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Physical Exercise and Well-Being in College Students: Comparing the Parallel Mediating Roles of Perceived Social Support, Self-Efficacy, and Psychological Resilience

Quanhong Lu
Chengdu Sport University

Deke Liu
Chengdu Sport University

Duan Yu
Chengdu Sport University

Xiupeng Li
Department of Physical Education, China University of Mining and Technology (Beijing)

Yunmei Chai
littlmei7251@163.com

Chengdu Sport University

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Abstract

This study examined whether physical exercise was associated with well-being among college students and whether perceived social support, self-efficacy, and psychological resilience mediated this association in parallel. Using a cross-sectional design, 1,450 students from multiple universities in China completed standardized measures of physical exercise, well-being, perceived social support, self-efficacy, and psychological resilience. Data were analyzed using descriptive statistics, hierarchical regression, and a covariate-adjusted parallel multiple mediation model controlling for gender, age group, and grade. Physical exercise was positively associated with well-being and with all three proposed mediators. When the mediators were estimated simultaneously, perceived social support and psychological resilience remained significant predictors of well-being, whereas self-efficacy did not. Bootstrap analyses further showed significant indirect effects via perceived social support and psychological resilience, but not via self-efficacy. The direct association between physical exercise and well-being remained significant, indicating partial mediation. These findings suggest that the association between physical exercise and well-being in college students may be more closely linked to social connectedness and adaptive coping capacity than to generalized efficacy beliefs.

1 Introduction

University life represents a critical developmental period during which young adults face increasing academic demands, interpersonal challenges, and career-related uncertainty. In this context, well-being has become an important outcome in higher education research because it reflects not merely the absence of distress, but students' positive evaluation of their lives and functioning. Diener (1984) conceptualized subjective well-being as a broad construct comprising cognitive judgments of life satisfaction and affective experiences. More recent work has further shown that well-being is closely linked to academic functioning, psychological adjustment, and longer-term developmental outcomes among university students (Diener et al., 2018; du Toit et al., 2022). Accordingly, examining the antecedents of well-being is of substantial theoretical and practical significance in college populations.

Among the many factors associated with college students' well-being, physical exercise has received sustained attention because it is modifiable, scalable, and relevant to both public health and educational practice. Meta-analytic evidence indicates that leisure-time physical activity is positively associated with subjective well-being, including life satisfaction and positive affect (Wiese et al., 2018). A broader meta-analytic review of healthy populations reached a similar conclusion, showing a reliable positive relationship between physical activity and subjective well-being across studies (Buecker et al., 2021). Evidence from university student samples also points in the same direction, with more frequent physical activity being associated with better well-being outcomes (Peralta et al., 2021). However, although the positive association between physical exercise and well-being is relatively well established, far less is known about the mechanisms through which exercise may be linked to well-being in college students. In a recent systematic review, White et al. (2024) emphasized that the mediating and moderating processes underlying the physical activity–mental health association remain insufficiently clarified.

One plausible pathway is perceived social support. In college settings, physical exercise often occurs in socially embedded contexts, such as team sports, group training, campus fitness programs, and peer-based recreational activities. These contexts may strengthen students' sense of belonging, interpersonal connection, and perceived availability of support. More broadly, social support is a robust correlate of positive adjustment. Meta-analytic evidence has shown that social support contributes meaningfully to students' psychological adjustment, with perceived support often emerging as particularly important (Bender et al., 2019). Recent systematic evidence focused on university populations likewise indicates that social support is consistently linked to better mental health and well-being outcomes among students. From this perspective, physical exercise may be linked to well-being partly through students' perceptions of being supported, connected, and socially embedded.

A second potential pathway is self-efficacy, which reflects a cognitive resource. According to Bandura's (1977) social cognitive theory, self-efficacy refers to individuals' beliefs in their capacity to organize and execute actions required to manage prospective situations. Physical exercise may be positively related to self-efficacy because it provides repeated opportunities for mastery experiences, goal attainment, persistence, and behavioral self-regulation. It is therefore reasonable to propose that physical exercise may be associated with higher well-being partly through students' beliefs in their own competence and capacity to cope with everyday challenges. A recent systematic review and meta-analysis found that exercise interventions may improve perceived self-efficacy in adults, although the magnitude of this effect varies across contexts and measures (Ghayour Baghbani et al., 2023). In turn, self-efficacy has been linked to life satisfaction and subjective well-being in prior research (Azizli et al., 2015; Strobel et al., 2011).

