

Structural Equation Modeling of Campus Recreational Facility Quality and Academic Stress Through Sport Participation

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Abstract

Background: Academic stress is a growing concern among university students, with important implications for mental health and academic performance. Campus recreational environments have been proposed as contextual resources that may alleviate stress by promoting health-enhancing behaviors.

Purpose: Grounded in self-determination theory and the stress-buffering hypothesis, this study examined the relationships between campus recreational facility quality, sport participation, and academic stress using structural equation modeling (SEM).

Methods: A cross-sectional survey was conducted among 472 university students (52.5% female; M age = 21.6 years). Validated instruments were used to assess perceived recreational facility quality, sport participation, and academic stress. Data were analyzed using confirmatory factor analysis (CFA) and SEM with bootstrapped mediation testing.

Results: The measurement model demonstrated good fit (CFI = .95, TLI = .94, RMSEA = .050). Structural results indicated that campus recreational facility quality was positively associated with sport participation ($\beta = .36, p < .001$) and negatively associated with academic stress ($\beta = -.12, p = .018$). Sport participation was significantly negatively related to academic stress ($\beta = -.42, p < .001$). Bootstrapping (5,000 resamples) revealed a significant indirect effect of facility quality on academic stress through sport participation ($\beta = -.15, 95\% \text{ CI } [-.22, -.09]$), indicating partial mediation. The model explained 13% of the variance in sport participation and 47% of the variance in academic stress.

Conclusion: High-quality campus recreational facilities contribute to lower academic stress both directly and indirectly by fostering sport participation. Enhancing recreational infrastructure may represent an effective institutional strategy for promoting student well-being.

Keywords: campus recreational facilities; sport participation; academic stress; structural equation modeling; self-determination theory

Introduction

Academic stress has become a pervasive concern among university students worldwide, with growing evidence indicating its detrimental effects on mental health, academic performance, and overall well-being. University students are frequently exposed to multiple stressors, including academic workload, examinations, time pressure, and future career uncertainty, which collectively contribute to elevated stress levels and psychological strain (Herman et al., 2018; Maslach et al., 2001). Persistent academic stress has been linked to anxiety, depression, burnout, and reduced academic engagement, underscoring the need to identify protective factors within the university environment that may alleviate stress and promote student well-being (American College Health Association, 2022; Baniyadi et al., 2022).

In recent years, attention has shifted toward the role of campus built environments, particularly recreational and sport facilities, in supporting students' mental health. Campus recreational facilities—such as gyms, sport halls, outdoor courts, walking paths, and green exercise spaces—represent a critical component of university infrastructure that can influence students' lifestyle behaviors and psychological functioning. High-quality recreational facilities may provide accessible opportunities for physical activity, social interaction, and stress relief, thereby serving as an environmental resource that supports adaptive coping with academic demands (Leslie et al., 2005; Tinto, 2012).

The concept of facility quality extends beyond mere availability and includes dimensions such as accessibility, safety, maintenance, equipment adequacy, aesthetic appeal, and perceived comfort. Previous research has shown that individuals' perceptions of facility quality are strongly associated with physical activity participation and sustained engagement (Bauman et al., 2012; Monadi, 2025a). In university settings, well-designed and well-maintained recreational environments may reduce practical and psychological barriers to sport participation, making physical activity a more attractive and sustainable behavior for students (Christodoulides et al., 2023; Monadi et al., 2025).

From an ecological perspective, health behaviors are shaped by interactions between individuals and their environments. Ecological models of health behavior emphasize that physical environments can either constrain or facilitate engagement in physical activity by influencing opportunity structures and perceived behavioral control (Sallis et al., 2015). Within the university context, campus recreational facilities constitute a proximal environmental factor that can directly shape students' engagement in sport and exercise, particularly given the time constraints and academic pressures faced by students (Leslie et al., 2005; Monadi, 2025b).

