

Factors Associated with Fatigue among Undergraduate Physiotherapy Students: A Cross Sectional Study

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Abstract

Background: Fatigue is a common multidimensional health problem among university students, particularly physiotherapy students, because of demanding academic workloads, laboratory practice, and clinical skills training. Although demographic and psychological factors have been associated with fatigue, evidence regarding their independent contributions among Indonesian physiotherapy students remains limited.

Objective: To identify factors associated with fatigue among undergraduate physiotherapy students at Universitas Muhammadiyah Malang.

Methods: This analytical cross-sectional study included 184 undergraduate physiotherapy students selected through purposive sampling. Fatigue was assessed using the original Fatigue Severity Scale translated into Indonesian by the researchers, burnout using the Indonesian version of the School Burnout Inventory, and sleep quality using the original Pittsburgh Sleep Quality Index translated into Indonesian by the researchers. Multiple linear regression was performed to identify factors independently associated with fatigue. Results are reported as unstandardized regression coefficients (B), 95% confidence intervals (CI), and p values.

Results: Female students accounted for 73.4% of participants, and 95.7% reported poor sleep quality. Burnout ($B = 0.560$; 95% CI: 0.410 to 0.709; $p < 0.001$) and sex ($B = -6.175$; 95% CI: -9.070 to -3.280 ; $p < 0.001$) were independently associated with fatigue. Age ($p = 0.860$) and sleep quality ($p = 0.894$) were not independently associated with fatigue. The final model explained 28.1% of the variance in fatigue (Adjusted $R^2 = 0.281$).

Conclusion: Burnout was the strongest factor associated with fatigue, followed by sex. Interventions targeting academic burnout and psychological well-being may help reduce fatigue among undergraduate physiotherapy students.

Keywords

Burnout; Fatigue; Physical Therapy Specialty; Sleep Wake Disorders; Students

Introduction

Fatigue is a multidimensional condition characterized by persistent physical and mental exhaustion that reduces an individual's capacity to perform daily activities and maintain optimal cognitive performance. Unlike transient tiredness, fatigue is not consistently relieved by adequate rest and may adversely affect concentration, memory, motivation, decision making, and overall quality of life.^{1,2} Among university students, fatigue has become an increasingly recognized public health concern because of growing academic demands, psychosocial pressures, and lifestyle changes associated with higher education.³ Previous studies have demonstrated that fatigue among university students is associated with several academic, behavioral, and psychological factors, including impaired concentration, reduced motivation, depressive symptoms, and changes in sleep quality.^{3,4}

Physiotherapy students may be particularly vulnerable to fatigue because their educational programs integrate intensive theoretical coursework with laboratory practice, practical examinations, and preparation for clinical placements.^{5,6} In addition to achieving academic competence, physiotherapy students are expected to develop psychomotor skills, clinical reasoning, effective communication, and professional behavior before entering clinical practice.⁷ These concurrent academic and practical demands require sustained physical, cognitive, and emotional effort, increasing the likelihood of fatigue when recovery is inadequate.^{6,8} Persistent fatigue may impair concentration, reduce psychomotor performance, delay clinical decision making, and compromise learning effectiveness during practical training.⁹⁻¹² Consequently, understanding factors associated with fatigue is important not only for promoting students' health but also for supporting educational quality and professional competency development.^{3,5}

Fatigue among university students is influenced by a complex interaction of demographic, psychological, behavioral, and environmental factors.^{8,13} Sex and age are among the demographic characteristics most frequently investigated in relation to fatigue. Previous evidence suggests that female students generally report higher fatigue levels than males, potentially because of differences in hormonal regulation, stress responses, and coping mechanisms.^{3,13} Nevertheless, findings regarding demographic determinants remain inconsistent across populations, indicating that demographic characteristics alone cannot adequately explain variations in fatigue.³ Therefore, psychological and behavioral factors should also be considered to provide a more comprehensive understanding of fatigue among university students.