A third pathway is psychological resilience, which can be understood as an adaptive resource. Resilience refers to the capacity to maintain or regain psychological functioning in the face of adversity, stress, or disruption. In higher education contexts, resilience is especially relevant because college students often encounter academic pressure, social transition, and uncertainty about future roles. Meta-analytic evidence has shown that trait resilience is negatively associated with psychological distress and positively associated with indicators of positive mental health, including life satisfaction and positive affect (Hu et al., 2015). Given that regular physical exercise is often linked to better emotion regulation, stress buffering, and recovery processes, it is plausible that exercise may be associated with well-being in part through psychological resilience. In this sense, resilience may represent a more proximal explanatory pathway in the association between exercise and students' positive functioning.

Taken together, the existing literature suggests that physical exercise may be linked to well-being through multiple psychological and social pathways. Nevertheless, an important unresolved issue is not simply whether different resources are individually relevant, but which of them retain unique explanatory value when they are evaluated concurrently. Many prior studies have examined a single mediator in isolation, which makes it difficult to distinguish robust explanatory pathways from those whose effects overlap with other psychosocial resources. In addition, some studies have imposed sequential relations among mediators that are difficult to justify convincingly in cross-sectional research. In the present study, perceived social support, self-efficacy, and psychological resilience are conceptualized as three distinct but related resources—a social resource, a cognitive resource, and an adaptive resource, respectively. Rather than assuming a strict causal chain among them, this study adopts a parallel multiple mediation model to compare their distinct explanatory roles in the association between physical exercise and well-being among college students.

Against this background, the present study aims to examine the association between physical exercise and well-being among college students and to test whether perceived social support, self-efficacy, and psychological resilience mediate this association in parallel. The contribution of the study lies not merely in combining multiple mediators within one framework, but in identifying which resource-based pathways remain uniquely informative when they are compared simultaneously. By doing so, the study seeks to provide a more differentiated account of how physical exercise relates to well-being and a more precise basis for future exercise-related well-being research and practice in university settings.

Hypotheses:

H1. Physical exercise is positively associated with well-being among college students.

H2. Physical exercise is positively associated with perceived social support, self-efficacy, and psychological resilience.

H3. Perceived social support, self-efficacy, and psychological resilience are positively associated with well-being.

H4a. Perceived social support mediates the association between physical exercise and well-being.

H4b. Self-efficacy mediates the association between physical exercise and well-being.

H4c. Psychological resilience mediates the association between physical exercise and well-being.

2 Method

2.1. Participants and procedure

This study employed a cross-sectional survey design to examine the association between physical exercise and well-being among university students, as well as the parallel mediating roles of perceived social support, self-efficacy, and psychological resilience. Participants were recruited using convenience sampling. To broaden sample coverage, the survey was administered through both online and offline channels across multiple universities in China, including institutions located in Sichuan, Chongqing, Guangdong, and Henan, and students from different academic majors were invited to participate. The questionnaire included demographic items together with standardized measures of physical exercise, well-being, perceived social support, self-efficacy, and psychological resilience. Participation was voluntary and anonymous, and small gifts were provided to enhance response engagement and completion quality.

An a priori Monte Carlo power analysis for mediation models indicated that a minimum sample size of 133 would be sufficient to detect the hypothesized indirect effects with adequate statistical power. The final dataset substantially exceeded this threshold. A total of 1,535 questionnaires were distributed. After routine screening for questionnaire completeness and response usability, 1,451 responses were retained as valid cases. During final data checking, one additional case was excluded because it contained an out-of-range response on the well-being measure. The final analytic sample therefore consisted of 1,450 participants.

As shown in Table 1, 53.3% of the participants were male and 46.7% were female. Age was recorded in grouped categories, with Category 2 representing the largest age subgroup in the source dataset. Academic year was also coded categorically, with the majority of respondents drawn from the third and fourth year cohorts. To reduce the risk of common method bias at the procedural level, participants were informed that the survey was intended for research purposes only, that their responses would remain anonymous, and that there were no right or wrong answers. They were encouraged to answer honestly according to their actual situation, which was intended to reduce evaluation apprehension and socially desirable responding.

2.2. Measures

2.2.1. Physical exercise

Physical exercise was assessed using the Physical Activity Rating Scale-3 (PARS-3), a brief three-item instrument that evaluates exercise intensity, exercise duration, and exercise frequency. Each item is rated on a five-point scale. Following the standard scoring procedure, the overall exercise score was computed as: Physical exercise score = intensity × (duration − 1) × frequency

This yields a composite index ranging from 0 to 100, with higher scores indicating greater exercise involvement. Conventionally, scores of 19 or below indicate low exercise, scores from 20 to 42 indicate moderate exercise, and scores of 43 or above indicate high exercise. Because PARS-3 is a formative composite index rather than a reflective multi-item scale, Cronbach's alpha was not calculated.

