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Cognitive Function and Academic Performance among *Physical Therapy Program Students* after COVID-19 Infection

Shatha Alkhazaaleh, MSc, PT [1]; Hasan Alkhawaldeh, MPT [2]; Abdullah Alkhawaldeh, RN, MSN, PhD [3*]; Mohammed ALBashtawy, RN, MPH, PhD [3]; Omar Al Omari, PhD [4]; Imad Abu Khader, MSN, PhD [5]; Asem Abdalrahim, RN, MSN, PhD [3]; Mohammad R. Alosta, RN, PhD [6]; Khloud Al Dameery, RN, MSN [4]; Zaher Al-bashabsheh, PhD [7]; Nisser Alhroub, PhD [8]; Yahya H. Al-Rshoud, RN, MSN [3]

1 *Al-Balqa Applied University, Irbid University College. Department of Applied Health Sciences, Physiotherapy Program, Irbid, Jordan.*
2 *Department of Physical Therapy, Faculty of Applied Medical Sciences (FAMS), Zarqa University, Zarqa, Jordan.*
3 *Department of Community and Mental Health, Princess Salma Faculty of Nursing, Al al-Bayt University.*
** Corresponding Author. Email: dr-abd@aabu.edu.jo*
4 *College of Nursing, Sultan Qaboos University, Muscat, Oman.*
5 *Faculty of Nursing, Arab American University, Jenin, Palestine.*
6 *Faculty of Nursing, Zarqa University, Zarqa, Jordan.*
7 *Nutrition and Diets Department, Faculty of Applied Medical Sciences, Al al-Bayt University, Jordan.*
8 *Faculty of Nursing, Jerash University, Jerash, Jordan.*

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ABSTRACT

Background: COVID-19 infection may cause *cognitive function impairment, which persists beyond the infection acute stage. It is unknown if cognition is impaired among young undergraduate university students, and whether it affects their* academic performance. ***Purpose:*** To measure the cognitive function and academic performance levels among students who had COVID-19 infection and to explore predictors of academic performance. ***Methods:*** Using a cross sectional design, 63 university students from the physical therapy program were divided into an infected group and a non-infected group. Academic performance was measured using the grade point average, current semester, and course final score. ***Results:*** A significant difference between groups was found in visuospatial/executive function (**F (1,52) = 4.34,** p = 0.04), as well as in second semester cumulative score (**F (1,51) = 4.87,** p= 0.03), and final score (**F (1,51) = 4.68,** p = 0.03). No significant difference was found between the two groups in other cognitive domains and GPA. Exploratory regression analyses did not identify significant predictors of academic performance; these analyses were underpowered and should be interpreted cautiously. ***Conclusion:*** COVID-19 may not have long-term cognitive effects among young adults; a more comprehensive battery of cognitive assessment is warranted to detect possible subtle changes in cognition in this population. ***Implications for Nursing:*** The study found few long-term cognitive effects of COVID-19 in young adults, but noted differences in visuospatial skills and academic performance. It recommends ongoing monitoring and support. Nurses in academic and clinical settings should promote cognitive screening, mental health support, and health education tailored to students.

Keywords: Cognitive function, Academic performance, University students, COVID-19.

What does this paper add?

1. This study is among the first studies to compare cognitive function and academic performance between COVID-19–infected and non-infected undergraduate university students, a population that has been largely under-represented in post-COVID cognitive research.
2. It provides evidence that, although global cognitive function and GPA may not differ significantly, subtle deficits in visuospatial/executive function and specific academic outcomes (semester cumulative score and course final score) may persist long after recovery, highlighting the need for targeted screening and academic support in young adults.

Introduction

Coronavirus disease 2019 (COVID-19) has been reported to affect multiple body systems beyond the respiratory system, including neurological and cognitive functions (Chowdhury et al., 2021; Hugon et al., 2022). In this broader context, the term *neurocognitive effects* refers to alterations in brain-related cognitive processes—such as attention, memory, executive functioning, and processing speed—that arise from neurological or neuro-inflammatory mechanisms associated with disease or injury (American Psychiatric Association, 2013). Globally, more than 700 million confirmed COVID-19 cases have been reported, highlighting the widespread and ongoing public health impact of the disease (World Health Organization [WHO], 2023). Consistent with this burden, recent studies have found an association between COVID-19 and cognitive impairment (Miners et al., 2020), suggesting that the virus may have long-term neurocognitive effects even after the acute infection phase**,** commonly referred to as long-COVID. Notably, emerging evidence indicates that approximately 20%-30% of individuals recovering from COVID-19 experience persistent cognitive symptoms, underscoring the magnitude of this problem (Ceban et al., 2022).