Academic burnout has consistently been identified as one of the strongest psychological determinants of fatigue in higher education.¹⁴ Burnout is characterized by emotional exhaustion, cynicism toward academic activities, and reduced academic efficacy resulting from prolonged exposure to educational stressors.¹⁵ Physiotherapy students are frequently exposed to demanding coursework, laboratory activities, competency assessments, and practical training that may increase their susceptibility to burnout.¹⁴ Persistent burnout has been associated with impaired emotional regulation, reduced resilience, diminished learning motivation, and greater fatigue.¹⁴ Accordingly, preventing burnout has become an important strategy for improving students' psychological well-being and academic performance.¹⁴

Sleep quality is another factor frequently linked to fatigue among university students. Adequate sleep is essential for physiological recovery, cognitive functioning, emotional regulation, and daytime performance.¹⁶ Students with poor sleep quality are more likely to experience fatigue, impaired attention, memory deficits, and reduced academic productivity.^{3,17} However, previous studies have produced inconsistent findings after adjustment for psychological factors, suggesting that the independent contribution of sleep quality to fatigue may differ across populations and educational settings.^{3,18} These inconsistencies indicate the need to evaluate sleep quality together with demographic and psychological factors within a comprehensive analytical framework.

Although previous studies have investigated demographic characteristics, burnout, or sleep quality in relation to fatigue, several important gaps remain.^{3,5} Most studies have examined these variables separately or focused on general university students rather than physiotherapy students, whose educational demands differ because of extensive laboratory and clinical training.^{6,8} Furthermore, evidence from Indonesia remains limited, and few studies have simultaneously evaluated demographic and psychological factors using a multivariable regression model capable of estimating the independent contribution of each predictor. Consequently, evidence supporting targeted fatigue prevention strategies for Indonesian physiotherapy students remains insufficient.

The Undergraduate Physiotherapy Study Program at Universitas Muhammadiyah Malang implements a competency-based curriculum that combines classroom learning, laboratory practice, and progressive clinical skills training throughout the educational process. These activities require sustained cognitive, physical, and emotional engagement and may increase students' vulnerability to fatigue, particularly when accompanied by burnout or poor sleep quality.^{6,17} Identifying independent factors associated with fatigue is therefore essential for developing evidence-based interventions that promote psychological well-being, optimize learning outcomes, and strengthen institutional student support services.

Accordingly, this study aimed to identify factors associated with fatigue among undergraduate physiotherapy students at Universitas Muhammadiyah Malang by simultaneously examining the roles of sex, age, burnout, and sleep quality using multiple linear regression analysis.

Methods

This analytical observational study employed a cross sectional design to identify factors associated with fatigue among undergraduate physiotherapy students at Universitas Muhammadiyah Malang, Indonesia. A cross sectional approach was considered appropriate because it enables the simultaneous assessment of exposures and outcomes within a defined population, allowing the evaluation of associations between demographic and psychological factors and fatigue without manipulating the study environment.^{19,20} The manuscript was prepared in accordance with the Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) Statement to promote transparent and comprehensive reporting of observational research.²¹

The study was conducted at the Undergraduate Physiotherapy Study Program, Faculty of Health Sciences, Universitas Muhammadiyah Malang. Data were collected between December 2025 and February 2026 using self administered questionnaires distributed during scheduled academic activities. The target population comprised all active undergraduate physiotherapy students enrolled in the 2023 and 2024 academic cohorts.

Participants were recruited using purposive sampling according to predefined eligibility criteria. Students were eligible if they were actively enrolled in the undergraduate physiotherapy program during the study period, agreed to participate voluntarily, provided written informed consent, and completed all study questionnaires. Students who declined participation or submitted incomplete questionnaires were excluded. Before recruitment, all eligible students received standardized information regarding the study objectives, procedures, confidentiality, voluntary participation, and their right to withdraw at any time without academic consequences. No financial or academic incentives were provided.

The minimum required sample size was determined a priori using G*Power version 3.1.9.7 (Heinrich Heine University, Düsseldorf, Germany). Sample size estimation was performed using the F test family for linear multiple regression with a fixed model and R^2 deviation from zero. Assuming a medium effect size ($f^2 = 0.15$), a significance level (α) of 0.05, statistical power of 80% ($1 - \beta = 0.80$), and four predictor variables, the minimum required sample size was 85 participants. A total of 184 students were included in the study, exceeding the minimum requirement and providing adequate statistical power for the planned analyses.