2.2.2. Well-being

Well-being was assessed using the 20-item Chinese Subjective Well-Being Scale revised by Xing (2002). The scale uses a six-point Likert response format, with higher scores indicating higher levels of subjective well-being. Item scores were

summed to generate a total well-being score, with higher total scores reflecting better subjective well-being. In the present sample, the internal consistency of the scale was acceptable (Cronbach's α = .867).

2.2.3. Perceived social support

Perceived social support was measured using the 12-item Chinese version of the Perceived Social Support Scale (PSSS). The scale assesses perceived support from family, friends, and other important people in one's social environment. Each item was rated on a seven-point Likert scale ranging from strong disagreement to strong agreement. Scores were summed across items, with higher scores indicating stronger perceived social support. In the present sample, the scale showed excellent internal consistency (Cronbach's α = .923).

2.2.4. Self-efficacy

Self-efficacy was measured using the General Self-Efficacy Scale (GSES). The scale consists of 10 items assessing individuals' general beliefs in their ability to cope effectively with difficulties and accomplish challenging tasks. Items were rated on a four-point Likert scale. Consistent with the scale's conventional scoring procedure, the mean of the 10 items was used as the observed self-efficacy score, with higher scores indicating stronger perceived self-efficacy. In the present sample, Cronbach's alpha was .848.

2.2.5. Psychological resilience

Psychological resilience was assessed using the 10-item version of the Connor-Davidson Resilience Scale (CD-RISC-10). The scale captures adaptive coping capacity and the ability to maintain or regain psychological functioning under stress and adversity. Items were rated on a five-point Likert scale, and scores were summed across the 10 items, with higher scores indicating greater resilience. In the present sample, the scale demonstrated good internal consistency (Cronbach's α = .895).

2.3. Data analysis

Data analysis proceeded in four stages. Before formal analyses, the dataset was screened for response usability and obvious data irregularities; one case containing an out-of-range value on the well-being measure was removed prior to model estimation.

First, descriptive statistics were computed for all study variables, including means, standard deviations, skewness, kurtosis, and internal consistency coefficients where applicable. Pearson zero-order correlations were then estimated to examine the bivariate associations among physical exercise, perceived social support, self-efficacy, psychological resilience, and well-being.

Second, hierarchical multiple regression was conducted to examine the incremental contribution of physical exercise and the proposed mediators to well-being. Gender, age group, and grade were entered as covariates in Model 1. Physical exercise was added in Model 2. Perceived social support, self-efficacy, and psychological resilience were entered simultaneously in Model 3.

Third, HC3 heteroskedasticity-robust standard errors were additionally estimated for the final regression model as a robustness check against mild deviations from ideal regression assumptions.

Fourth, a covariate-adjusted parallel multiple mediation model was estimated to test whether perceived social support, self-efficacy, and psychological resilience mediated the association between physical exercise and well-being. Gender, age group, and grade were retained as covariates in all mediation equations. For mediation analyses, the core continuous variables were standardized prior to estimation so that path coefficients could be interpreted on an approximately standardized metric. Indirect effects were evaluated using bootstrap 95% confidence intervals based on

repeated resampling. An indirect effect was considered statistically significant when its confidence interval did not include zero. Statistical significance was judged using a two-tailed criterion of $p < .05$.

For visual presentation, the zero-order associations among the five core variables were additionally illustrated using pairwise distributions, bivariate scatterplots, and Pearson correlations in Fig. 1.

3 Results

3.1. Sample characteristics

The final analytic sample comprised 1,450 participants. As shown in Table 1, 773 participants (53.3%) were male and 677 (46.7%) were female. In terms of age group, most participants were concentrated in Category 2 (72.1%), followed by Category 1 (19.4%) and Category 3 (7.9%), whereas Categories 4 and 5 accounted for only a very small proportion of the sample. Regarding academic year, Grade 4 represented the largest subgroup (48.0%), followed by Grade 3 (36.8%), Grade 2 (10.0%), and Grade 1 (5.2%). Overall, the sample was primarily composed of students in the later years of university study.

Table 1
Sample characteristics (N = 1,450)

Characteristic	Category	n	%
Total sample	—	1450	100.0
Gender	Male	773	53.3
	Female	677	46.7
Age group (coded)	Category 1	281	19.4
	Category 2	1045	72.1
	Category 3	115	7.9
	Category 4	7	0.5
	Category 5	2	0.1
Grade (coded)	Grade 1	75	5.2
	Grade 2	145	10.0
	Grade 3	534	36.8
	Grade 4	696	48.0

Note. Age was recorded as grouped coded categories in the source dataset (Categories 1–5), and the original category labels were not retained in the analytic file. Grade was recorded as coded academic year categories (Grades 1–4). Percentages may not total exactly 100.0 because of rounding.