In line with these findings, cognitive impairment is a common and clinically relevant consequence of COVID-19 infection. Within the present study, neurocognitive effects are operationalized as measurable changes in cognitive performance across key domains, including mental processes, such as memory (verbal, spatial, and working), attention, and executive function, which are essential for perception, language, decision-making, and problem-solving (Hodges, 2017). Empirical evidence further indicates that individuals infected with COVID-19—ranging in age from 21 to 75 years— may experience impairments in attention, working memory, processing speed, and executive function (Henneghan et al., 2022). Importantly, these impairments can occur shortly after infection and may persist for over 12 weeks, representing clinically significant post-COVID cognitive dysfunction (Becker et al., 2021). Moreover, cognitive dysfunction has been observed even in patients with mild or non-critical COVID-19 cases (Henneghan et al., 2022), suggesting that the severity of acute illness does not necessarily predict long-term cognitive outcomes.

Cognitive function plays a central role in academic performance, particularly among undergraduate students. Specifically, it directly influences learning, information processing, problem-solving, and examination performance (Shi & Qu, 2021). Poor cognitive function, compounded by mental health issues and sleep disturbances, can negatively impact academic outcomes (Henning et al., 2021). While prior studies have documented post-COVID cognitive impairments in the general population, few have critically examined how these impairments translate into academic consequences**,** particularly among undergraduate students who rely heavily on optimal cognitive functioning for academic success.

In this regard**,** undergraduate students represent a uniquely vulnerable population in the context of post-COVID cognitive impairment. In addition to academic demands, they face stressors, such as irregular sleep patterns, employment responsibilities, social pressures, and the challenges of early adulthood (Asif et al., 2020). Collectively, these factors may interact with post-COVID cognitive deficits, potentially amplifying their negative effects on academic performance. Despite this vulnerability, no study to date has directly compared cognitive function and academic performance between undergraduate students who have recovered from COVID-19 and those who were not infected, indicating a clear gap in the existing literature.

Addressing this gap is therefore essential for both research and practice. Specifically**,** the findings from this study may provide evidence of the long-term effects of COVID-19, particularly its impact on cognitive function and academic performance among undergraduate students. They also contribute to existing research on the role of cognitive function in academic success. Previous studies have shown that academic performance can be influenced, not only by cognitive ability, but also by factors, such as poor mental health (e.g. depression, anxiety, stress) and poor sleep quality (e.g. insomnia) (Bakkar et al., 2024). However, few studies have examined these factors simultaneously within a post-COVID framework, limiting the ability to identify key predictors of academic outcomes in this context.

Understanding the factors that influence academic performance among undergraduate students recovering from COVID-19 may inform future intervention strategies. For example, such studies could aim to improve academic outcomes through behavioral, psychological and physical therapy programs that enhance mental health, cognitive function, and sleep quality. Moreover, the findings may encourage educational institutions to implement targeted support strategies—such as academic accommodations, mental health services, awareness campaigns, and flexible teaching approaches—to better support students experiencing post-COVID cognitive difficulties.

Accordingly, the primary aim of this study was to examine cognitive function and academic performance among undergraduate students who had recovered from COVID-19 compared to those who were not infected, based on the hypothesis that the post-COVID group would demonstrate lower cognitive function and poorer academic performance. In addition, a secondary aim was to identify predictors of academic performance**,** specifically depression, anxiety, stress, self-esteem, and sleep quality.

Methods

Design and Sample

This cross-sectional study recruited a convenience sample of undergraduate students enrolled in a mandatory course within the physical therapy program. A cross-sectional design was selected, as it allows efficient examination of associations between COVID-19 infection status, cognitive function, and academic performance at a single point of time, which is appropriate for exploratory research when longitudinal data is unavailable (Setia, 2016). Convenience sampling was used due to accessibility and feasibility constraints within the academic setting and has been commonly employed in similar post-COVID-19 cognitive studies among university populations.

