Quality</i>	<i>Frequency (n)</i>	<i>Percentage (%)</i>
<i>Good (≤ 5)</i>	27	27%
<i>Poor (> 5)</i>	73	73%
<i>Total</i>	100	100%

Table 4 demonstrates that 73% of the physiotherapy students reported poor sleep quality (PSQI > 5), whereas only 27% experienced good sleep quality (PSQI ≤ 5). This high prevalence of poor sleep reflects a concerning trend, particularly within health science students, who are highly vulnerable to sleep disturbances due to academic stress, irregular daily routines, and the overuse of digital devices.

These findings are consistent with broader literature. A systematic review and meta-analysis among African university students reported a pooled prevalence of poor sleep quality of approximately 63%, with academic stress, late-night device use, and year of study identified as major contributing factors (21). Likewise, a quantitative study from Pakistan demonstrated that poor sleep quality was significantly associated with increased *cognitive failures* among students aged 18–25, indicating that impairments in memory, attention, and concentration are frequent consequences of disrupted sleep (22). Further evidence from a systematic review and meta-analysis confirmed moderate correlations between poor sleep or insomnia symptoms and higher levels of stress in undergraduate populations, reinforcing the bidirectional link between sleep disturbance and mental health (23). In addition, Fernández-Ozcorta et al. (2020) showed that sleep quality and duration were closely related to academic performance, with poorer sleep linked to lower grades among university students (24).

Collectively, these studies demonstrate that inadequate sleep can interfere with neurocognitive processes such as memory consolidation, attentional control, and emotional regulation. In the present study, the association between poor sleep and high smartphone usage (Table 3) further suggests that nighttime screen exposure may contribute to delayed sleep onset and reduced efficiency, exacerbating fatigue and cognitive strain. These results highlight the importance of incorporating sleep hygiene education in student wellness programs, including strategies such as limiting smartphone use before bedtime, maintaining regular sleep schedules, and managing academic stress to mitigate the negative impact of poor sleep on health and performance.

Table 5. Pearson Correlation Between Lifestyle Factors and Cognitive Function

<i>Variable</i>	<i>r</i>	<i>p-value</i>	<i>Interpretation</i>
<i>Sleep Quality (PSQI) $\times$ CFQ</i>	0.41	0.000**	Moderate positive correlation
<i>Physical Activity (IPAQ) $\times$ CFQ</i>	-0.33	0.001**	Moderate negative correlation
<i>Smartphone Impact Score $\times$ CFQ</i>	0.45	0.000**	Strong positive correlation

Table 5 presents the results of the Pearson correlation analysis, which explored the relationships between physical activity, smartphone usage, and cognitive function as measured by CFQ scores among physiotherapy students. The findings revealed two statistically significant correlations.

First, there was a moderate negative correlation between physical activity levels and cognitive failure scores ($r = -0.33$, $p = 0.001$). This indicates that students who engaged in more frequent or intense physical activity experienced fewer cognitive failures. This result is consistent with numerous studies highlighting the neuroprotective effects of

exercise, including improved prefrontal cortex efficiency, enhanced synaptic plasticity, and better memory consolidation (25). A systematic review and meta-analysis by Voelcker-Rehage and Niemann (2022) further supports these findings, concluding that physical activity is positively associated with executive functioning in young adults and university populations (26).

Second, a strong positive correlation was identified between smartphone usage impact and cognitive failure scores ($r = 0.45$, $p = 0.000$). Students who reported higher levels of smartphone-related emotional, behavioral, or physical interference were more likely to experience cognitive lapses such as forgetfulness, attentional errors, and disorganization. This pattern aligns with recent research showing that excessive screen exposure and smartphone dependency disrupt attention regulation and increase mental fatigue (27). For example, a study by Özalp et al. (2025) found that university students classified as having mobile phone addiction scored significantly higher on CFQ, indicating more frequent cognitive failures (19). Similarly, a systematic review by Amalakanti et al. (2024) reported that problematic smartphone use was consistently linked to diminished executive function, impaired memory, and reduced attentional control (28).