3.2. Descriptive statistics, reliability, and zero-order correlations

Descriptive statistics, internal consistency estimates, and zero-order correlations for the core study variables are presented in Table 2. Physical exercise showed a mean of 29.16 (SD = 24.48), perceived social support a mean of 60.90 (SD = 10.99), self-efficacy a mean of 2.90 (SD = 0.41), psychological resilience a mean of 36.29 (SD = 6.29), and well-being a mean of 82.89 (SD = 12.79). Internal consistency was acceptable to excellent for all reflective measures, with Cronbach's alpha coefficients ranging from .848 to .923; alpha was not applicable to the physical exercise composite index.

Table 2
Descriptive statistics, internal consistency, and zero-order correlations among the core study variables

No.	Variable	M	SD	Skewness	Kurtosis	α	1	2	3	4	5
1	Physical exercise	29.16	24.48	0.90	0.06	—	—				
2	Perceived social support	60.90	10.99	-0.11	0.10	0.923	.08**	—			
3	Self-efficacy	2.90	0.41	0.49	1.43	0.848	.18***	.47***	—		
4	Psychological resilience	36.29	6.29	0.19	0.21	0.895	.24***	.51***	.61***	—	
5	Well-being	82.89	12.79	0.35	-0.21	0.867	.16***	.44***	.33***	.47***	—

*Note.1 = Physical exercise, 2 = Perceived social support, 3 = Self-efficacy, 4 = Psychological resilience, and 5 = Well-being. α is Cronbach's alpha. Alpha was not applicable to the physical exercise composite index. Correlations are Pearson coefficients. ** p < .01. *** p < .001.*

In terms of bivariate associations, physical exercise was positively correlated with perceived social support ($r = .08$, $p < .01$), self-efficacy ($r = .18$, $p < .001$), psychological resilience ($r = .24$, $p < .001$), and well-being ($r = .16$, $p < .001$). Perceived social support was positively correlated with self-efficacy ($r = .47$, $p < .001$), psychological resilience ($r = .51$, $p < .001$), and well-being ($r = .44$, $p < .001$). Self-efficacy was positively associated with psychological resilience ($r = .61$, $p < .001$) and well-being ($r = .33$, $p < .001$). In addition, psychological resilience was positively correlated with well-being ($r = .47$, $p < .001$). Overall, all core variables were significantly and positively interrelated, providing preliminary support for the hypothesized associations.

These pairwise associations and bivariate linear trends are further illustrated in Fig. 1. As shown in the figure, the distributions of the five core variables were generally acceptable, and the scatterplots indicated positive linear relationships across the major variable pairs. Among the proposed mediators, the strongest zero-order association was observed between self-efficacy and psychological resilience.

3.3. Hierarchical multiple regression predicting well-being

To further examine the incremental contribution of physical exercise and the proposed mediators to well-being, a hierarchical multiple regression analysis was conducted. As shown in Table 3, the covariates entered in Model 1 accounted for a relatively small proportion of the variance in well-being ($R^2 = .014$). After physical exercise was added in Model 2, the model fit improved significantly ($\Delta R^2 = .041$, $\Delta F = 83.70$, $p < .001$), yielding a total R^2 of .054. When perceived social support, self-efficacy, and psychological resilience were simultaneously entered in Model 3, the explained variance increased substantially ($\Delta R^2 = .247$, $\Delta F = 169.30$, $p < .001$), and the final model explained 30.1% of the variance in well-being.

Table 3
Hierarchical regression predicting well-being and HC3 robust check
Panel A. Standardized hierarchical regression coefficients

Predictor	Model 1 β	Model 2 β	Model 3 β
Physical exercise	—	.226***	.119***
Perceived social support	—	—	.258***
Self-efficacy	—	—	.002
Psychological resilience	—	—	.326***
R^2	.014	.054	.301
Adjusted R^2	.008	.049	.296
ΔR^2	—	.041	.247
ΔF	—	83.70***	169.30***

Panel B. Final model estimated with HC3 heteroskedasticity-robust standard errors

Predictor	β	Robust SE	95% CI	p
Physical exercise	.119	.029	[.063, .175]	< .001
Perceived social support	.258	.028	[.203, .312]	< .001
Self-efficacy	.002	.034	[-.064, .069]	= .944
Psychological resilience	.326	.031	[.265, .387]	< .001

*Note. All coefficients are standardized (β). Gender, age group, and grade were included as covariates in all models but are omitted from the manuscript table for parsimony; full coefficient output was retained in the analytic files. Model 1 included covariates only. Model 2 added physical exercise. Model 3 added perceived social support, self-efficacy, and psychological resilience. ΔF values refer to the change in model fit relative to the immediately preceding model. In Panel B, HC3 robust standard errors were used because diagnostic plots suggested mild heteroskedasticity; the substantive pattern of results was unchanged. * p < .05. ** p < .01. *** p < .001.*

In the final model, physical exercise remained a significant positive predictor of well-being (β = .119, p < .001), indicating that physical exercise retained an independent association with well-being after accounting for the three mediators and the demographic covariates. Perceived social support (β = .258, p < .001) and psychological resilience (β = .326, p < .001) also emerged as significant positive predictors. In contrast, self-efficacy was not a significant independent predictor of well-being in the full model (β = .002, p = .944).