The initial intention was to recruit students from a single course to minimize bias related to learning styles, curriculum structure, and instructor influence. However, due to logistical constraints and institutional policies, participants were ultimately recruited from two universities offering comparable physical therapy curricula. The School of Rehabilitation Sciences enrolls approximately 1,200 undergraduate students, of whom approximately 400 are registered in the physical therapy program. The College of Allied Medical Sciences enrolls approximately 700 undergraduate students, including approximately 250 students in the physical therapy program.

To reduce potential heterogeneity associated with multi-institution recruitment, students were selected from mandatory courses with similar learning objectives, assessment strategies, and academic levels. In addition, both programs adhere to national accreditation standards, which helped ensure curricular comparability and minimize systematic differences between groups. Participants were recruited from a single faculty (physical therapy) to maintain homogeneity in academic demands, clinical exposure, and cognitive workload; however, this decision may limit the external validity of the findings to students in other disciplines.

Participants who had recovered from COVID-19 were included if they had a confirmed diagnosis based on a prior positive RT-PCR test**,** with infection occurring at least 4 weeks (28 days) prior to participation. Accepted medical documentation included official laboratory reports of RT-PCR test results, hospital discharge summaries, or physician-issued medical reports confirming a COVID-19 diagnosis. Participants were asked to provide copies or photographs of these documents when available. PCR test results and dates were self-reported by participants and were cross-checked against the provided medical documentation solely for verification of infection status and date; however, no additional laboratory verification was conducted at the time of data collection**.**

The researchers did not have direct access to participants' full medical records. Review of COVID-19–related documentation was conducted only with the participants' explicit written consent and was limited to documents voluntarily provided by the participants. No information beyond confirmation of infection status and date was extracted.

General inclusion criteria for all participants were: (1) aged 18-25 years, (2) no neurological disorders affecting cognitive function (e.g. multiple sclerosis), and (3) either hospitalized or not hospitalized due to COVID-19. Exclusion criteria included: (1) family history of dementia, (2) prior brain injury with cognitive consequences, (3) recent COVID-19 infection (<4 weeks), (4) uncorrected visual or hearing impairments, and (5) pregnancy.

Participants were divided into two groups: infected and non-infected. Participants were randomly assigned to assessment time periods using a simple randomization procedure generated through a computerized random number table; however, group allocation was based solely on infection status and not experimentally manipulated.

As no prior studies provided adequate data for power calculations—especially given the younger age range of the target population—the sample size was initially calculated using a test for the difference between two independent means**.** Sample size estimation was performed using G*Power software (version 3.1, Faul et al., 2009), assuming 80% statistical power, a significance level of $\alpha = 0.05$, and a medium effect size ($d = 0.5$). However, it should be noted that this calculation was based solely on a t-test, and may not fully account for the sample size requirements for multiple regression analyses. Future studies should consider calculating sample size based on the primary statistical analyses, using the largest required sample size to guide recruitment, to ensure adequate power for multivariable analyses. A total of 63 participants was determined to be sufficient for the t-test, but may have limited power for regression analyses.

Data Collection

An official request letter was sent to the universities to obtain approval for data collection. After approval was granted, data was collected from undergraduate physical therapy students at the School of Rehabilitation Sciences and the College of Allied Medical Sciences during the summer semester of the 2021/2022 academic year. Both universities are serving predominantly urban and suburban populations, and offer undergraduate and postgraduate programs in health sciences.

Recruitment was conducted via official university email to ensure voluntariness and reduce any perceived pressure to participate. Face-to-face recruitment was intentionally avoided to prevent coercion and to comply with ethical guidelines emphasizing autonomy, especially given the academic relationship between students and faculty. Flyers were also distributed within the Department of Applied Medical Sciences to increase awareness while maintaining voluntary participation.

Data collection took place in a private office at the department during the midterm period. To minimize distractions, assessments were conducted in a quiet, private setting with only the participant and the examiner present. All data was collected by the principal investigator, who received prior training in standardized administration and scoring procedures for all assessment tools.

Each session began with participants completing a screening form (~10 minutes), which included demographic and health-related information: name, age, sex, comorbidities (e.g. diabetes, hypertension, autoimmune diseases, vitamin deficiencies), self-reported history of COVID-19 infection, date of confirmed diagnosis, and type of medical documentation available (e.g. PCR report or physician note)**,** COVID-19 vaccination history (type, doses, dates), number of infections, academic year, courses taken as credit/no credit, final grade in the mandatory course, current semester GPA, and cumulative GPA. Following the screening, participants completed a validated instrument.