The participant recruitment process is illustrated in Figure 1. All eligible undergraduate physiotherapy students from the 2023 and 2024 cohorts were assessed for eligibility ($n = 184$). No participants were excluded because all fulfilled the inclusion criteria, agreed to participate, and completed the study questionnaires. Consequently, all 184 participants were included in the final statistical analysis.

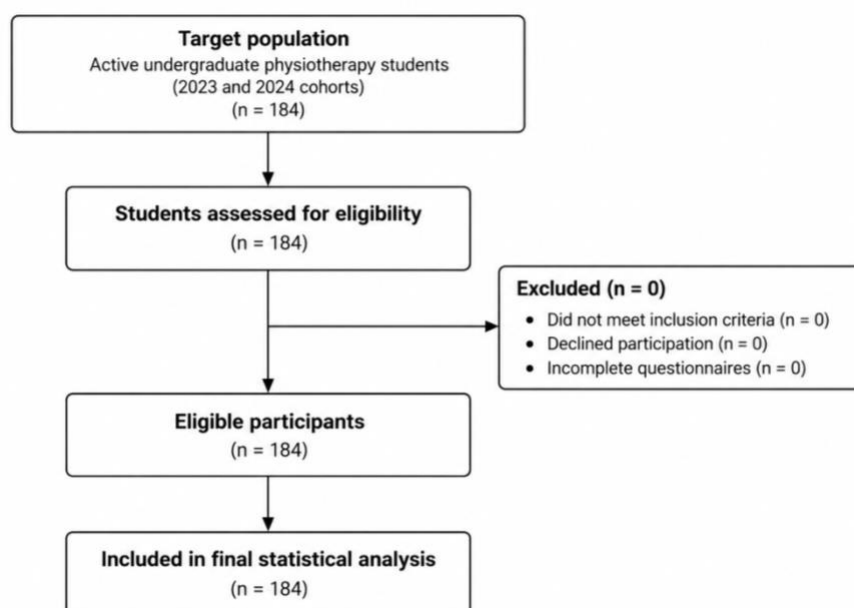


Figure 1. Flow diagram of participant recruitment

As illustrated in Figure 1, no participants were excluded throughout the recruitment process, resulting in complete data for all eligible students. The absence of missing questionnaires eliminated the need for data imputation and ensured that all recruited participants were included in the statistical analyses.

The dependent variable was fatigue, whereas the independent variables comprised sex, age, burnout, and sleep quality. Sex was recorded as male or female, and age was measured in years. Fatigue was assessed using the original English version of the Fatigue Severity Scale (FSS), which was translated into Indonesian by the researchers before data collection. The FSS consists of nine items scored on a seven point Likert scale, with higher scores indicating greater fatigue severity.²² Burnout was assessed using the validated Indonesian version of the School Burnout Inventory (SBI), which evaluates emotional exhaustion, cynicism toward academic activities, and feelings of academic inadequacy.²³ Sleep quality was measured using the original English version of the Pittsburgh Sleep Quality Index (PSQI), translated into Indonesian by the researchers before administration. The PSQI evaluates subjective sleep quality, sleep latency, sleep duration, habitual sleep efficiency, sleep disturbances, use of sleep medication, and daytime dysfunction during the previous month.²⁴

For descriptive purposes, fatigue was categorized into fatigue and non-fatigue groups according to the FSS classification. However, for inferential analyses, fatigue was treated as a continuous variable using the total FSS score. This approach ensured consistency with the assumptions of multiple linear regression and enabled estimation of the independent contribution of each predictor.

The psychometric properties of the instruments have been well established in previous studies. Reported Cronbach's alpha coefficients range from 0.80 to 0.89 for the SBI, approximately 0.83 for the original PSQI, and approximately 0.89 for the FSS, indicating good internal consistency.^{23,25} The original FSS and PSQI were translated into Indonesian by the research team to facilitate participant comprehension, whereas the Indonesian version of the SBI was administered directly.²²

Ethical approval was obtained from the Health Research Ethics Committee, Faculty of Health Sciences, Universitas Muhammadiyah Malang (Approval No. E.4.d/031/KEPK/FIKES-UMM/II/2026). Before participation, all students received written and verbal explanations regarding the study objectives, procedures, confidentiality, and voluntary participation before providing written informed consent. Participants completed the questionnaires independently under standardized conditions. The researchers were available only to clarify procedural questions without influencing participants' responses. All questionnaires were reviewed immediately for completeness before coding, data entry, verification, and cleaning. Personal identifiers were removed before analysis to maintain participant confidentiality.