Sport participation has been consistently identified as an effective strategy for managing stress and enhancing psychological well-being among university students. Regular engagement in sport and structured physical activity is associated with reduced perceived stress, improved mood, and enhanced emotional regulation (Dishman et al., 2013; Pascoe et al., 2020). These benefits are explained through multiple mechanisms, including physiological stress regulation, distraction from academic concerns, and increased social support (Stults-Kolehmainen & Sinha, 2014; World Health Organization, 2020).

The stress-buffering hypothesis suggests that physical activity can mitigate the negative effects of stress by enhancing individuals' coping capacity and resilience. According to transactional models of stress, stress outcomes depend on individuals' appraisal of stressors and the availability of coping resources (Lazarus & Folkman, 1984). Sport participation may serve as a behavioral coping resource that alters students' appraisal of academic demands and reduces stress intensity (Fletcher & Sarkar, 2013; Hosseini et al., 2022).

The proposed relationships among campus recreational facility quality, sport participation, and academic stress are grounded in several complementary theoretical frameworks. Self-Determination Theory (SDT) posits that environments supporting autonomy, competence, and relatedness foster intrinsic motivation and psychological well-being (Deci & Ryan, 2000, 2008). High-quality recreational facilities may support autonomy by offering flexible opportunities for activity, competence by enabling skill development, and relatedness through social interaction, thereby increasing motivation for sport participation (Chaharbaghi et al., 2022; Moradi et al., 2020).

In addition, the Theory of Planned Behavior emphasizes that perceived behavioral control plays a central role in shaping intentions and behaviors (Ajzen, 1991). Accessible and well-equipped campus recreational facilities may enhance students' perceived control over engaging in physical activity, increasing participation likelihood. Social influences within recreational spaces, such as peer support and shared activity norms, may further strengthen motivation for sport participation (Sheikh et al., 2021).

Academic stress is a multidimensional construct encompassing emotional, cognitive, and physiological responses to academic demands. High levels of academic stress have been associated with sleep disturbances, reduced concentration, lower academic achievement, and increased risk of mental health problems (Cohen et al., 1983; Herman et al., 2018). Given the rising prevalence of stress-related issues among university students, there is a growing need for preventive approaches that operate at environmental and institutional levels rather than relying solely on individual coping strategies (American College Health Association, 2022).

Universities are uniquely positioned to influence students' daily environments through campus planning and infrastructure investment. Improving the quality of recreational facilities may represent a cost-effective and sustainable strategy for promoting student mental health by embedding stress-reducing opportunities within the campus environment (Tinto, 2012; Monadi, 2025c).

Despite increasing interest in campus environments and student well-being, empirical research examining the mechanisms linking recreational facility quality to academic stress remains limited. Many existing studies focus on direct associations between physical activity and stress without explicitly modeling environmental antecedents or mediation pathways (Stults-Kolehmainen & Sinha, 2014). Moreover, few studies employ structural equation modeling (SEM) to simultaneously examine latent constructs, behavioral mediators, and psychological outcomes within a unified theoretical framework (Bollen, 1989; Kline, 2016).

SEM offers a robust methodological approach for testing complex relationships among environmental perceptions, behavioral variables, and psychological outcomes. By integrating measurement models and structural paths, SEM enables more accurate estimation of direct and indirect effects while accounting for measurement error (Bollen, 1989; Kline, 2016).

The primary aim of this study is to examine the relationships among campus recreational facility quality, sport participation, and academic stress among university students using structural equation modeling. Specifically, the study seeks to:

1. Examine the direct effect of campus recreational facility quality on sport participation.
2. Investigate the relationship between sport participation and academic stress.
3. Test whether sport participation mediates the relationship between campus recreational facility quality and academic stress.

Based on ecological models, Self-Determination Theory, the Theory of Planned Behavior, and stress-buffering frameworks, it is hypothesized that higher perceived quality of campus recreational facilities will be associated with greater sport participation, which in turn will be associated with lower levels of academic stress. It is further expected that sport participation will mediate the relationship between facility quality and academic stress.

