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ASSOCIATION BETWEEN PHYSICAL ACTIVITY, STRESS, DEPRESSION, AND ANXIETY AMONG UNIVERSITY STUDENTS: A CROSS-SECTIONAL STUDY

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ABSTRACT-

Students are a susceptible group with physiological health problems, including stress, depression and anxiety, and physical activity is a lifestyle factor that has been extensively studied as a potential protector. The relationship of physiological health status with weekly physical activity in university students was investigated in this study, which utilized a secondary data analysis approach involving 300 students. Physiological health outcomes included current stress, depression, and anxiety scores, while physical activity was categorised as low, moderate, or high frequency. Spearman rank correlations, Kruskal-Wallis tests, and descriptive statistics were employed, followed by regression analyses using age, gender, current CGPA and sleep quality as control factors and adjusting ordinal logistic regression. The most prevalent level of physical activity was moderate (56.3%), followed by low (24.7%) and high (19.0%). Stress ($p = 0.563$), sadness ($p = 0.393$), and anxiety ($p = 0.377$) did not significantly differ across the physical activity groups. Spearman correlations between physical activity and the three physiological health outcomes were negligible and non-significant, while adjusted ordinal logistic regression models likewise showed no statistically significant associations. Quality of sleep was weakly inversely related to stress and anxiety, and current CGPA was weakly inversely related to depression. The results also show that physical activity was not independently related to stress, depression, or anxiety in this sample and suggest that physiological health of students might be the result of several lifestyle, academic, and psychosocial factors.

Keywords: Physical activity; stress; depression; anxiety; sleep quality

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1.Introduction

The frequency of physiological health issues among students has grown to be an important public health concern over the years, and this period of life is often marked by a variety of changes, such as academic stress, shifts in social relationships, financial worries, changes in sleep patterns and lifestyle behaviors. Higher education can be affected by stress, anxiety, and depressive symptoms, which can hinder academic performance, social engagement, quality of life, and well-being. The authors of the study Fruehwirth et al. (2023) showed that perceived stress in the transition to college is strongly related to negative physiological health symptoms and unhealthy behaviors. So, there has been a rise in research in recent years focusing on factors among young adults that can be changed for the better in their psychological health.

One such factor has been given a lot of attention, due to its psychological and physiological effects, and that is physical activity. Many years ago, it was believed that regular exercise improved mood and physiological health by regulating stress, adaptation changes in the brain and nervous system, social interaction and self-perception (Fox, 1999). This link has been reinforced in more recent evidence in university populations. Huang et al. (2024) found that physical activity interventions could have a positive impact on physiological health outcomes of undergraduate students, and Donnelly et al. (2024) found similar benefits of physical activity interventions in higher education settings.

A relevant issue is depression because of the lower level of physical activity and sedentarism that is so common among university students. In a large meta-analysis of over 66,000 university students, increased physical activity was linked to a decrease in the likelihood of having depressive symptoms (Waclawovsky et al., 2026). In addition, Wang et al. (2026) found physical activity to be significantly related to depression among university students, but with variable association depending on the study populations and methodological designs. There is also experimental support for the therapeutic potential of exercise, with Noetel et al. (2024) showing that exercise can have beneficial effects in various depressive illnesses.

The pattern of physical activity is also closely related to anxiety and stress. University students were shown to be linked with anxiety by physical activity, but this relationship was mediated by psychosocial factors (Qin et al., 2024). Likewise, Liu et al. (2024) also demonstrated that physical activity could impact depression, anxiety, and stress partly through the psychological resilience and coping strategies. The results suggest that there is no simple direct link between physical activity and physiological health and that this relationship may relate to psychological and behavioural traits that differ across individuals.

Another lifestyle factor in this relationship is sleep. The irregular sleep schedule and decreasing sleep quality among university students can exacerbate psychological distress. Li et al. (2024) found that physical activity and sleep were related to physiological health in students. In a study

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of college students, Ma et al. (2024) also found associations between the intensity of physical activity, sleep quality, and depression. Built on the outcomes in the current study, sleep quality could be an important coexisting variable between physical activity and psychological health.

Studies on possible mediations between physical activity, sleep and psychological health further support the link between physical activity, sleep and psychological health. Mu et al., (2024) have found that the association between physical exercise and negative emotions in college students can be partially explained through sleep quality. Consistent with this, Wang et al. (2024) also discovered that physical activity indirectly predicted sleep quality via stress and smartphone addictions. This is evidence that supports the need to include sleep in the assessment of the independent effects of physical activity on psychological outcomes.

There is overall positive evidence, but results are not uniform within the university population. Rogowska et al. (2020) identified differences in the relationship between PA and physiological health depending on psychological and contextual factors during the COVID-19 pandemic. Additionally, Wilson et al. (2021) found significant shifts in physical activity and physiological health among college students during the same period. Newer synthesis studies suggest that the benefits of physical activity might be moderated by behavioral, social, and psychological factors and not exhibit a consistent dose-response relationship (White et al., 2024).

Thus, further research is necessary with respect to physical activity and stress, depression, anxiety, and associated lifestyle factors in samples of students. The present study intended to evaluate the relationship between physiological health outcomes with weekly physical activity among young adults.

2. Methodology

2.1 Study Data and Variables

Cleaned data set with 300 participants (Nawaz et al., 2026) was used for analysis. The variables that were included in the present analysis were age, gender, current CGPA, weekly levels of physical activity, current stress level, sleep quality, depression, and anxiety level. Based on performed physical activity per week, it was categorized as low, moderate, or high. Stress, depression and anxiety were measured on a scale of 1 to 5.

2.2 Descriptive Analysis

The distribution of physical activity levels and study participant characteristics were shown using descriptive statistics. The mean of age, current CGPA, current stress level, depression level and anxiety level was calculated. The distribution of participants by physical activity level was described using frequencies and percentages.