These results reinforce the hypothesis that lifestyle factors do not operate in isolation but collectively influence cognitive function. Particularly in health science students such as those in physiotherapy programs who must sustain high levels of cognitive and physical engagement, imbalances in lifestyle behaviors may pose cumulative risks to learning efficiency and clinical readiness. Thus, the integration of health promotion strategies focusing on digital hygiene, physical activity, and mental rest is essential in educational environments.

Table 6. Regression Model Predicting Cognitive Failures Based on Lifestyle Factors
Dependent Variable: Cognitive Failures (CFQ Score)
Predictor Variables: Physical Activity, Smartphone Impact

<i>Predictor Variable</i>	<i>β (Standardized Coefficient)</i>	<i>t-value</i>	<i>p-value</i>
<i>Sleep Quality (PSQI)</i>	0.328	3.76	0.000**
<i>Physical Activity (IPAQ)</i>	-0.281	-2.95	0.004**
<i>Smartphone Impact (Likert)</i>	0.392	4.50	0.000**
<i>Model Summary</i>	R² = 0.42		

Table 6 presents the results of the multiple linear regression analysis conducted to determine the extent to which lifestyle variables—namely physical activity and smartphone usage—predict cognitive failures among physiotherapy students. The model yielded a coefficient of determination ($R^2 = 0.42$), indicating that approximately 42% of the variance in CFQ scores can be explained by the combined influence of the predictor variables.

The standardized coefficient for physical activity was negative and statistically significant ($\beta = -0.281$, $p = 0.004$), suggesting that students with higher levels of physical activity tended to report fewer cognitive failures. This aligns with evidence that regular physical exercise enhances cognitive functioning by improving cerebral blood flow, stimulating neurogenesis, and reducing stress (25). Importantly, a randomized clinical trial by Stern et al. (2019) demonstrated that six months of aerobic exercise led to measurable improvements in executive function and memory in younger adults, reinforcing the protective effects of physical activity on cognition (29).

In contrast, smartphone impact showed a positive and significant association with cognitive failures ($\beta = 0.392$, $p = 0.000$), indicating that higher reported interference from smartphone use was linked to increased cognitive lapses. This is consistent with findings by Li et al. (2022), who reported that excessive mobile phone use was associated with reduced sleep quality, poorer academic performance, and greater attentional problems (30). Similarly, Demirci et al. (2015) found

that problematic smartphone use among university students was strongly associated with poor sleep quality and heightened mental fatigue, both of which contribute to attentional lapses and cognitive dysfunction (31).

Interestingly, while sleep quality was included as a predictor variable, it did not emerge as statistically significant in the final model. This may reflect the mediating role of smartphone use on sleep, or overlapping variance between poor sleep and digital engagement, both of which are frequently co-occurring in university populations. Prior work by Exelmans and Van den Bulck (2016) showed that bedtime smartphone use delays sleep onset and reduces efficiency, suggesting that its effect on cognition may be indirect (3).

Collectively, these findings underscore the multifactorial nature of cognitive health. While physical activity serves as a protective factor, unregulated smartphone use may exacerbate cognitive dysfunction. For physiotherapy students whose training demands both physical stamina and cognitive agility—such insights are critical for shaping wellness programs, time management strategies, and campus-based interventions to optimize academic and clinical performance

CONCLUSION

This study highlights the significant influence of digital behaviors and physical activity on cognitive function among physiotherapy students, showing that higher smartphone usage is strongly associated with increased cognitive failures, whereas greater physical activity is linked to reduced cognitive dysfunction, together explaining 42% of the variance in cognitive performance. These findings underscore the importance of promoting digital wellness and active living as institutional priorities to support the academic and clinical readiness of future healthcare professionals. Universities are encouraged to implement targeted strategies such as awareness campaigns, structured physical activity programs, and guidance on healthy technology use, while future research with longitudinal designs and larger samples is recommended to strengthen causal interpretation and inform effective intervention development.

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