To assess the robustness of these findings, HC3 heteroskedasticity-robust standard errors were additionally estimated for the final model. The substantive pattern of results remained unchanged: physical exercise, perceived social support, and psychological resilience remained significant positive predictors of well-being, whereas self-efficacy remained non-significant. These robust estimates supported the stability of the final regression model. Because the manuscript table omits the covariate coefficients for parsimony, the robustness statement should be kept concise and limited to the stability of the focal predictors.

3.4. Parallel multiple mediation analysis

A covariate-adjusted parallel multiple mediation model was estimated to examine whether perceived social support, self-efficacy, and psychological resilience mediated the association between physical exercise and well-being. The overall structure of the model is illustrated in Fig. 2A, and the exact inferential estimates are reported in Table 4.

Physical exercise significantly and positively predicted perceived social support (b = .130, SE = .031, 95% CI [.070, .190], p < .001), self-efficacy (b = .170, SE = .029, 95% CI [.115, .227], p < .001), and psychological resilience (b = .228, SE = .029, 95% CI [.170, .284], p < .001). When all three mediators were entered simultaneously, perceived social support remained a significant positive predictor of well-being (b = .262, SE = .028, 95% CI [.207, .316], p < .001), as did psychological resilience (b = .320, SE = .030, 95% CI [.260, .381], p < .001). By contrast, self-efficacy did not significantly predict well-being (b = − .004, SE = .034, 95% CI [− .069, .062], p = .908). The direct effect of physical exercise on well-being remained significant (c' = .115, SE = .028, 95% CI [.060, .171], p < .001), indicating partial rather than full mediation. The model explained 1.8% of the variance in perceived social support, 3.5% in self-efficacy, 6.0% in psychological resilience, and 29.4% in well-being.

Figure 2A. *Parallel multiple mediation model linking physical exercise to well-being through perceived social support, self-efficacy, and psychological resilience. The figure illustrates the overall model structure and standardized paths; exact covariate-adjusted inferential estimates are reported in* Table 4.

Table 4
Parallel multiple mediation model estimating well-being through perceived social support, self-efficacy, and psychological resilience Panel A. Path coefficients from the covariate-adjusted parallel mediation model

Path	b	SE	95% CI	p
Physical exercise → perceived social support	.130	.031	[.070, .190]	< .001
Physical exercise → self-efficacy	.170	.029	[.115, .227]	< .001
Physical exercise → psychological resilience	.228	.029	[.170, .284]	< .001
Perceived social support → well-being	.262	.028	[.207, .316]	< .001
Self-efficacy → well-being	− .004	.034	[-.069, .062]	= .908
Psychological resilience → well-being	.320	.030	[.260, .381]	< .001
Direct effect (physical exercise → well-being, c')	.115	.028	[.060, .171]	< .001

Explained variance. R^2 = .018 for perceived social support, .035 for self-efficacy, .060 for psychological resilience, and .294 for well-being.

Panel B. Bootstrap decomposition of indirect, direct, and total effects

Effect	Estimate	Bootstrap SE	95% bootstrap CI	Inference
Indirect effect via perceived social support	.034	.009	[.018, .052]	Significant
Indirect effect via self-efficacy	− .001	.006	[-.012, .011]	Not significant
Indirect effect via psychological resilience	.073	.012	[.051, .097]	Significant
Total indirect effect	.106	.017	[.075, .141]	Significant
Direct effect (c')	.115	.028	[.060, .171]	Significant
Total effect (c)	.222	.029	[.165, .280]	Significant

Note. Core study variables were estimated on z-scored metrics and can therefore be interpreted on an approximately standardized scale. Gender, age group, and grade were included as covariates. Bootstrap confidence intervals were used for indirect effects; intervals excluding zero indicated significance. The indirect effect via self-efficacy was not significant because its confidence interval included zero. c' = direct effect; c = total effect.