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Physiological health outcomes were also summarized by physical activity level by the mean and SD values for stress, depression and anxiety. The distribution, median, spread and within-group variability of the stress and anxiety were examined using boxplots across the three physical activity categories.

2.3 Comparison of Physiological health Outcomes Across Physical Activity Groups

Stress, depression, and anxiety were assessed on an ordinal scale, so the Kruskal–Wallis test was used to compare the outcomes between the low, moderate, and high physical activity groups. The current stress level test, depression level test and anxiety level test were conducted separately. The significance was tested by the p-values.

2.4 Spearman Rank Correlation Analysis

Monotonic relationships between physical activity and the psychological health outcomes were measured from Spearman rank correlation analysis. Physical activity groups were regarded as an ordered variable, while current stress, depression, and anxiety were correlated with physical activity.

A larger Spearman correlation matrix was also created to analyze the correlation between physical activity, stress, depression, anxiety, sleep quality, current CGPA and age. Spearman's rho (ρ) was used for the presentation of correlation coefficients.

2.5 Ordinal Logistic Regression Analysis

Adjusted ordinal logistic regression models were used to examine the association between weekly physical activity and each physiological health outcome. Each of the models was fitted separately, for current stress, depression, and anxiety. Low physical activity was considered the reference group, with moderate and high physical activity groups entered as comparison groups.

Age, gender, current CGPA, and sleep quality were adjusted in the regression models. Adjusted odds ratios (AORs) with matching 95% confidence intervals (95% CIs) and p-values were used to report associations.

2.6 Adjusted Predicted Probability Analysis

For a visual interpretation of the likelihood of relatively high levels of physiological health symptomology by physical activity category, (adjusted) ordinal logistic regression models were used to estimate probabilities. A high symptom level indicated by an ordinal score of 4 or 5 was considered high for stress, depression and anxiety. Physical activity groups were estimated with adjusted probabilities and adjusted for age, gender, current CGPA and sleep quality.

2.7 Ethical Consideration

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Analysis was solely conducted on the available secondary data and no direct interaction was had with participants. For the statistical analysis only the variables included in the dataset were used. The information of participants was analysed and reported in an aggregated form and no personally identifying information was included in the presented results.

3. Results

3.1 Participant Characteristics and Physical Activity Pattern

The final analysis included 300 people who had complete observations for all the variables. The average age of the participants was 21.90 years and the mean current CGPA was 3.47. Their mean scores for stress, depression and anxiety were 2.55, 2.34 and 2.53 on a scale from 1 to 5, respectively.

Most was at moderate level of weekly physical activity. A total of 169 (56.3%) participants reported moderate physical activity, 74 (24.7%) reported low physical activity, and 57 (19.0%) reported high physical activity. So, over half of the study group were in the moderate physical activity category. Participant characteristics are summarized in Table 1.

Table 1. Overall descriptive characteristics of the study participants

Variable	Mean
Age, years	21.90
Current CGPA	3.47
Current stress level	2.55
Depression level	2.34
Anxiety level	2.53

Moderate physical activity was identified to be the most common activity classification, while fewer than 1/5 reported high physical activity (see Figure 1).

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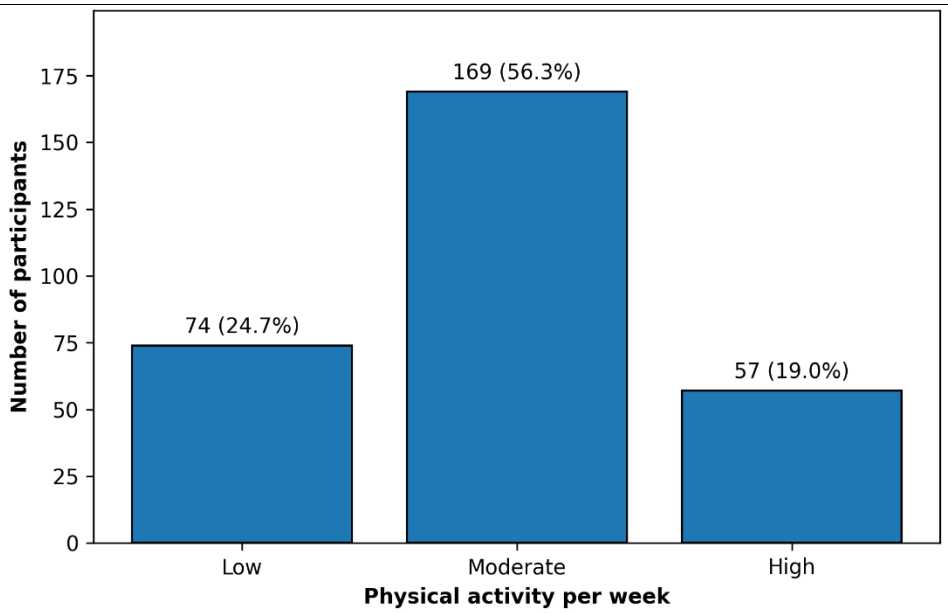


Figure 1. Distribution of physical activity per week among participants

3.2 Physiological health Outcomes Across Physical Activity Levels

Minimal differences were observed among physical activity categories in descriptive comparisons for physiological health scores. The mean current stress scores were 2.51 (SD 1.38), 2.61 (SD 1.43) and 2.40 (SD 1.49) for low, moderate and high physical activity groups, respectively. However, the differences in stress scores between the groups were small, with the high activity group having the lowest descriptive mean stress score.

Mean depression scores were 2.26 ± 1.37, 2.30 ± 1.34, and 2.58 ± 1.46 for the low-, moderate-, and high-activity groups, respectively. The anxiety scores were 2.32 ± 1.23, 2.63 ± 1.42, and 2.53 ± 1.50 respectively for low, moderately, and highly active participants. Physiological health outcomes according to physical activity level are presented in Table 2.