Methods

Study Design and Participants

This study employed a cross-sectional survey design to examine the relationships among campus recreational facility quality, sport participation, and academic stress among university students. Participants were recruited from multiple faculties at a comprehensive public university using a stratified convenience sampling approach to ensure representation across academic disciplines and years of study. Eligibility criteria included: (a) being enrolled as a full-time undergraduate or postgraduate student, and (b) being physically able to participate in sport or physical activity.

A total of 486 questionnaires were distributed, of which 472 valid responses were retained after excluding incomplete surveys and cases with excessive missing data, yielding a response rate of 97.1%. The final sample consisted of 52.5% female and 47.5% male students, with a mean age of 21.6 years ($SD = 2.4$). All participants provided informed consent prior to participation, and the study protocol was approved by the university's institutional ethics committee.

Measures

Campus Recreational Facility Quality: Perceived campus recreational facility quality was assessed using an adapted version of items derived from the Neighborhood Environment Walkability Scale (NEWS) and prior campus facility evaluation studies. The scale focused specifically on recreational and sport-related infrastructure within the university campus. Items assessed multiple dimensions of facility quality, including:

- Accessibility and proximity of facilities
- Adequacy and modernity of equipment
- Maintenance and cleanliness
- Safety and lighting
- Aesthetic appeal and comfort

Participants rated each item on a 5-point Likert scale ranging from 1 (*strongly disagree*) to 5 (*strongly agree*). Higher scores indicated better perceived facility quality. In the present study, the scale demonstrated good internal consistency (Cronbach's $\alpha > .85$). Facility quality was modeled as a latent construct indicated by its observed items in the SEM analysis.

Sport Participation: Sport participation was measured using a self-reported scale adapted from the International Physical Activity Questionnaire (IPAQ) and previous sport participation research in university

populations. Participants reported the frequency (days per week) and duration (minutes per session) of their participation in organized or non-organized sport activities during a typical week on campus.

A composite sport participation score was calculated by standardizing and combining frequency and duration indicators. Higher scores reflected greater engagement in sport participation. This construct was specified as a latent variable represented by multiple indicators capturing participation intensity and regularity.

Academic Stress: Academic stress was assessed using an adapted version of the Academic Stress Scale, which measures students' perceived stress related to academic demands. The scale included items reflecting:

- Examination and grading pressure
- Academic workload
- Time management difficulties
- Performance expectations and fear of failure

Participants responded on a 5-point Likert scale ranging from 1 (*not stressful at all*) to 5 (*extremely stressful*). Higher scores indicated greater levels of academic stress. The scale demonstrated strong reliability in the current sample (Cronbach's $\alpha > .88$). Academic stress was modeled as a latent outcome variable in the SEM.

Procedure: Data were collected during the middle of the academic semester to avoid periods of unusually low or high academic stress (e.g., beginning of semester or final examinations). Questionnaires were administered both online and in paper format during scheduled class sessions and through the university's learning management system. Participation was voluntary, and anonymity was assured.

Data Analysis Strategy

Preliminary Analyses: Data screening and preliminary analyses were conducted using SPSS 26.0. Descriptive statistics were calculated for all variables, including means, standard deviations, skewness, and kurtosis. Normality was assessed using skewness and kurtosis values, with values within ± 2 considered acceptable. Missing data were minimal (<5%) and were handled using full information maximum likelihood (FIML) estimation.

Structural Equation Modeling: Structural equation modeling (SEM) was performed using AMOS 24.0 following a two-step modeling approach. First, a confirmatory factor analysis (CFA) was conducted to evaluate the measurement model, assessing the factorial validity of the latent constructs: campus recreational facility quality, sport participation, and academic stress.