Bootstrap analyses further decomposed the indirect pathways, and the magnitude of the specific indirect effects, total indirect effect, direct effect, and total effect is summarized in Fig. 2B and Table 4. The specific indirect effect of physical exercise on well-being through perceived social support was significant (estimate = .034, 95% bootstrap CI [.018, .052]), as was the indirect effect through psychological resilience (estimate = .073, 95% bootstrap CI [.051, .097]). In contrast, the specific indirect effect via self-efficacy was not significant (estimate = − .001, 95% bootstrap CI [− .012, .011]), because the confidence interval included zero. The total indirect effect was significant (estimate = .106, 95% bootstrap CI [.075, .141]), and the total effect of physical exercise on well-being was also significant (estimate = .222, 95% bootstrap CI [.165, .280]). Taken together, these findings indicate that perceived social support and psychological resilience functioned as significant and independent parallel mediators, whereas self-efficacy did not demonstrate a unique mediating effect once the three mediators were considered simultaneously.

4 Discussion

This study examined whether physical exercise was associated with well-being among university students and whether this association was consistent with indirect pathways via perceived social support, self-efficacy, and psychological resilience modeled in parallel. Three findings are especially noteworthy. First, physical exercise was positively associated with well-being. Second, when the three proposed mediators were estimated simultaneously, perceived social support and psychological resilience retained unique explanatory value, whereas self-efficacy did not. Third, the direct association between physical exercise and well-being remained significant after the inclusion of the mediators, which is consistent with partial rather than full mediation. Taken together, these findings suggest that the association between physical exercise and well-being may be more closely linked to interpersonal support and adaptive resilience than to generalized efficacy beliefs.

4.1 Physical Exercise and Well-Being Are Positively Associated

The present study first found that physical exercise was positively associated with well-being among university students. This result is broadly consistent with prior evidence showing that physical activity is reliably related to subjective well-being across healthy populations, including student samples. Meta-analytic work has shown that individuals who engage in more physical activity tend to report better subjective well-being, while more recent reviews have also emphasized that the psychological pathways underlying this association remain insufficiently clarified

(Buecker et al., 2021; White et al., 2024). Evidence from college students likewise suggests that physical activity intensity is positively related to subjective well-being (Zhang et al., 2022). Against this background, the present findings are theoretically meaningful not simply because they replicate a positive exercise–well-being association, but because they help clarify which psychosocial resources retain explanatory value when several plausible pathways are estimated concurrently.

4.2 Perceived Social Support as a Distinct Interpersonal Pathway

A key finding of the present study is that perceived social support retained a unique mediating role even when self-efficacy and psychological resilience were included in the same model. This suggests that the association between physical exercise and well-being may not be understood solely in intrapersonal terms, but also through the social environments in which exercise participation is embedded. In university settings, physical exercise often occurs in peer-based, group-oriented, or socially interactive contexts, which may strengthen students' perceptions of being supported, connected, and socially included. This interpretation is consistent with prior evidence showing that perceived social support is closely related to psychological adjustment in student populations and is positively associated with mental health outcomes among college students (Bender et al., 2019; Hefner & Eisenberg, 2009). In this sense, the present findings extend the literature by indicating that social support is not merely correlated with well-being, but remains a distinct explanatory pathway when several resource-based mechanisms are considered simultaneously.

4.3 Psychological Resilience as a Stronger Adaptive Pathway

Psychological resilience emerged as the comparatively stronger pathway in the final model, suggesting that the association between physical exercise and well-being may be more closely linked to adaptive coping capacity than to generalized competence beliefs alone. Conceptually, resilience reflects the ability to maintain or regain psychological functioning under stress, which makes it particularly relevant in university life, where students frequently face academic demands, uncertainty, and developmental transition. Prior research has shown that resilience is positively associated with positive mental health indicators and that greater physical activity is also related to higher resilience in college students (Hu et al., 2015; Dunston et al., 2022). Against this background, the present findings suggest that physical exercise may be linked to well-being partly because it is associated with experiences relevant to adaptation under challenge, such as persistence, effort, frustration tolerance, and recovery. This may help explain why resilience retained stronger explanatory specificity than self-efficacy when the three mediators were modeled in parallel.

4.4 Self-Efficacy as a Relevant but Non-Distinctive Pathway

By contrast, self-efficacy did not retain a unique mediating role once perceived social support and psychological resilience were included in the same model. This finding should not be interpreted as evidence that self-efficacy is irrelevant. Rather, it suggests that, in the present framework, self-efficacy may function as a broader coping-related belief rather than as a uniquely explanatory pathway. This interpretation is compatible with earlier research showing that self-efficacy is positively related to life satisfaction and subjective well-being (Azizli et al., 2015; Strobel et al., 2011). At the same time, the present results imply that such effects may become less distinctive when more proximal social and adaptive resources are modeled concurrently. In other words, self-efficacy may still matter at the correlational level, yet its explanatory contribution appears to overlap substantially with constructs that are more directly tied to interpersonal support and effective adaptation under stress. From this perspective, the present findings refine the literature by distinguishing between variables that are broadly relevant and variables that retain greater explanatory specificity under concurrent testing conditions.