Table 2. Physiological health outcomes according to weekly physical activity level

Outcome	Low, n=74	Moderate, n=169	High, n=57
Current stress	2.51 ± 1.38	2.61 ± 1.43	2.40 ± 1.49
Depression	2.26 ± 1.37	2.30 ± 1.34	2.58 ± 1.46
Anxiety	2.32 ± 1.23	2.63 ± 1.42	2.53 ± 1.50

Mean patterns are illustrated in Figure 2, which shows the comparative mean patterns. There was no consistent monotonic decrease in stress, depression or anxiety as physical activity increased.

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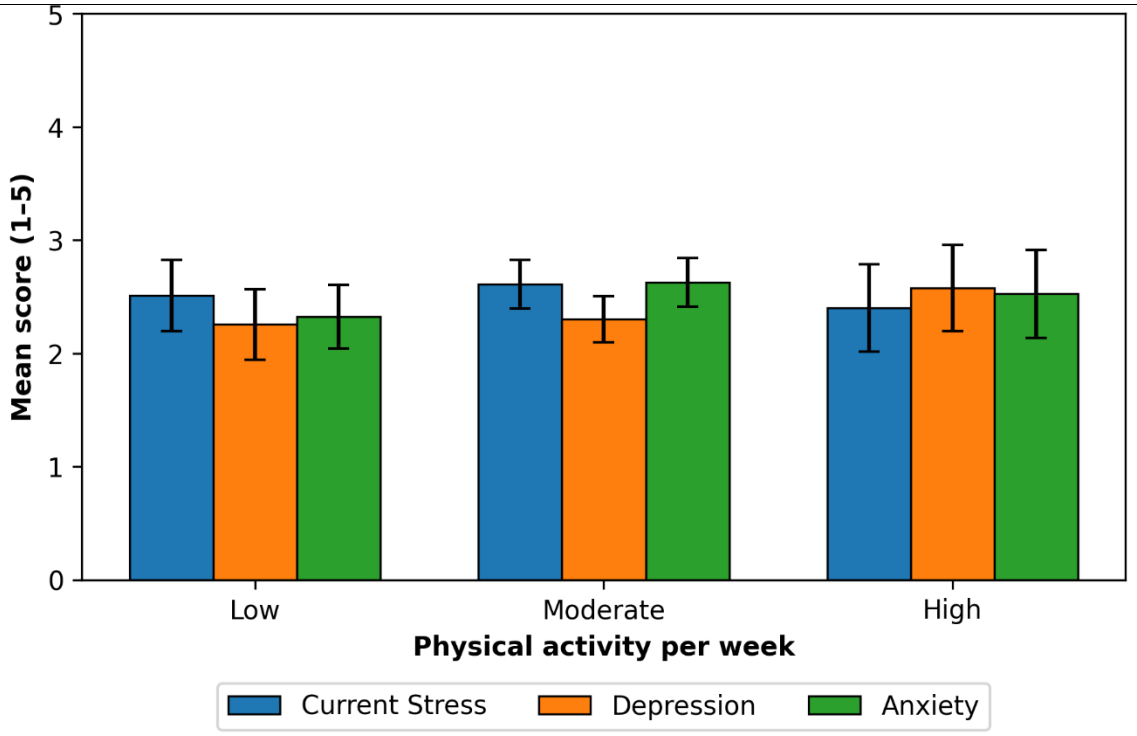


Figure 2. Mean stress, depression, and anxiety scores across weekly physical activity categories. Error bars represent approximate 95% confidence intervals

3.3 Distribution of Stress According to Physical Activity

The overall score distributions for the activity groups were evaluated to check if there was any variability within the activity groups which might have been masked by the mean stress scores. Stress scores spanned the scale available in all three physical activity categories as demonstrated in Figure 3. The interquartile range is represented by boxes, medians are shown by horizontal lines, score dispersion is displayed by whiskers, and group means are represented by diamond markers. Both the moderate and high activity groups and the low and moderate activity groups showed significant overlap.

The mean stress score was slightly lower in the highly active group compared to the other two groups, but the medians and interquartile ranges were similar in most respects. The figure represents, therefore, a large spread of stress levels within groups and only slight separation between groups of physically active and inactive people.

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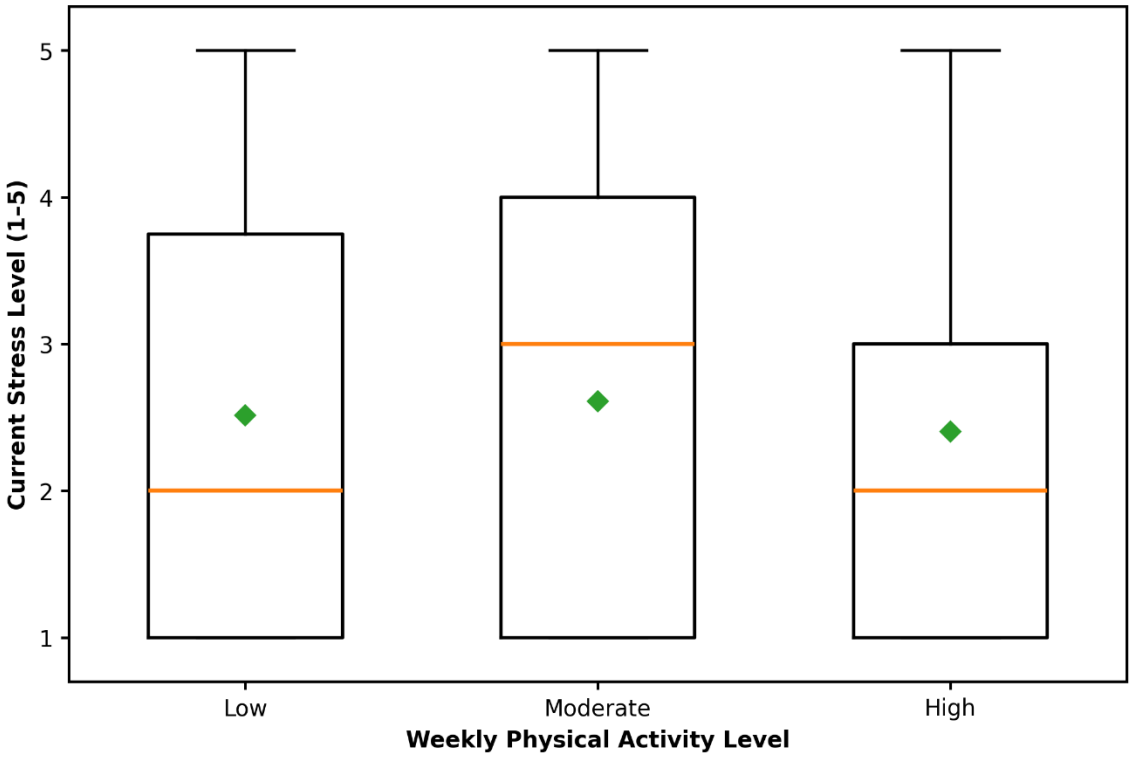