Depression, Anxiety, and Stress

The Depression, Anxiety, and Stress Scale (DASS-21) is a 21-item self-report tool designed to assess the severity of depression, anxiety, and stress (Lovibond & Lovibond, 1995). Each item is scored on a 4-point Likert scale (0 = Did not apply to me at all; 3 = Applied to me very much or most of the time), yielding subscale scores ranging from 0 to 21 for depression, anxiety, and stress. The DASS-21 has demonstrated strong internal consistency, with Cronbach's alpha values typically exceeding 0.80 for all subscales. The validated Arabic version was used in this study, which has shown good construct validity and reliability ($\alpha = 0.83$–0.90) in university student populations.

Global Cognitive Function

The Montreal Cognitive Assessment (MoCA) was used to assess global cognitive function (Nasreddine et al., 2005). It evaluates multiple cognitive domains, including attention, memory, language, visuospatial skills, executive functions, and orientation. The MoCA consists of 30 items, with a total possible score range of 0–30, where higher scores indicate better cognitive performance. The MoCA is a reliable and valid instrument for detecting major neurocognitive disorders. Inter-rater reliability has been reported as 0.96, and internal consistency (Cronbach's alpha) as 0.79. The tool also demonstrates good concurrent and construct validity (Daniel et al., 2022).

Executive Function and Processing Speed

The Trail Making Test (TMT-A and TMT-B) measures executive function and processing speed. TMT-A requires connecting 25 numbered circles in order, and TMT-B requires alternating between numbers and letters up to 25 items; performance is measured as completion time in seconds. The TMT has demonstrated good test–retest reliability (r = 0.60–0.90) and strong construct validity in assessing executive functioning. The validated Arabic version was used (Stanczak et al., 2001), with established age-related norms, and has been widely utilized in non-clinical and student populations.

Attention and Working Memory

The Digit Span Test (Forward and Backward), adapted from the WAIS-R, was used to assess attention and verbal working memory (Melika, 1991). It consists of 7–9 sequences of digits per span condition, with each correctly recalled sequence scored as 1 point; total scores range from 0 to 16 for Forward and 0 to 14 for Backward. It demonstrated good concurrent validity and showed reasonable diagnostic validity for identifying major cognitive impairment, with a sensitivity of 0.77 and a specificity of 0.78 at an optimal cutoff score of < 3. These findings support the use of the Digit Span Test as a brief, reliable cognitive screening tool in clinical settings (Leung et al., 2011).

Non-verbal Declarative Memory

The Brief Visual Memory Test (BVMT) assesses visual and spatial memory. It contains 6 items per trial across 3 trials, with scores ranging from 0 to 12 per trial and a total possible score of 0–36; higher scores indicate better visual memory. The BVMT has demonstrated good internal consistency (α > 0.80) and construct validity in both clinical and non-clinical populations. Higher scores indicate better visual memory (Beier et al., 2017).

Global Sleep Quality

The Pittsburgh Sleep Quality Index (PSQI) assesses sleep quality over a one-month period (Buysse et al., 1989). It contains 19 self-rated items, yielding a total score ranging from 0 to 21, with higher scores indicating poorer sleep quality. The PSQI demonstrates good internal consistency (α ≈ 0.83) and diagnostic validity**.** The Arabic version has been validated among university students and has shown acceptable reliability **(**α= 0.83**)** (Aloba et al., 2007).

Insomnia

The Insomnia Severity Index (ISI) is a measure assessing insomnia severity. Each item is rated on a 5-point Likert scale (0 = no problem; 4 = very severe problem), where higher scores indicate more severe insomnia. The Arabic version has demonstrated good reliability and validity (α = 0.90) and has been used in student samples (Suleiman & Yates, 2011).

Self-esteem

The Rosenberg Self-esteem Scale (SES) consists of 10 items rated on a Likert scale (1 = strongly disagree; 4 = strongly agree), yielding total scores from 10 to 40, with higher scores indicating higher self-esteem. The Arabic version has shown good psychometric properties in university populations, with Cronbach's alpha (α ≈ 0.85-0.90), indicating high internal consistency, meaning that the items reliably measure the same underlying construct of self-esteem (Zaidi et al., 2015).