4.5 Theoretical Implications of Comparing Parallel Resource Pathways

From a theoretical perspective, the contribution of the present study lies less in combining multiple mediators within a single model than in comparing whether different resource-based pathways retain unique explanatory value when estimated concurrently. Much of the existing literature has examined single mediators in isolation, whereas recent reviews have emphasized the need for stronger theory-based work on the mechanisms linking physical activity and mental health outcomes (White et al., 2024). By modeling perceived social support, self-efficacy, and psychological resilience in parallel, the present study makes it possible to distinguish between resources that are broadly relevant and those that remain more specifically explanatory once alternative pathways are considered at the same time. In this regard, the results suggest that interpersonal support and adaptive resilience provide greater explanatory specificity than generalized efficacy beliefs in understanding how physical exercise is associated with well-being among university students.

4.6 Practical Implications for University Well-Being Promotion

The present findings also have practical implications for university well-being promotion, although these implications should be interpreted cautiously given the cross-sectional design. If higher education institutions seek to support student well-being through exercise-related programming, the current results suggest that attention may usefully be directed not only to exercise participation itself but also to the social and psychological experiences surrounding it. In particular, exercise settings that are socially engaging and compatible with resilience-relevant experiences may be especially pertinent, because these features are more closely aligned with the two pathways that retained unique explanatory value in the present model. Although causal interpretation remains limited, this implication is broadly consistent with recent review evidence indicating that physical activity-related interventions show potential for improving mental health and quality of life in higher education students, while stronger theory-based design and implementation remain necessary (Donnelly et al., 2024).

4.7 Limitations and Future Directions

Several limitations should be acknowledged. First, the study employed a cross-sectional design, which limits causal inference and prevents definitive conclusions about temporal ordering. Second, all core variables were measured using self-report data collected from the same participants at a single time point, which raises the possibility of common method bias and shared method variance. Third, the sample was obtained through convenience sampling and combined online and offline recruitment across multiple universities, which may limit representativeness and leave potential mode-related differences unresolved. Future research would therefore benefit from longitudinal or experimental designs, multi-source data, and broader sampling strategies to further examine the robustness and temporal ordering of the indirect pathways identified in the present study.

5. Conclusion

This study examined the association between physical exercise and well-being among college students and tested whether perceived social support, self-efficacy, and psychological resilience mediated this association in parallel. When these theoretically relevant resources were compared simultaneously, only perceived social support and psychological resilience retained unique mediating roles, whereas self-efficacy did not show a distinct indirect effect. The main contribution of the study therefore lies in identifying which pathways are more explanatorily informative, rather than simply demonstrating that multiple mediators can be included in one model. These findings suggest that the association between physical exercise and well-being among college students may be more closely linked to social connectedness and adaptive coping capacity than to generalized efficacy beliefs. Accordingly, exercise-related well-being programs in higher education may be better aligned with the present findings when they also emphasize supportive social environments and resilience-relevant experiences.

Declarations

Ethics approval and consent to participate

This study was reviewed and approved by the relevant institutional ethics committee. The institution name and approval number are provided in the cover letter for editorial assessment and are withheld from the anonymized manuscript to preserve double-blind peer review. The study was conducted in accordance with the Declaration of Helsinki. Written informed consent was obtained from all participants before participation.

Consent for publication

Not applicable.

Competing interests

The authors declare that they have no competing interests.

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Data Availability

The anonymized raw dataset, processed analysis dataset, survey materials, variable codebook, data-cleaning record, and analysis scripts have been provided as supplementary files for editorial assessment and peer review. If the manuscript is accepted, the anonymized materials can be made available with the article as supplementary information, subject to applicable scale-use or copyright restrictions.