Figure 3. Distribution of current stress scores across physical activity levels

3.4 Distribution of Anxiety According to Physical Activity

The same trend was seen for anxiety. The score distributions for anxiety scores are shown and there is considerable overlap between the three physical activity groups in Figure 4. Within category of activities, participants reported scores over a full range of the 5-point anxiety scale, suggesting considerable heterogeneity across activity categories.

The mean anxiety score was highest among moderately active participants (2.63), followed by highly active participants (2.53) and those with low physical activity (2.32). The distribution overlap was broad however and did not show a clear grade relation between greater levels of physical activity and decreased anxiety levels.

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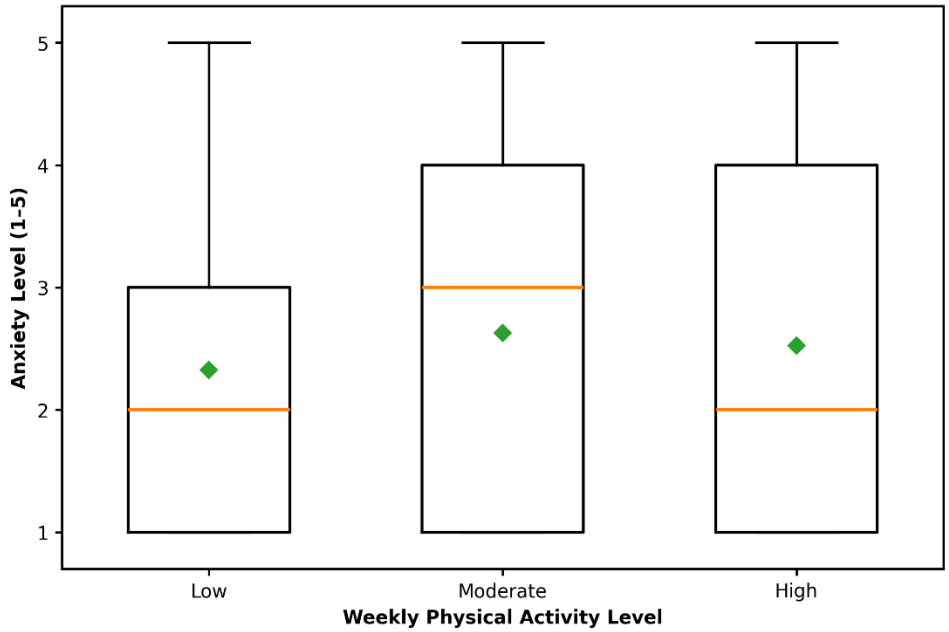


Figure 4. Distribution of anxiety scores across physical activity levels

3.5 Comparison of Physiological health Outcomes Between Activity Groups

Kruskal–Wallis tests were conducted to determine if there were significant differences in stress, depression, and anxiety between the physical activity categories.

No statistically significant differences between-group were observed for current stress ($H = 1.151$, $df = 2$, $p = 0.563$), depression ($H = 1.870$, $df = 2$, $p = 0.393$), or anxiety ($H = 1.953$, $df = 2$, $p = 0.377$). The Kruskal–Wallis results are tabulated in Table 3.

Table 3. Kruskal–Wallis tests comparing physiological health outcomes across physical activity groups

Outcome	H	df	p-value
Current stress	1.151	2	0.563
Depression	1.870	2	0.393
Anxiety	1.953	2	0.377

The results of these inferential tests confirm the similarity that is suggested by the graphs in Figures 3 & 4, which suggest that the differences between the physical activity groups in terms of their descriptions were not statistically significant.

3.6 Correlation Between Physical Activity and Physiological health Outcomes

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To explore monotonic relationships between the increasing scores of physical activity and physiological health scores, Spearman rank correlation analysis was used. Physical activity had a slight, negative correlation with current stress ($\rho = -0.027$, $p = 0.638$), a slight, positive correlation with depression ($\rho = 0.070$, $p = 0.224$), and a slight, positive correlation with anxiety ($\rho = 0.043$, $p = 0.453$).

Physical activity level was not significantly related to any of the three physiological health outcomes at a statistically significant level, nor was there a consistent trend of increasing or decreasing scores. Spearman correlation coefficients are summarized in Table 4.

Table 4. Spearman correlations between physical activity and physiological health outcomes

Outcome	Spearman ρ	p-value
Current stress	−0.027	0.638
Depression	0.070	0.224
Anxiety	0.043	0.453

3.7 Broader Correlation Structure of Lifestyle and Physiological health Variables

Figure 5 shows the Spearman correlation matrix of all variables. The overall correlations between physical activity, physiological health, sleep quality, CGPA and age were weak.

Physical activity exhibited only very small correlations with stress ($\rho = -0.03$), depression ($\rho = 0.07$), anxiety ($\rho = 0.04$), sleep quality ($\rho = 0.05$), CGPA ($\rho = 0.02$), and age ($\rho = -0.06$). These values also provide further evidence of the weak bivariate correlation between physical activity and the outcomes measured.