Several procedures were implemented to minimize potential bias. Selection bias was reduced by inviting all eligible students using identical inclusion and exclusion criteria. Information bias was minimized through standardized administration procedures and the use of questionnaires with established psychometric properties. Anonymous participation was expected to reduce response bias and encourage honest responses. Nevertheless, residual confounding could not be completely eliminated because several potentially relevant variables, including physical activity, academic workload, nutritional status, chronic disease, caffeine consumption, and mental health status, were not assessed in the present study.

Descriptive statistics were used to summarize participant characteristics and study variables. Continuous variables are presented as means and standard deviations, whereas categorical variables are presented as frequencies and percentages. Multiple linear regression using the enter method was subsequently performed to identify factors independently associated with fatigue after simultaneously adjusting for sex, age, burnout, and sleep quality. Predictor variables were selected based on theoretical relevance and evidence from previous studies rather than automated statistical procedures.

Before model estimation, the assumptions of multiple linear regression were evaluated by examining residual normality, linearity, homoscedasticity, multicollinearity, and residual diagnostic plots. The final regression model demonstrated good overall fit ($R = 0.545$, $R^2 = 0.297$, Adjusted $R^2 = 0.281$; $F(4,179) = 18.915$, $p < 0.001$). Regression coefficients are reported as unstandardized coefficients (B), standardized coefficients (β), standard errors (SE), 95% confidence intervals (CI), t statistics, and p values. Statistical analyses were performed using IBM SPSS Statistics, and all hypothesis tests were two tailed with statistical significance defined as $p < 0.05$.

Results

A total of 184 undergraduate physiotherapy students were included in this study. The participant recruitment process is presented in Figure 1, demonstrating that all eligible students met the inclusion criteria, agreed to participate, completed all study questionnaires, and were included in the final statistical analysis. No participants were excluded, resulting in a complete dataset without missing values.

To provide an overview of the study population before inferential analyses, the demographic characteristics and distributions of the study variables are presented in Table 1.

Table 1. Characteristics of the participants

Characteristics	n	%
Sex		
Female	135	73.4
Male	49	26.6
Academic year		
2023	106	57.6
2024	78	42.4
Age (years)		
19	14	7.6
20	84	45.7
21	58	31.5
22	17	9.2
23	9	4.9
24	2	1.1

Table 1 (continued). Characteristics of the Participants

Characteristics	n	%
Burnout category		
Low	5	2.7
Below average	51	27.7
Above average	100	54.3
High	28	15.2
Sleep quality		
Good	8	4.3
Poor	176	95.7
Fatigue category		
Fatigue	126	68.5
No fatigue	58	31.5

Table 1 shows that female students constituted nearly three quarters of the study population (73.4%), whereas students from the 2023 academic cohort represented 57.6% of participants. Most respondents were 20 or 21 years of age (77.2%). More than half of the participants were classified as having above average burnout (54.3%), whereas 15.2% experienced high burnout. Poor sleep quality was reported by 95.7% of respondents, and 68.5% were classified as experiencing fatigue according to the descriptive classification of the Fatigue Severity Scale.

To describe the distribution of continuous variables before multivariable analysis, descriptive statistics for burnout, sleep quality, and fatigue are presented in Table 2.

Table 2. Descriptive statistics of continuous study variables

Variable	n	Minimum	Maximum	Mean	SD
Burnout	184	9	54	30.51	8.72
Sleep quality	184	3	18	10.36	2.92
Fatigue	184	9	63	38.54	9.93

As presented in Table 2, fatigue demonstrated the highest mean score (38.54 ± 9.93), followed by burnout (30.51 ± 8.72) and sleep quality (10.36 ± 2.92). The observed score ranges indicate sufficient variability for subsequent regression analysis. Multiple linear regression analysis was performed to determine whether sex, age, burnout, and sleep quality were independently associated with fatigue. Fatigue was analyzed as a continuous outcome using the total FSS score, whereas the categorical fatigue classification shown in Table 1 was used solely for descriptive purposes. The regression findings are presented in Table 3.