Academic Performance

Academic performance was measured using final course grade, semester GPA, and cumulative GPA. These objective indicators were obtained from official university records, ensuring high reliability and eliminating self-report bias.

Ethical Consideration

Prior to participation, all students signed an informed consent form. Ethical approval was obtained from the Institutional Review Board (IRB) of the Deanship of Scientific Research. The informed consent explicitly included permission for the researcher to review

COVID-19–related medical documentation voluntarily provided by participants for verification purposes only.

Participants contacted the researchers directly, and study procedures were explained to them in detail. Participants' anonymity was protected by assigning unique identification codes, removing all personal identifiers, and storing data in password-protected files accessible only to the research team**.** Any medical documentation reviewed was not copied into the dataset and was used solely to confirm eligibility, after which it was returned to the participant. Participation was voluntary, and students could withdraw at any time without penalty.

Statistical Analysis

Data was analyzed using SPSS, version 23. Descriptive statistics summarized demographic and clinical variables. The Kolmogorov–Smirnov test assessed normality.

Independent t-tests examined baseline differences between groups. Group differences in cognitive and academic outcomes were analyzed using one-way ANCOVA with Bonferroni correction to account for potential confounding effects of demographic, psychological, and sleep-related variables known to influence cognitive performance and academic outcomes. ANCOVA was therefore selected to allow more accurate estimation of the independent association between COVID-19 infection status and outcome measures.

Spearman correlations assessed relationships between psychological variables and academic performance. Multiple linear regression was conducted to explore potential predictors of academic performance. As the study was powered for group comparisons rather than regression, these analyses were exploratory and intended to detect trends rather than definitive associations. The level of statistical significance was set at $\alpha = 0.05$.

Results

Characteristics of Participants

A total of 63 undergraduate students participated in the study, with a mean age of 20.01 ± 0.12 years. The sample included 31 males and 32 females. The non-infected group consisted of 32 participants, while the infected group had 31 participants. None of the infected participants was hospitalized. All participants who were enrolled completed the study and were included in the final analysis; therefore, the attrition rate was 0.00%. While a 0.00% attrition rate is uncommon in real-world research, this outcome can be explained by the short duration of the study, the controlled university setting, and the voluntary nature of participation, which likely enhanced compliance and retention.

The duration since COVID-19 infection in the infected group was determined based on self-reported confirmation of a positive PCR test or physician-diagnosed COVID-19 infection, with participants reporting the month and year of diagnosis. The time elapsed since infection was calculated in months at the time of data collection, yielding an average duration of 16 months.

There was no significant difference between the groups in terms of age or gender. Table 1 presents the demographic difference between the two groups.

Table 1. Baseline difference in demographic characteristics

Characteristics		Minimum	Maximum	Mean ± SD	Level	N	%	P
Age	Non-infected	20	20	20± 0				0.1
	Infected	20	21	20.03± 0.17				
gender	Male				Non-infected	18	56.3 %	0.2
					Infected	13	41.9 %	
	Female				Non-infected	14	43.8 %	
					Infected	18	58.1 %	
Vaccine doses	1 Dose				Non-infected	0	0 %	0.3
					Infected	0	0 %	
	2 Doses				Non-infected	30	93.8 %	
					Infected	27	87.1 %	
	3 Doses				Non-infected	2	6.3 %	
					Infected	4	12.9 %	
Duration post Infection in months		6.00	29.00	16.9 ± 7.27				

Footnote: SD = standard deviation; N = number of participants; P = p value.

Difference in Cognitive Function between Groups

A one-way ANCOVA with Bonferroni correction was conducted to compare cognitive function and academic performance between the infected and non-infected groups, while controlling for covariates, including age, gender, number of vaccine doses, sleep disorders, insomnia, depression, anxiety, stress, and self-esteem.

The ANCOVA analysis revealed a significant difference in MOCA scores, specifically in the visuospatial/executive function domain, between the infected and non-infected groups, F (1, 52) = 4.33, p = 0.04. However, no significant differences were found in other cognitive measures: TMT A (p = 0.10), TMT B (p = 0.33), Digit Span Forward and Backward (p = 0.95), and BVMT (p = 0.32). Table 2 displays the means of the cognitive function scores before and after adjustment.