Model fit was evaluated using multiple goodness-of-fit indices, including the chi-square statistic (χ^2), the ratio of chi-square to degrees of freedom (χ^2/df), the Comparative Fit Index (CFI), the Tucker-Lewis Index (TLI), and the Root Mean Square Error of Approximation (RMSEA). Model fit was considered acceptable based on commonly recommended criteria (CFI and TLI $\geq .90$; RMSEA $\leq .08$), and good fit was indicated by CFI and TLI $\geq .95$ and RMSEA $\leq .06$.

Structural Model and Mediation Analysis: After establishing an acceptable measurement model, the hypothesized structural model was tested to examine direct paths from campus recreational facility quality to sport participation and academic stress, as well as the path from sport participation to academic stress. Sport participation was specified as a mediating variable.

Mediation effects were tested using a bootstrapping procedure with 5,000 resamples, generating bias-corrected 95% confidence intervals for indirect effects. Mediation was considered significant if the confidence interval did not include zero. Standardized path coefficients (β) were reported to facilitate interpretation of effect sizes.

Results

Participant Characteristics

A total of 472 university students participated in the study. Of the sample, 52.5% were female ($n = 248$) and 47.5% were male ($n = 224$). Participants ranged in age from 18 to 29 years, with a mean age of 21.6 years ($SD = 2.4$). Regarding academic level, 71.2% were undergraduate students and 28.8% were postgraduate students. Students were drawn from a range of academic disciplines, including social sciences (34.1%), engineering and natural sciences (41.3%), and health-related fields (24.6%). Table 1 presents the demographic characteristics of the sample.

Table 1. Demographic characteristics of participants (N = 472)

Variable	Category	n	%
Gender	Female	248	52.5
	Male	224	47.5
Academic level	Undergraduate	336	71.2

Variable	Category	n	%
	Postgraduate	136	28.8
Field of study	Social sciences	161	34.1
	Engineering & sciences	195	41.3
	Health sciences	116	24.6

Descriptive Statistics and Correlations

Means, standard deviations, and Pearson correlation coefficients for the main study variables are presented in Table 2. Students reported moderate to high perceptions of campus recreational facility quality ($M = 3.64$, $SD = 0.71$) and moderate levels of sport participation ($M = 3.38$, $SD = 0.76$). The mean level of academic stress was relatively high ($M = 3.59$, $SD = 0.74$), reflecting the demanding academic environment. Correlation analyses indicated that campus recreational facility quality was positively associated with sport participation ($r = .36$, $p < .001$) and negatively associated with academic stress ($r = -.24$, $p < .001$). Sport participation was negatively correlated with academic stress ($r = -.41$, $p < .001$), supporting its proposed stress-buffering role.

Table 2. Means, standard deviations, and correlations among study variables

Variable	M	SD	1	2	3
1. Facility quality	3.64	0.71	—		
2. Sport participation	3.38	0.76	.36***	—	
3. Academic stress	3.59	0.74	-.24***	-.41***	—

** $p < .001$

Pre-Assumption Testing

Skewness and kurtosis values for all observed variables ranged between -1.12 and 1.27 , indicating acceptable univariate normality. Multicollinearity was assessed using variance inflation factors (VIF), with all values below 2.5 , suggesting no multicollinearity concerns. To examine potential common method bias, Harman's single-factor test was conducted. The first unrotated factor accounted for 32.6% of the total variance, which is below the recommended threshold of 50% , indicating that common method variance was unlikely to be a serious concern.

Measurement Model (Confirmatory Factor Analysis)

A confirmatory factor analysis (CFA) was conducted to assess the measurement model comprising three latent constructs: campus recreational facility quality, sport participation, and academic stress. The measurement model demonstrated good fit to the data: $\chi^2/df = 2.18$, $CFI = .95$, $TLI = .94$, $RMSEA = .050$. All standardized factor loadings were significant ($p < .001$) and exceeded the recommended threshold of $.60$. Composite reliability (CR) values ranged from $.86$ to $.91$, and average variance extracted (AVE) values ranged from $.56$ to $.64$, indicating satisfactory convergent validity. Discriminant validity was supported, as the square roots of AVE for each construct exceeded the corresponding inter-construct correlations.