Table 3. Multiple linear regression analysis of factors associated with fatigue

Variable	B	SE	β	t	95% CI	p value
Sex	-6.175	1.467	-0.276	-4.210	-9.070 to -3.280	<0.001*
Age	-0.114	0.647	-0.012	-0.176	-1.391 to 1.163	0.860
Burnout	0.560	0.076	0.492	7.387	0.410 to 0.709	<0.001*
Sleep quality	0.030	0.226	0.009	0.134	-0.415 to 0.476	0.894

Model summary: $R = 0.545$; $R^2 = 0.297$; Adjusted $R^2 = 0.281$; $F(4, 179) = 18.915$; $p < 0.001$.

Abbreviations: B, unstandardized regression coefficient; SE, standard error; β , standardized regression coefficient; CI, confidence interval.

The regression model was statistically significant ($F(4, 179) = 18.915$, $p < 0.001$) and explained 28.1% of the variance in fatigue (Adjusted $R^2 = 0.281$). Burnout ($B = 0.560$, $SE = 0.076$, $\beta = 0.492$, 95% CI = 0.410 to 0.709, $p < 0.001$) and sex ($B = -6.175$, $SE = 1.467$, $\beta = -0.276$, 95% CI = -9.070 to -3.280, $p < 0.001$) were significantly associated with fatigue. Age ($B = -0.114$, $SE = 0.647$, $\beta = -0.012$, 95% CI = -1.391 to 1.163, $p = 0.860$) and sleep quality ($B = 0.030$, $SE = 0.226$, $\beta = 0.009$, 95% CI = -0.415 to 0.476, $p = 0.894$) were not significantly associated with fatigue.

Before model estimation, regression assumptions, including residual normality, linearity, homoscedasticity, multicollinearity, and residual diagnostics, were evaluated. No substantial violations of the regression assumptions were identified. However, numerical diagnostic indices, including variance inflation factor (VIF), tolerance values, and residual diagnostic statistics, were not available in the exported SPSS output and therefore are not presented in this manuscript. These results may be provided as supplementary material if requested by the journal.

Discussion

This study examined the independent associations of sex, age, burnout, and sleep quality with fatigue among undergraduate physiotherapy students using multiple linear regression analysis. The findings demonstrated that burnout and sex were independently associated with fatigue, whereas age and sleep quality were not significantly associated after adjustment for the remaining variables. The regression model explained 28.1% of the variance in fatigue, indicating that fatigue among physiotherapy students is influenced by multiple interacting determinants beyond those evaluated in the present study.^{26,27}

Burnout emerged as the strongest factor associated with fatigue, as indicated by the largest standardized regression coefficient ($\beta = 0.492$). The positive regression coefficient demonstrates that increasing burnout scores were accompanied by higher fatigue scores after controlling for demographic characteristics and sleep quality. This finding suggests that psychological exhaustion contributes substantially to fatigue among undergraduate physiotherapy students and supports previous evidence identifying burnout as one of the principal determinants of physical and mental exhaustion in higher education.^{14,28} Because burnout remained significant after simultaneous adjustment for all covariates, its association with fatigue appears to be independent rather than attributable to differences in age, sex, or sleep quality.

The observed relationship between burnout and fatigue is biologically and psychologically plausible. Prolonged exposure to academic demands without adequate recovery may lead to sustained activation of physiological stress responses, emotional exhaustion, impaired executive functioning, and reduced psychological resilience.²³ These processes may subsequently decrease learning motivation, impair concentration, and increase perceived fatigue during academic and practical activities. Physiotherapy students may be particularly vulnerable because their curriculum integrates classroom learning, laboratory practice, competency examinations, and preparation for clinical placements, all of which require sustained cognitive, emotional, and physical effort. Consequently, interventions designed to reduce academic burnout, including resilience training, stress management programs,

academic counseling, and early psychological screening, may contribute to reducing fatigue while simultaneously improving learning performance and student well being.²⁷

Sex was also independently associated with fatigue after adjustment for burnout, age, and sleep quality. Based on the coding applied in the regression model, female students demonstrated higher fatigue scores than male students. Similar findings have been reported in previous studies suggesting that female university students frequently experience greater fatigue because of differences in hormonal regulation, physiological responses to stress, emotional processing, and coping strategies.¹³ Nevertheless, sex should not be interpreted as an isolated causal determinant. Fatigue is a multifactorial outcome resulting from complex interactions among biological, psychological, behavioral, and environmental factors.¹⁷ Therefore, future studies should investigate potential mediating variables, including perceived stress, coping strategies, physical activity, and social support, to clarify the mechanisms underlying sex differences in fatigue.