Table 2. Summary of the means of the cognitive function as dependent variables before and after the adjustment

Dependent variable	Means before adjustment		Means after the adjustment	
	Non-infected	Infected	Non-infected	Infected
MOCA (visuospatial)	4.2187	3.7419	4.197	3.765
TMT A	35.8019	40.0087	35.007	40.829
TMAT B	78.7100	90.4519	78.846	90.312
Digit span forward and backward test	8.2500	8.1290	8.203	8.178

Footnote: MOCA = Montreal Cognitive Assessment; TMT A = Trail Making Test Part A; TMT B = Trail Making Test Part B.

Difference in Academic Performance Outcomes between Groups

A one-way ANCOVA with Bonferroni correction was conducted to compare academic performance between the infected and non-infected groups, while controlling for covariates, including age, gender, number of vaccine doses, sleep disorders, insomnia, depression, anxiety, stress, self-esteem, and the number of passed and failed courses.

The ANCOVA analysis revealed a significant difference in 2nd semester cumulative scores (F (1, 51) = 4.87, p = 0.03) and final course scores (F (1, 51) = 4.68, p = 0.03), with the non-infected group scoring higher. However, no significant difference was found in GPA between the two groups (p = 0.22). Table 3 presents the mean academic performance scores before and after adjustment.

Table 3. Summary of the means of the academic performance as dependent variables before and after the adjustment

Dependent Variable	Means Before Adjustment		Means After Adjustment	
	Non-infected	**Infected**	**Non-infected**	**Infected**
2nd semester cumulative score	3.318	3.013	3.367	2.962
Final score of the course	31.266	28.226	31.916	27.555
GPA	3.246	3.180	3.298	3.126

Footnote: GPA = Grade Point Average.

Correlation and Regression Analysis between Outcome Measures

Correlation Analysis between Outcome Measures

Bivariate Spearman correlation analyses were conducted to assess the relationships between academic performance measures (GPA, final course score, and second semester cumulative score) and depression, anxiety, sleep quality, and self-esteem within both groups. The results showed that none of the academic performance measures was significantly correlated with these variables in either group (Table 4).

Table 4. Spearman correlation matrix for outcome measures of interest in non-infected and infected groups

Variable	Group	GPA	Final Course Score	2nd Semester Cumulative Score
PSQI	Non-infected (N=32)	-0.24	-0.13	-0.17
		p = 0.19	p = 0.50	p = 0.35
	Infected (N=31)	0.08	0.02	0.14
		p = 0.67	p = 0.91	p = 0.46
ISI	Non-infected	-0.28	-0.28	-0.27
		p = 0.13	p = 0.12	p = 0.14
	Infected	-0.06	-0.07	-0.06
		p = 0.76	p = 0.73	p = 0.73
SES	Non-infected	-0.16	-0.14	-0.15
		p = 0.39	p = 0.43	p = 0.41
	Infected	-0.10	0.03	-0.16
		p = 0.61	p = 0.88	p = 0.39
Depression	Non-infected	-0.06	-0.08	-0.07
		p = 0.77	p = 0.67	p = 0.70
	Infected	-0.04	-0.08	0.09
		p = 0.85	p = 0.68	p = 0.64
Anxiety	Non-infected	-0.06	-0.04	-0.11
		p = 0.73	p = 0.83	p = 0.57
	Infected	-0.11	-0.18	-0.18
		p = 0.57	p = 0.34	p = 0.34
Stress	Non-infected	-0.08	-0.03	-0.08
		p = 0.67	p = 0.86	p = 0.66
	Infected	0.03	-0.11	0.10
		p = 0.90	p = 0.57	p = 0.58

Footnotes: PSQI = Pittsburgh Sleep Quality Index; ISI = Insomnia Severity Index; SES = Self-Esteem Scale; GPA = Grade Point Average.
**Correlation is significant at the 0.01 level (2-tailed).
*Correlation is significant at the 0.05 level (2-tailed).

Regression Analysis for Predictors of Academic Performance

Multiple linear regression analyses were conducted separately within the non-infected and infected groups to explore potential trends in predictors of academic performance (GPA, final course score, and 2nd semester cumulative score). Independent variables included depression, stress, anxiety, global sleep quality, insomnia, and self-esteem, entered simultaneously using the enter method. Given that the study was not powered for regression modeling, these analyses were exploratory, and the results should not be interpreted as definitive evidence of the absence of effect.