Other lifestyle and school-related factors had slightly stronger associations, however. Better sleep quality was negatively correlated with stress ($\rho = -0.16$, $p = 0.005$) and anxiety ($\rho = -0.14$, $p = 0.018$). The current CGPA was also found to have a weak, inverse correlation with depression ($\rho = -0.14$, $p = 0.015$). However, the overall correlation structure was not very strong.

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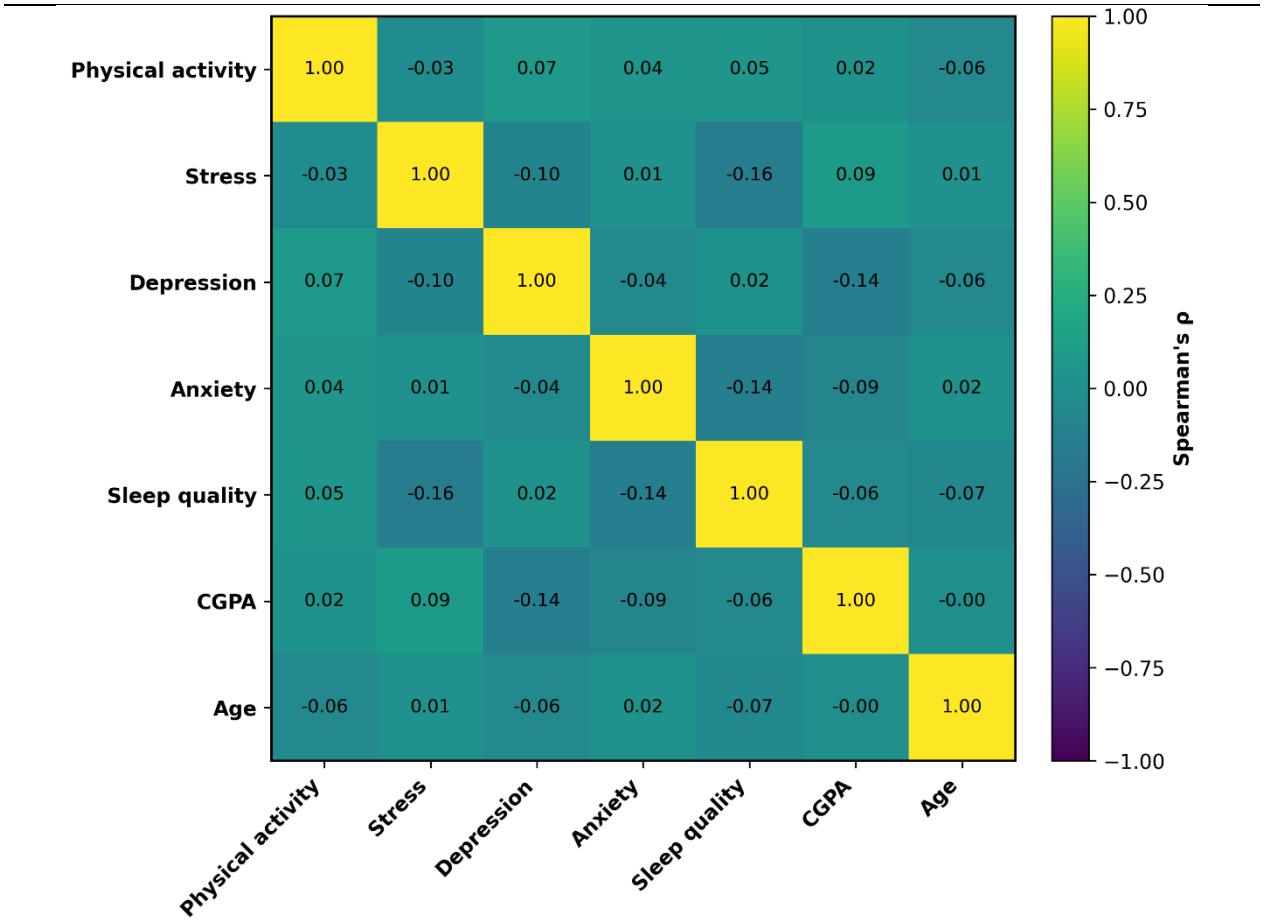


Figure 5. Spearman correlation matrix for physical activity, stress, depression, anxiety, sleep quality, CGPA, and age.

Positive coefficients indicate that variables tend to increase together, whereas negative coefficients indicate an inverse relationship.

3.8 Adjusted Ordinal Regression Analysis

Ordinal logistic regression models were then employed to test for the independent association of physical activity with physiological health outcomes after controlling for age, gender, current CGPA and sleep quality. The reference group was those with low physical activity.

For stress, moderate physical activity was associated with an adjusted odds ratio of 1.21 (95% CI: 0.74–1.98, p = 0.445), while high activity had an adjusted odds ratio of 0.91 (95% CI: 0.48–1.72, p = 0.773). Both associations were not significant.

Likewise, there were no noteworthy, adjusted associations for depression. Compared with low physical activity, the adjusted odds ratios were 1.04 (95% CI: 0.63–1.71, p = 0.888) for moderate activity and 1.49 (95% CI: 0.79–2.81, p = 0.223) for high activity.

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For anxiety, moderate activity yielded an adjusted odds ratio of 1.39 (95% CI: 0.86–2.24, p = 0.183), while high activity yielded an adjusted odds ratio of 1.26 (95% CI: 0.68–2.37, p = 0.463). Adjusted ordinal logistic regression estimates are presented in Table 5.

Table 5. Adjusted ordinal logistic regression examining physical activity and physiological health outcomes

Outcome	Physical activity	Adjusted OR	95% CI	p-value
Stress	Moderate vs Low	1.21	0.74–1.98	0.445
Stress	High vs Low	0.91	0.48–1.72	0.773
Depression	Moderate vs Low	1.04	0.63–1.71	0.888
Depression	High vs Low	1.49	0.79–2.81	0.223
Anxiety	Moderate vs Low	1.39	0.86–2.24	0.183
Anxiety	High vs Low	1.26	0.68–2.37	0.463

3.9 Adjusted Predicted Probability of Higher Physiological health Symptom Scores

For ease of interpretation of ordinal regression results, adjusted predicted probabilities were computed for having relatively high symptom scores, which were scored at 4 or 5 on the physiological health scales respectively.