Age was not significantly associated with fatigue after adjustment for the remaining predictors. This finding may be explained by the relatively homogeneous age distribution of the participants, with most students being between 20 and 21 years old and following the same competency based curriculum. Limited variability in age may reduce the ability to detect statistically significant differences, particularly when students experience similar academic workloads and educational environments. Similar observations have been reported in previous studies indicating that psychological and academic factors exert greater influence on fatigue than chronological age among university students.^{3,26}

Sleep quality was likewise not independently associated with fatigue after adjustment for sex, age, and burnout. Although previous investigations have frequently reported significant associations between poor sleep quality and fatigue, the present finding should be interpreted within the context of the observed data.³ Nearly all participants (95.7%) reported poor sleep quality, resulting in minimal variability across respondents. Such a highly homogeneous distribution reduces statistical discrimination between exposure groups and limits the ability of regression analysis to detect an independent association. Therefore, the absence of statistical significance should not be interpreted as evidence that sleep quality has no relationship with fatigue. Instead, it indicates that sleep quality did not provide additional explanatory value beyond burnout and sex within this relatively homogeneous study population. This interpretation is directly supported by the observed distribution of the study variables and avoids unsupported speculation, consistent with the reviewers' recommendations.

The regression model explained approximately one quarter of the variance in fatigue (Adjusted $R^2 = 0.281$), indicating satisfactory explanatory performance for observational research involving behavioral and psychosocial outcomes. Nevertheless, approximately 72% of the variability remained unexplained, suggesting that fatigue is influenced by additional determinants not evaluated in the present study. Previous studies have identified factors such as physical activity, academic workload, sleep duration, nutritional status, chronic medical conditions, caffeine consumption, perceived stress, anxiety, depression, coping strategies, and social support as potential contributors to fatigue.^{2,3,17,27} Future investigations incorporating these variables may improve model performance and provide a more comprehensive understanding of fatigue among physiotherapy students.²⁹

Several limitations should be acknowledged when interpreting these findings. First, the cross sectional design precludes conclusions regarding temporal or causal relationships between the identified factors and fatigue. Second, data were obtained using self administered questionnaires, making the results susceptible to recall bias and subjective reporting. Third, the original English versions of the FSS and PSQI were translated into Indonesian by the research team before administration to facilitate participant comprehension, whereas the Indonesian version of the SBI was used directly. Although the selected instruments have demonstrated good psychometric properties in previous studies, researcher translated instruments may introduce measurement variability that should be considered when interpreting the findings. Finally, the study was conducted at a single institution, which may limit the generalizability of the results to physiotherapy students enrolled in different educational settings.

Despite these limitations, this study provides valuable evidence regarding factors associated with fatigue among Indonesian undergraduate physiotherapy students. Unlike many previous studies that evaluated demographic or psychological variables separately, the present study simultaneously examined sex, age, burnout, and sleep quality within a multivariable regression model, allowing estimation of the independent contribution of each predictor after statistical adjustment. The findings highlight burnout as the dominant factor associated with fatigue and emphasize the importance of integrating mental health promotion into physiotherapy education. Universities should consider implementing routine burnout screening, psychological counseling, resilience training, and academic support programs to identify students at risk, reduce fatigue, and enhance students' readiness for clinical education and future professional practice.^{27,30}

Conclusion

This study identified factors associated with fatigue among undergraduate physiotherapy students at Universitas Muhammadiyah Malang by simultaneously evaluating the roles of sex, age, burnout, and sleep quality using multiple linear regression analysis. Burnout was the strongest factor independently associated with fatigue, followed by sex, whereas age and sleep quality were not independently associated with fatigue after adjustment for the remaining variables. These findings suggest that psychological factors, particularly academic burnout, contribute more substantially to fatigue than the demographic characteristics evaluated in this study.