For the non-infected group, none of the regression models was statistically significant: GPA ($R^2 = 0.11$, $F (6,25) = 0.53$, $p = 0.77$), final course score ($R^2 = 0.14$, $F (6,25) = 0.68$, $p = 0.66$), or 2nd semester cumulative score ($R^2 = 0.08$, $F (6,25) = 0.40$, $p = 0.86$).

Similarly, for the infected group, the regression models were not statistically significant: GPA ($R^2 = 0.04$, $F (6,24) = 0.20$, $p = 0.97$), final course score ($R^2 = 0.05$, $F (6,24) = 0.24$, $p = 0.95$), or 2nd semester cumulative score ($R^2 = 0.16$, $F (6,24) = 0.78$, $p = 0.59$).

Discussion

This study aimed to investigate cognitive function and academic performance among undergraduate university students following COVID-19 infection. Overall, the main findings indicated a significant difference between groups only in a specific cognitive domain, with the infected group scoring lower in the visuospatial/executive domain of the MoCA, rather than in overall global cognitive function. In parallel, the non-infected group had significantly higher scores in the 2nd semester cumulative score and the final course score. However, there was no significant difference in GPA between the infected and non-infected groups.

Furthermore, consistent with the lack of associations found, none of the psychological or sleep-related variables significantly predicted academic performance in this sample. Similarly, the exploratory regression analyses did not identify significant predictors of GPA, final course score, or second semester cumulative score. However, these findings should be interpreted with caution, as the study was not powered for multivariable regression analyses and the sample size was originally calculated for group comparisons. Rather than indicating a true absence of relationships, the null findings may reflect limited statistical power to detect small to moderate effects. Future studies with larger samples are needed to more conclusively evaluate predictors of academic performance in post-COVID undergraduate populations.

The findings of this study contradict previous research (Poletti et al., 2022), which reported a link between COVID-19 infection and cognitive dysfunction. Several factors may explain this discrepancy. In the current study, no widespread differences in cognitive function were observed between the infected and non-infected groups, except for the MoCA visuospatial/executive domain.

One possible explanation relates to how participants were classified based on COVID-19 status. Infection was determined solely by a past RT-PCR test, while any recurrent infections were self-reported. There was no objective verification, such as a PCR test, to confirm infection in cases of flu-like symptoms or possible reinfection. Consequently, it is possible that some individuals in the control group were recently infected—either without being tested or due to asymptomatic infection.

This concern is supported by previous evidence showing that approximately one in five people infected with COVID-19 remain asymptomatic (Nogrady, 2020). Therefore, future studies should address this potential confounding factor by employing longitudinal designs with repeated objective verification of infection status.

Previous studies have shown that long-term effects of COVID-19 are common within six to twelve months after acute SARS-CoV-2 infection (Ma et al., 2022). However, no studies to date have explored effects beyond 12 months. In the present study, data was collected approximately 16 months post-infection (range: 6–29 months). This raises the possibility that the long-term cognitive effects of COVID-19 may diminish after 12 months, potentially explaining the lack of cognitive differences observed between the infected and non-infected groups. Although no evidence of widespread long-term cognitive impairment was found, subtle domain-specific changes cannot be excluded, particularly in visuospatial/executive functioning. Future large-scale studies are needed to confirm these findings across broader age groups.

Additionally, evidence suggests that older age is associated with cognitive decline (Murman, 2015). The relatively young age of participants in this study may have influenced the sensitivity of the cognitive assessments used, as younger individuals might require a more extensive battery of tests with varying levels of difficulty to detect subtle impairments. Educational level is another important factor influencing cognitive function. Research showed that individuals with higher education tend to perform better on cognitive tests and have a lower risk of cognitive decline, even when controlling for age, gender, and health status (Ritchie & Tucker-Drob, 2018). This work highlights the role of education as a form of cognitive reserve, which may buffer against neurological insults and age-related cognitive decline. In the context of the present study, the uniformly high educational attainment of undergraduate students may have mitigated or masked subtle cognitive effects of prior COVID-19 infection, contributing to the largely null findings in global cognition. Thus, the results of Ritchie and Tucker-Drob (2018) provided a plausible explanation for why only domain-specific differences—rather than generalized cognitive deficits—were detected in this relatively homogeneous, highly educated sample.