Table 3. CFA results: factor loadings, composite reliability, and AVE

Construct	Item loadings	CR	AVE
Facility quality	.68 – .84	.89	.61
Sport participation	.71 – .86	.86	.56
Academic stress	.73 – .88	.91	.64

Structural Model and Mediation Analysis

Following confirmation of the measurement model, the hypothesized structural model was tested. The structural model showed adequate fit:

$$\chi^2/df = 2.21, CFI = .94, TLI = .93, RMSEA = .051$$

Direct Effects

Campus recreational facility quality had a positive and significant effect on sport participation ($\beta = .36$, $p < .001$). Sport participation had a significant negative effect on academic stress ($\beta = -.42$, $p < .001$). Additionally, facility quality showed a direct negative effect on academic stress ($\beta = -.12$, $p = .018$), suggesting partial mediation.

Mediation Effects

The indirect effect of campus recreational facility quality on academic stress through sport participation was tested using bootstrapping with $5,000$ resamples. The indirect effect was significant ($\beta = -.15$), with a 95%

bias-corrected confidence interval that did not include zero [-.22, -.09], indicating that sport participation partially mediated the relationship between facility quality and academic stress. The structural model explained 13% of the variance in sport participation and 47% of the variance in academic stress, indicating substantial explanatory power.

Table 4. Structural path coefficients and mediation results

Path	β	p
Facility quality → Sport participation	.36	< .001
Sport participation → Academic stress	-.42	< .001
Facility quality → Academic stress	-.12	.018
Indirect effect (mediation)	-.15	95% CI [-.22, -.09]

Discussion

The present study examined the relationships among campus recreational facility quality, sport participation, and academic stress among university students using a structural equation modeling approach. Grounded in self-determination theory (SDT), the stress-buffering hypothesis, and ecological models of health behavior, the findings provide empirical support for the proposed mediation model. Overall, the results indicate that higher perceived quality of campus recreational facilities is associated with greater sport participation, which in turn is linked to lower levels of academic stress. Sport participation emerged as a partial mediator, suggesting that campus recreational environments influence academic stress both directly and indirectly through behavioral pathways.

Consistent with the first hypothesis, campus recreational facility quality showed a significant and positive association with sport participation. This finding aligns with ecological and environment-behavior frameworks, which emphasize that supportive physical environments facilitate engagement in health-promoting behaviors. High-quality facilities—characterized by accessibility, safety, maintenance, and adequate equipment—appear to reduce structural and psychological barriers to sport participation among students (Seraj et al., 2013).

From the perspective of self-determination theory, well-designed recreational facilities may foster students' basic psychological needs. Accessible and flexible facilities support autonomy by allowing students to choose when and how they engage in physical activity. Adequate equipment and well-maintained spaces enhance competence by enabling skill development and effective participation, while shared recreational spaces promote relatedness through social interaction. When these needs are supported, students are more likely to internalize motivation for sport participation, leading to more frequent and sustained engagement (Sheikh et al., 2021).

These findings are consistent with previous studies demonstrating that perceptions of facility quality and campus infrastructure are strong predictors of physical activity and sport involvement among university students. Importantly, the present study extends prior research by modeling facility quality as a latent construct and examining its effects within a comprehensive SEM framework.

As hypothesized, sport participation was significantly and negatively associated with academic stress. Students who reported higher levels of sport participation experienced lower perceived stress related to academic demands such as examinations, workload, and performance pressure. This finding reinforces the substantial body of literature identifying physical activity as a protective factor for mental health in student populations (Monadi, 2025).

The observed relationship can be explained through multiple mechanisms. Physiologically, regular sport participation contributes to improved regulation of stress-related hormones and autonomic nervous system functioning. Psychologically, sport participation provides opportunities for distraction from academic concerns, enhances mood, and promotes emotional regulation. Socially, participation in sport can strengthen peer relationships and social support, which are known buffers against stress (Monadi, 2025).