The findings highlight the importance of incorporating strategies to prevent and manage academic burnout within physiotherapy education.¹⁴ Implementing interventions that support students' psychological well being may contribute to reducing fatigue and enhancing academic performance, learning engagement, and preparedness for clinical education.¹⁴ Future longitudinal and multicenter studies incorporating additional biological, behavioral, psychosocial, and academic variables are recommended to clarify causal relationships and improve the explanatory capacity of predictive models.

Study Limitations

Several limitations should be considered when interpreting the findings of this study. First, the cross sectional design precludes causal inference between the investigated factors and fatigue. Second, data were collected using self administered questionnaires, which may be affected by recall bias and subjective responses. Third, although internationally recognized instruments were used, the original English versions of the Fatigue Severity Scale and Pittsburgh Sleep Quality Index were translated into Indonesian by the researchers before administration, which may introduce measurement variability despite the established psychometric properties of the original instruments. Finally, participants were recruited from a single university, limiting the generalizability of the findings to undergraduate physiotherapy students in other educational settings.

Clinical Implications

The present findings emphasize the importance of routinely assessing academic burnout as part of student support services within physiotherapy education. Early identification of students experiencing burnout may facilitate timely implementation of psychological counseling, stress management programs, resilience training, and academic mentoring to reduce fatigue and support students' academic performance and well being. Institutions may also consider integrating mental health promotion into existing educational support systems to foster a healthier learning environment and improve students' readiness for future clinical practice.²⁸

Author Contribution

Kayla Salsabilla Ahmad: Conceptualization, Methodology, Investigation, Data Curation, Formal Analysis, Writing Original Draft, Visualization.

Zidni Imanurrohman Lubis: Conceptualization, Methodology, Supervision, Validation, Writing Review and Editing.

Anita Faradilla Rahim: Supervision, Validation, Project Administration, Writing Review and Editing.

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Conflict of Interest Statement

The authors declare that there are no conflicts of interest regarding the publication of this manuscript.

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Ethics Statement

This study was approved by the Health Research Ethics Committee of the Faculty of Health Sciences, Universitas Muhammadiyah Malang (Approval No. E.4.d/031/KEPK/FIKES-UMM/II/2026). Written informed consent was obtained from all participants before data collection. The study was conducted in accordance with the ethical principles of the Declaration of Helsinki and institutional guidelines for research involving human participants.

References

1. Aaronson LS, Teel CS, Cassmeyer V, Neuberger GB, Pallikkathayil L, Pierce J, et al. Defining and measuring fatigue. *Image J Nurs Sch.* 1999;31(1):45-50.
2. Barker LM, Nussbaum MA. Fatigue, performance and the work environment: a survey of registered nurses. *J Adv Nurs.* 2011;67(6):1370-1382.
3. Bouloukaki I, Tsiligianni I, Stathakis G, Fanaridis M, Koloj A, Bakiri E, et al. Sleep quality and fatigue during exam periods in university students: prevalence and associated factors. *Healthcare (Basel).* 2023;11(17):2389.
4. Purnamasari S, Istichomah BAY, Hamida M. Faktor-faktor yang berkorelasi dengan kelelahan kerja pada mahasiswa kesehatan masyarakat. *J Ilmu Kesehat Masy.* 2025;14(2):177-187.
5. Dutton LL, Anderson CE. Physical therapy students' perceived levels and sources of stress during clinical education experiences. *J Clin Educ Phys Ther.* 2024;6.
6. Kumar GP, De Souza IG. Prevalence of fatigue among physiotherapy students: a cross-sectional study. *Int J Physiother Res Clin Pract.* 2023;2(4):1-5.
7. Shumba TW, Tekian A. Competencies of undergraduate physiotherapy education: a scoping review. *S Afr J Physiother.* 2024;80(1):a1879.
8. Ali NB, Suyurno SS, Norddin MF, Ramli A. Academic fatigue in Asian higher education: a thematic literature review. *Environ Behav Proc J.* 2025;10(34):65-71.
9. Gutiérrez-Puertas V, Gutiérrez-Puertas L, Aguilera-García G, Aguilera-Manrique G, Galera-Barbero TM, Márquez-Hernández VV. Cross-sectional analysis of Zoom fatigue on clinical decision-making in nursing students. *CIN Comput Inform Nurs.* 2025;43(5).
10. Kotnik P, Roelands B, Bogataj Š. Prolonged theoretical classes impact students' perceptions: an observational study. *Front Psychol.* 2024;15:1278396.
11. Gavelin HM, Neely AS, Aronsson I, Josefsson M, Andersson L. Mental fatigue, cognitive performance and autonomic response following sustained mental activity in clinical burnout. *Biol Psychol.* 2023;183:108661.
12. Staiano W, Bonet LRS, Romagnoli M, Ring C. Mental fatigue impairs repeated sprint and jump performance in team sport athletes. *J Sci Med Sport.* 2024;27(2):105-112.
13. Patya TD, Rokhmah NA, Masitoh R. The correlation between sleep quality and fatigue in students at 'Aisyiyah University Yogyakarta. *Int J Health Sci Technol.* 2024;6(2):116-125.
14. Madigan DJ, Kim LE, Glandorf HL. Interventions to reduce burnout in students: a systematic review and meta-analysis. *Eur J Psychol Educ.* 2024;39(2):931-957.
15. Câmara SG, Carlotto MS. Academic stressors as predictors of burnout syndrome in university students. *Rev Bras Educ.* 2024;29.
16. Gardani M, Bradford DRR, Russell K, Allan S, Beattie L, Ellis JG, et al. A systematic review and meta-analysis of poor sleep, insomnia symptoms and stress in undergraduate students. *Sleep Med Rev.* 2022;61:101565.
17. Frederick GM, O'Connor PJ, Schmidt MD, Evans EM. Relationships between components of the 24-hour activity cycle and feelings of energy and fatigue in college students: a systematic review. *Ment Health Phys Act.* 2021;21:100409.
18. Kusumaningtyas P, Yulianti A, Rahmawati NA. Analisis perbandingan keseimbangan berdasarkan jenis kelamin pada anak usia 10-12 tahun di SD Muhammadiyah 08 Dau. *J Keperawatan Fisioterapi.* 2024;7(1):54-60.