The expected probability of high stress was 23.8% for low physically active people, 27.5% for moderately active and 22.2% for high physically active people (Figure 6).

The adjusted probabilities were 18.7%, 19.2%, and 25.4% for low, moderate and high physical activity for depression, respectively. Predicted probabilities for low, moderate and high activity were 22.1%, 28.2% and 26.4%, respectively, for anxiety.

These probability patterns were small and non-linear, as there were no statistically significant associations in the adjusted ordinal regression models. Increased physical activity was not associated with a consistent decrease in high physiological health symptom scores, in particular.

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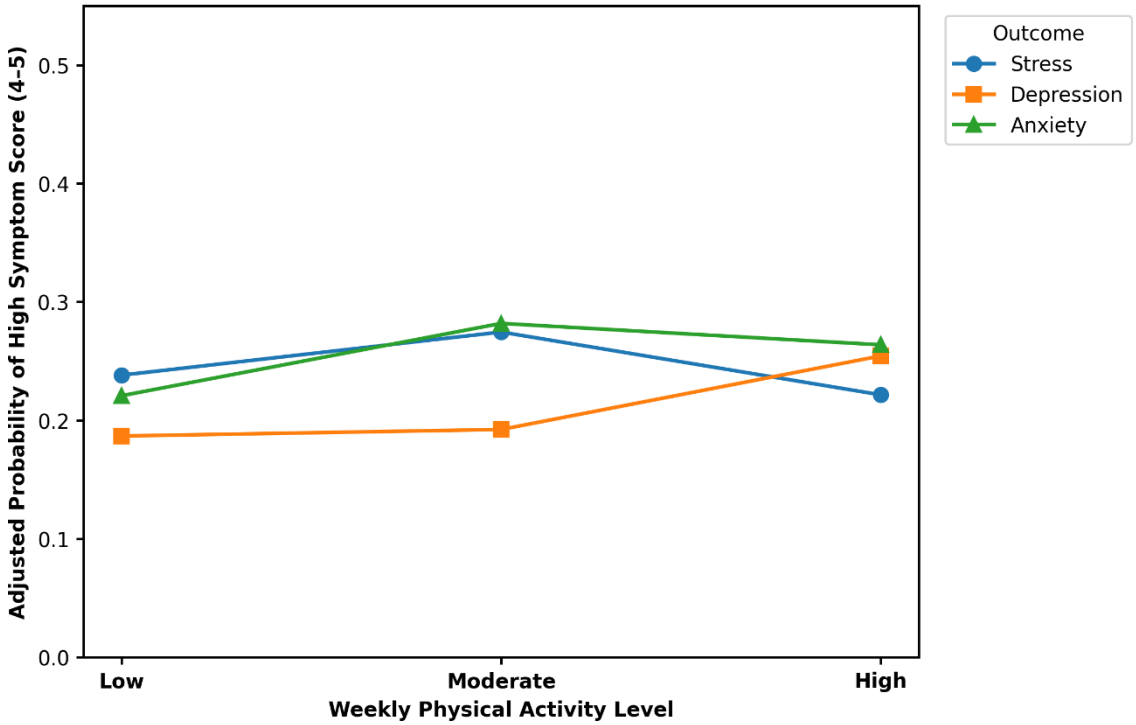


Figure 6. Adjusted predicted probabilities of high stress, depression, and anxiety scores according to weekly physical activity level

Severity was considered high when the result of the ordinal scale was 4-5. The estimates were obtained using ordinal logistic regression models controlling for age, gender, current CGPA, and sleep quality.

4. Discussion

The present study investigated the relationship between weekly physical activity and stress, depression and anxiety in university students. While descriptive differences were noted between low, moderate, and high physical activity groups, none of the between-group comparisons was statistically significant. Spearman correlations between physical activity and the three physiological health outcomes were also weak and non-significant, and the results were not altered by adjusting for the age, gender, current CGPA and sleep quality. Based on these findings, within this sample physical activity per se did not have a clear independent association with psychological symptom severity.

This finding is in contrast to a growing literature that has identified positive relationships between physical activity and student physiological health. In university students, Waclawovsky et al. (2026) reported that the odds of having depressive symptoms were lower among more physically active university students, and Wang et al. (2026) reported an overall inverse association between physical activity and depression. Furthermore, structured exercise is suggested to be an

intervention that could improve depressive and anxiety symptoms in university students based on evidence (Sveaas et al., 2026). The effects of physical activity interventions on anxiety and depression were also found to be positive by Luo et al. (2022).

The present findings, however, do not necessarily contradict the wider literature, as physical activity–physiological health relationships might differ across context, measurement, and person. Martín-Rodríguez and González-Prieto (2025) called attention to significant differences in the association between physical activity, perceived stress, and physiological health. White et al. (2024) also demonstrated how psychological and behavioral mediators and moderators can impact the strength of relationships between physical activity and physiological health.

Some research indicates that the benefits of exercise could be indirect. Ge et al. (2026) found that psychological resilience and social support were two intervening variables between physical activity and anxiety. Han et al. (2025) reported that social adaptability and the exercise-related behavioral mechanism were involved in the relationship between activity and physiological health. Likewise, Hu and Liu (2025) revealed emotion regulation and self-efficacy as mediators of the positive impact of physical activity. Wang et al. (2025) also noted that the pathways of sequential mediation (SM) via self-efficacy and emotion regulation were significant.