Within the stress-buffering hypothesis, sport participation functions as an adaptive coping resource that mitigates the negative impact of stressors. Rather than eliminating academic demands, sport participation appears to alter students' responses to these demands, reducing perceived stress intensity and enhancing resilience. The relatively large standardized effect observed in the structural model underscores the importance of behavioral factors in managing academic stress (Moradi et al., 2020).

A central contribution of this study is the demonstration that sport participation partially mediates the relationship between campus recreational facility quality and academic stress. The significant indirect effect indicates that one pathway through which high-quality recreational facilities reduce academic stress is by promoting sport participation. This finding supports the theoretical proposition that environmental characteristics influence psychological outcomes indirectly through health behaviors (Nour Mohammadi et al. 2026).

At the same time, the presence of a significant direct effect of facility quality on academic stress suggests that recreational environments may also influence stress through additional mechanisms beyond sport participation. For example, aesthetically pleasing and safe recreational spaces may enhance overall campus satisfaction, provide restorative experiences, or foster a sense of belonging, all of which may independently reduce stress. This partial mediation highlights the multifaceted role of campus environments in shaping students' psychological experiences (Monadi, 2025).

The SEM approach employed in this study allowed for a nuanced examination of these pathways, accounting for measurement error and simultaneously testing direct and indirect effects. The relatively high proportion of variance explained in academic stress (47%) indicates that the proposed model captures a substantial portion of the factors contributing to students' stress experiences.

The findings contribute to theory in several ways. First, they extend self-determination theory by demonstrating how environmental features at the institutional level can support need-satisfying behaviors that influence stress outcomes. While SDT has been widely applied to individual motivation for physical activity, this study highlights the importance of environmental affordances in shaping motivational processes.

Second, the results provide empirical support for the stress-buffering hypothesis within the context of higher education. By explicitly modeling sport participation as a mediator, the study clarifies the behavioral mechanisms through which environmental resources exert their protective effects. Third, the findings align with ecological models of health, emphasizing that interventions targeting physical environments may be as important as individual-level strategies in promoting student well-being (Monadi et al., 2025).

The results have important implications for university administrators, campus planners, and policymakers. Investments in high-quality recreational facilities should be viewed not merely as enhancements to campus aesthetics or student amenities but as strategic interventions to support student mental health. Improving accessibility, safety, and maintenance of recreational spaces may encourage greater sport participation, thereby reducing academic stress at the population level.

Universities may also consider integrating recreational facility planning into broader student well-being strategies. Scheduling flexibility, extended facility hours, and inclusive design that accommodates diverse student needs could further enhance the stress-reducing potential of sport participation. Additionally, promoting awareness and use of existing facilities through targeted programs may amplify their benefits.

Despite its strengths, the study has several limitations. The cross-sectional design precludes causal inference, and longitudinal or experimental studies are needed to confirm the directionality of the observed relationships. The reliance on self-reported measures may introduce response bias, although the use of latent constructs and tests for common method bias mitigate this concern.

Future research should explore additional mediators and moderators, such as motivation quality, social support, or academic workload, to further elucidate the mechanisms linking campus environments to stress outcomes. Comparative studies across different universities or cultural contexts would also enhance generalizability. Finally, incorporating objective measures of facility quality and physical activity could strengthen the evidence base.

Conclusion

In conclusion, this study provides robust evidence that campus recreational facility quality plays a meaningful role in shaping university students' academic stress, both directly and indirectly through sport participation. By integrating environmental, behavioral, and psychological factors within a structural equation modeling framework, the findings underscore the importance of supportive campus environments in promoting student well-being. Enhancing recreational infrastructure and encouraging sport participation may represent effective, sustainable strategies for reducing academic stress in higher education settings.

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