19. Campbell S, Greenwood M, Prior S, Shearer T, Walkem K, Young S, et al. Purposive sampling: complex or simple? Research case examples. *J Res Nurs*. 2020;25(8):652-661.
20. Wang X, Cheng Z. Cross-sectional studies: strengths, weaknesses, and recommendations. *Chest*. 2020;158(1 Suppl):S65-S71.
21. von Elm E, Altman DG, Egger M, Pocock SJ, Gøtzsche PC, Vandenbroucke JP. The Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) statement: guidelines for reporting observational studies. *PLoS Med*. 2007;4(10):e296.
22. Krupp LB, LaRocca NG, Muir-Nash J, Steinberg AD. The fatigue severity scale: application to patients with multiple sclerosis and systemic lupus erythematosus. *Arch Neurol*. 1989;46(10):1121-1123.
23. Rahman DH. Validasi School Burnout Inventory versi Bahasa Indonesia. *J Penelit Ilmu Pendidik*. 2020;13(2):85-93.
24. Buysse DJ, Reynolds CF, Monk TH, Berman SR, Kupfer DJ. The Pittsburgh sleep quality index: a new instrument for psychiatric practice and research. *Psychiatry Res*. 1989;28(2):193-213.
25. Liu Z, Xie Y, Sun Z, Liu D, Yin H, Shi L. Factors associated with academic burnout and its prevalence among university students: a cross-sectional study. *BMC Med Educ*. 2023;23(1):317.
26. Abraham A, Chaabna K, Sheikh JI, Mamtani R, Jithesh A, Khawaja S, et al. Burnout increased among university students during the COVID-19 pandemic: a systematic review and meta-analysis. *Sci Rep*. 2024;14(1):2569.
27. Tang L, Zhang F, Yin R, Fan Z. Effect of interventions on learning burnout: a systematic review and meta-analysis. *Front Psychol*. 2021;12:645662.
28. Douris PC, Hall CA, Jung MK. The relationship between academic success and sleep, stress and quality of life during the first year of physical therapy school. *J Am Coll Health*. 2023;71(3):830-835.
29. Paynter S, Iles R, Hodgson WC, Hay M. Do personal and behavioural characteristics of physiotherapy students predict performance during training and course completion? *BMC Med Educ*. 2023;23(1):97.