The non-significant findings may be a result of interactions with other lifestyle behaviors as well. Physical activity should not be looked at in isolation, as combinations of physical activity and screen time were related to both physiological health and sleep as shown by Gao et al (2026). In line with this, Jelleli et al. (2024) found that problematic internet use (PIU) could also impact the correlation between physical activity and depression, anxiety, and stress. Zhou et al. (2024) additionally showed that shifting sedentary time to other types of physical activity could be different in its relationship with depression and anxiety symptoms.

In the present analysis, sleep quality was found to be particularly relevant, and was negatively correlated with stress and anxiety, albeit weakly so. These findings align with those of Ramírez-Vélez et al. (2026) that found correlations between sleep quality, physical activity, and anxiety and depressive symptoms. In addition, Ye et al. (2022) showed that physical activity (PA) can enhance sleep quality via psychological mechanisms that include mindfulness and rumination. Yuting and Rashid (2025) also found that sleep and physical activity were interrelated factors of physiological health that was impacted by academic stress.

The current findings also indicated a weak inverse relationship between the CGPA and depression, which further suggests that there is a possible interplay between academic and psychological issues in the student context. During the transition to college, perceived stress and physiological health symptoms are found to be highly related by Fruehwirth et al. (2023). Similar, Liu and Shi (2023a) highlighted the role of social support and proactive personality in understanding anxiety in students.

Variation that is not reflected in the simple categories of activities can also be explained by depression-specific pathways. Liu et al. (2023b) found that rumination and anxiety were mediators between physical activity and depression. In addition to frequency or level, Fu and Cheng (2026) also found that the context of physical activity was associated with its physical and psychological health benefits.

The present results suggest that, in this sample, physical activity is not independently related to stress, depression, or anxiety, although the general literature suggests otherwise. This could be attributed to the complexity of students' physiological health, highlighted by Liu et al. (2025) and Streram et al. (2025). Therefore, physical activity must be seen as one of the components of a comprehensive behavioural and psychosocial approach, and not as a single factor affecting physiological health.

5. Conclusion

The study investigated the relationship between physiological health outcomes and weekly physical activity among university students with a focus on the relationship between physical activity and stress, depression, and anxiety. Differences in the descriptive variables between the three groups (low, moderate, and high physical activity) were noted but were not statistically significant. Spearman correlation also revealed very weak correlations between physical activity and the three physiological health outcomes. Physical activity was non-significantly associated with stress, depression and anxiety after age and gender and current CGPA and sleep quality was controlled. The same lack of a dose response pattern was also observed for the adjusted predicted probability analysis by activity categories. However, sleep quality was weakly inversely related to stress and anxiety, and current CGPA was weakly inversely associated with depression, suggesting that other, inter-related, factors in students' academic and lifestyle context may also influence physiological health. In conclusion it is suggested that physical activity is not to be seen as a standalone factor to psychological well-being in this group. Rather, physiological health in university students seems to be the result of interaction between behavioural, academic and psychosocial factors. Longitudinal study designs, larger and more diverse sample sizes, more intensive measures of physical activity intensity, duration, context, sleep, and related lifestyle behaviors are needed to further elucidate these relationships in future studies.

References

1. Donnelly, S., Penny, K., & Kynn, M. (2024). The effectiveness of physical activity interventions in improving higher education students' physiological health: A systematic review. Health promotion international, 39(2), daae027.
2. Fox, K. R. (1999). The influence of physical activity on mental well-being. Public health nutrition, 2(3a), 411-418.

3. Fruehwirth, J. C., Mazzolenis, M. E., Pepper, M. A., & Perreira, K. M. (2023). Perceived stress, physiological health symptoms, and deleterious behaviors during the transition to college. PloS one, 18(6), e0287735.

4. Fu, J., & Cheng, Z. The Influence of Outdoor Physical Activity on the Physical and Physiological health of College Students: A Systematic Review. Frontiers in Psychology, 17, 1898808.

5. Gao, W., Li, Z., & Li, M. (2026). Joint physical activity and screen time patterns in relation to physiological health and sleep among university students: A systematic review with exploratory quantitative synthesis. Journal of Affective Disorders, 121890.

6. Ge, C., Li, X., Li, J., & Yang, C. (2026). The influence pathways of physical activity on anxiety in university students: a systematic review and meta-analytic structural equation modeling study based on psychological resilience and social support. BMC psychology, 14(1), 193.

7. Han, X., Li, H., Xiao, C., Wang, W., Gao, K., Yan, S., & Niu, L. (2025). Physical activity enhances college students' physiological health through social adaptability and exercise behavior chain mediation. Scientific Reports, 15(1), 21127.

8. Hu, Y., & Liu, B. (2025). The impact of physical exercise on college students' physiological health through emotion regulation and self-efficacy. Scientific Reports, 15(1), 33548.

9. Huang, K., Beckman, E. M., Ng, N., Dingle, G. A., Han, R., James, K., ... & Gomersall, S. R. (2024). Effectiveness of physical activity interventions on undergraduate students' physiological health: systematic review and meta-analysis. Health promotion international, 39(3), daae054.

10. Jelleli, H., Ben Aissa, M., Kaddech, N., Saidane, M., Guelmami, N., Bragazzi, N. L., ... & Dergaa, I. (2024). Examining the interplay between physical activity, problematic internet use and the negative emotional state of depression, anxiety and stress: Insights from a moderated mediation path model in university students. BMC psychology, 12(1), 406.

11. Li, B., Han, S. S., Ye, Y. P., Li, Y. X., Meng, S. Q., Feng, S., ... & Liu, Y. (2024). Cross sectional associations of physical activity and sleep with physiological health among Chinese university students. Scientific reports, 14(1), 31614.

12. Liu, L., Xin, X., Wang, H., & Zhang, Y. (2025). Effectiveness of physical exercise on physiological health among university students: a systematic review and meta-analysis. Frontiers in psychology, 16, 1612408.

13. Liu, M., & Shi, B. (2023a). The effect of physical exercise on the anxiety of college students in the post-pandemic era: the mediating role of social support and proactive personality. Frontiers in Psychology, 14, 1128748.