Other lifestyle-related factors may also be associated with cognitive outcomes. Previous studies have shown that low physical activity, increased body weight, and low cardiorespiratory fitness are linked to reduced cognitive function (Mandolesi et al., 2018). Given that the study sample consisted of undergraduate students with an average age of 20, some of whom may engage in regular physical activity, these factors could help preserve or enhance cognitive function. Future studies should explore these variables using objective measurements.

Regarding academic performance, the analysis showed a significant difference in the 2nd semester cumulative score and final course score between the non-infected and infected groups, despite the absence of widespread cognitive differences**.** However, this difference may reflect factors unrelated to COVID-19 infection. Prior research suggested that academic performance is influenced by students' self-motivation, teaching quality, attitudes toward coursework, study habits, and living conditions (Hasan et al., 2017).

Moreover, university grading systems were substantially affected during the pandemic due to the shift from face-to-face to remote instruction (Li, 2022). The transition from norm-referenced to criterion-referenced grading—particularly the adoption of pass/fail systems—may have reduced the accuracy of academic performance assessment (Melrose, 2019). Pass/fail grading limits differentiation between high-achieving students and those meeting minimum requirements, potentially influencing GPA and learning outcomes.

All students in our study were graded using the pass/fail system, with a mean of 2.8 pass/fail courses in the infected group and 3.1 in the non-infected group. Additionally, high rates of academic dishonesty during online examinations were reported during the pandemic (Janke et al., 2021), further complicating interpretation of academic outcomes.

Several factors—including prior academic performance, family income, learning environment, study time, and social media use—are known to influence GPA (Al Shawwa et al., 2015). Therefore, the absence of a GPA differences between groups should be interpreted cautiously. The lack of association between cognitive outcomes and academic performance may also reflect limitations of the pass/fail grading system and the timing of data collection during the non-mandatory summer semester.

Strengths and Limitations

This study has several notable strengths. It is among the first studies to examine both cognitive function and academic performance in young adults following COVID-19 infection. The inclusion of an age-matched non-infected comparison group strengthens the validity of the findings. Additionally, the relatively long post-infection follow-up period provides valuable insight into potential longer-term cognitive outcomes beyond the acute and subacute phases of COVID-19.

On the other hand, a small sample size may have limited the ability to detect significant differences, particularly in multivariable regression analyses that were exploratory and underpowered by design. Data was collected from only two universities, one course, and one academic program, restricting generalizability. Information on recurrent infection was self-reported without objective verification, and baseline cognitive assessments prior to infection were unavailable, limiting causal interpretation.

Implications for Nursing

This study contributes to the emerging evidence on cognitive function and academic performance among undergraduate students following COVID-19 infection. While no widespread long-term cognitive impairment was observed, the presence of subtle visuospatial/executive differences suggests the need for continued attention to cognitive health in this population.

Implications for nursing practice include promoting awareness of potential post-COVID cognitive changes and supporting interventions that enhance cognitive resilience, such as encouraging physical activity and healthy lifestyle behaviors. Nurses working in university and community health settings can play a key role in early identification of cognitive concerns and referral for appropriate support services.

Consistent with the discussion findings, academic performance outcomes appear to be influenced more by contextual and systemic factors—such as grading policies and remote learning—than by cognitive impairment alone. Academic institutions, in collaboration with healthcare professionals, should consider evaluating grading systems and academic support strategies to ensure accurate assessment of student performance in post-pandemic contexts.

Conclusion

The findings showed no significant differences in overall cognitive function between post-COVID-19 and non-infected groups, except for a single significant difference in the visuospatial/executive domain on the MoCA test. Academic performance was largely comparable between groups; however, lower scores were observed in specific academic outcomes; namely, the second semester cumulative score and the final course score, while no significant difference was found in overall GPA. Additionally, depression, anxiety, stress, sleep quality, and self-esteem were not identified as significant predictors of academic performance in this exploratory and underpowered regression analysis, and these results should not be interpreted as definitive evidence of no association**.** Future research should employ longitudinal designs with larger samples to better understand potential domain-specific and academic effects of COVID-19 in undergraduate students. More comprehensive cognitive assessments, including digital tools, such as computerized mental rotation tests, should be considered. Further studies may also explore other influences on cognition and academic performance, including physical activity and cardiorespiratory fitness.

Conflict of Interests

No potential or actual conflict of interests was reported by the authors.

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Author Contributions

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