14. Liu, M., Liu, H., Qin, Z., Tao, Y., Ye, W., & Liu, R. (2024). Effects of physical activity on depression, anxiety, and stress in college students: the chain-based mediating role of psychological resilience and coping styles. Frontiers in psychology, 15, 1396795.

15. Liu, Y., Feng, Q., & Guo, K. (2023b). Physical activity and depression of Chinese college students: chain mediating role of rumination and anxiety. Frontiers in psychology, 14, 1190836.

16. Luo, Q., Zhang, P., Liu, Y., Ma, X., & Jennings, G. (2022). Intervention of physical activity for university students with anxiety and depression during the COVID-19 pandemic prevention and control period: A systematic review and meta-analysis. International journal of environmental research and public health, 19(22), 15338.

17. Ma, D., Fang, H., Li, Y., Sun, Y., & Wang, S. (2024). The association study on physical activity intensity, sleep quality, and depression among college students in the central plains region. Acta Psychologica, 250, 104497.

18. Martín-Rodríguez, A., & González-Prieto, N. (2025). Influence of physical activity on perceived stress and physiological health in university students: a systematic review. Frontiers in sports and active living, 7, 1710832.

19. Mu, F. Z., Liu, J., Lou, H., Zhu, W. D., Wang, Z. C., & Li, B. (2024). Influence of physical exercise on negative emotions in college students: chain mediating role of sleep quality and self-rated health. Frontiers in public health, 12, 1402801.

20. Nawaz, S., Ayon, S. M., Arman, M. S., & Tamim, M. N. (2026). Academic stress, sleep quality, and lifestyle factors among university students: A cross-sectional dataset (Version 2) [Data set]. Mendeley Data. https://doi.org/10.17632/srd3wmjd4r.2

21. Noetel, M., Sanders, T., Gallardo-Gómez, D., Taylor, P., del Pozo Cruz, B., Van Den Hoek, D., ... & Lonsdale, C. (2024). Effect of exercise for depression: systematic review and network meta-analysis of randomised controlled trials. bmj, 384.

22. Qin, T., Chen, P., Wang, J., Dong, J., & Zhang, K. (2024). Impact of physical activity on anxiety among university students: a moderated mediation model. Frontiers in Psychology, 15, 1509201.

23. Ramírez-Vélez, R., Calderón-González, J. C., Palma-Pulido, L. H., Mejía-Vásquez, A. F., Arias-Álzate, C., Urriago-Fontal, J. C., ... & Izquierdo, M. (2026). Associations of sleep

quality and physical activity with anxiety and depressive symptoms among university students: a cross-sectional study. Frontiers in Public Health, 14, 1799311.

24. Rogowska, A. M., Pavlova, I., Kuśnierz, C., Ochnik, D., Bodnar, I., & Petrytsa, P. (2020). Does physical activity matter for the physiological health of university students during the COVID-19 pandemic?. Journal of clinical medicine, 9(11), 3494.

25. Streram, S., Burrows, T., Duncan, M. J., & Hutchesson, M. (2025). Health behaviour interventions to improve physiological health outcomes for students in the university setting: a systematic review of randomised controlled trials. International Journal of Behavioral Nutrition and Physical Activity, 22(1), 32.

26. Sveaas, S. H., Brandtzæg, M., Smedslund, G., Rognlien, M. Ø., & Danielsen, K. K. (2026). Effects of exercise on depression and anxiety in university students: a systematic review and meta-analysis. Frontiers in Sports and Active Living, 8, 1708741.

27. Waclawovsky, A. J., De Oliveira, J., De Carvalho, C. P., Adornes, M. E., Dos Santos, E., Wolf, S., ... & Schuch, F. B. (2026). Higher physical activity is associated with reduced odds of depressive symptoms among university students: A meta-analysis of over 66,000 participants. Journal of Affective Disorders, 121319.

28. Wang, J., Chen, Q., Meng, J., Wei, J., Wang, C., & Hou, C. (2025). The relationship between physical activity and physiological health among university students: a chain mediation effect of self-efficacy and emotion regulation. Frontiers in Psychology, 16, 1681753.

29. Wang, J., Liu, X., Xu, X., Wang, H., & Yang, G. (2024). The effect of physical activity on sleep quality among Chinese college students: the chain mediating role of stress and smartphone addiction during the COVID-19 pandemic. Psychology Research and Behavior Management, 2135-2147.

30. Wang, Y., Mao, H., Zhang, X., Li, D., Liu, Z., Shang, W., & Song, G. (2026). Association between physical activity and depression in university students: a systematic review and meta-analysis with public health implications. Frontiers in Psychology, 17, 1850043.

31. White, R. L., Vella, S., Biddle, S., Sutcliffe, J., Guagliano, J. M., Uddin, R., ... & Teychenne, M. (2024). Physical activity and physiological health: a systematic review and best-evidence synthesis of mediation and moderation studies. International Journal of Behavioral Nutrition and Physical Activity, 21(1), 134.

32. Wilson, O. W., Holland, K. E., Elliott, L. D., Duffey, M., & Bopp, M. (2021). The impact of the COVID-19 pandemic on US college students' physical activity and physiological health. Journal of Physical Activity and Health, 18(3), 272-278.

33. Ye, J., Jia, X., Zhang, J., & Guo, K. (2022). Effect of physical exercise on sleep quality of college students: Chain intermediary effect of mindfulness and ruminative thinking. Frontiers in psychology, 13, 987537.

34. Yuting, L., & Rashid, R. A. B. A. (2025). Beyond the books: How sleep, school belonging, and physical activity affect the physiological health of students under academic stress. Acta Psychologica, 258, 105213.

35. Zhou, Y., Huang, Z., Liu, Y., & Liu, D. (2024). The effect of replacing sedentary behavior with different intensities of physical activity on depression and anxiety in Chinese university students: an isotemporal substitution model. BMC public health, 24(1), 1388.