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Figures

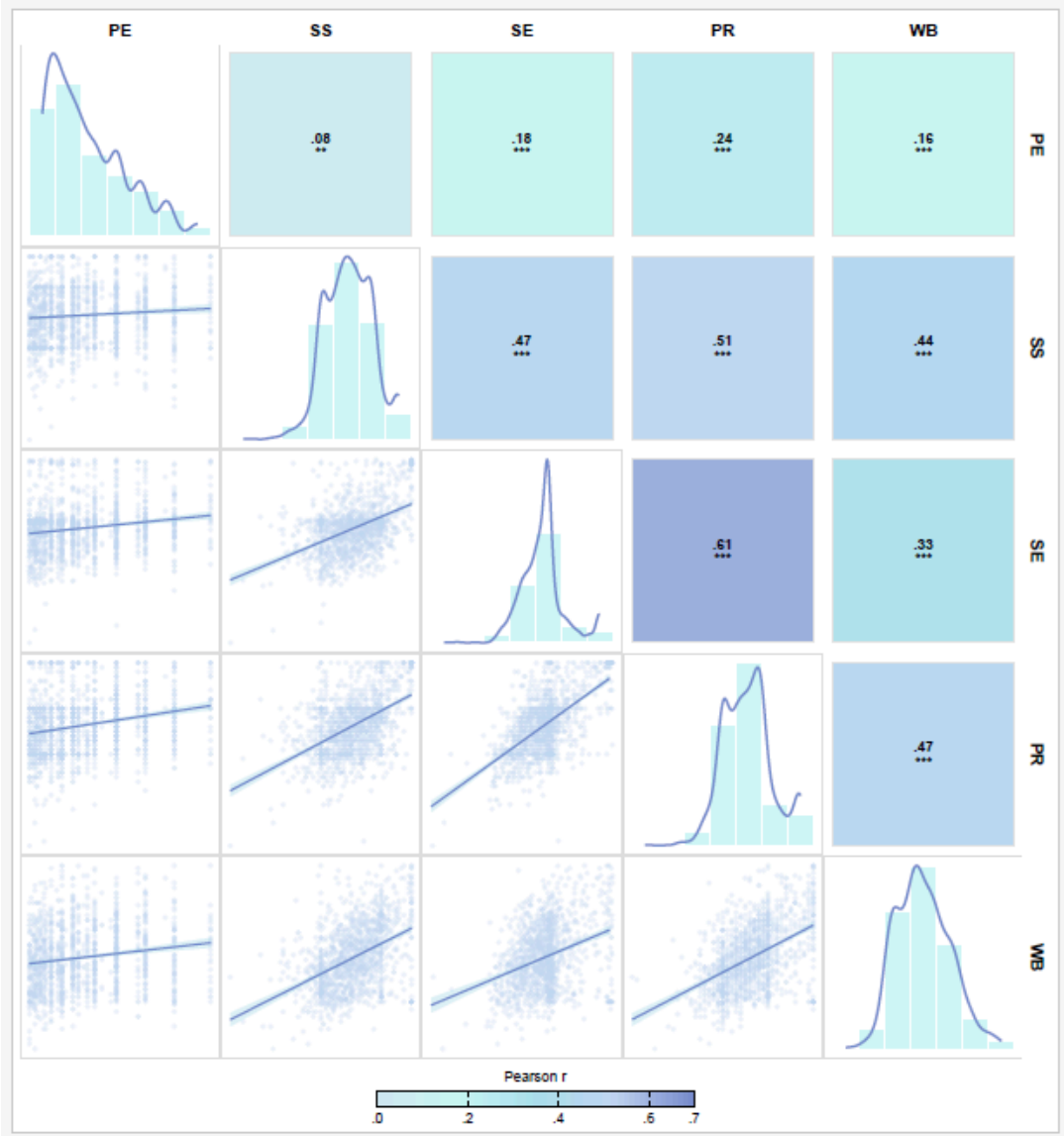


Figure 1

*Pairwise distributions, bivariate scatterplots, and Pearson correlations among the five core study variables. Diagonal panels display variable distributions; lower panels display bivariate scatterplots with fitted lines; upper panels display Pearson correlation coefficients with significance markers. PE = physical exercise; SS = perceived social support; SE = self-efficacy; PR = psychological resilience; WB = well-being. ** p < .01. *** p < .001.*

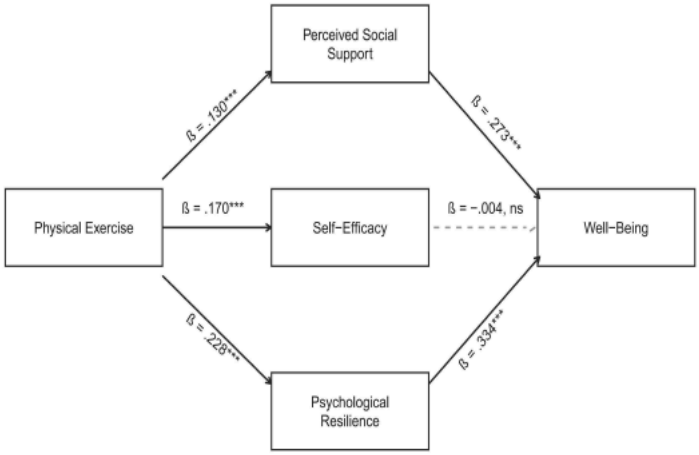


Figure 2 A

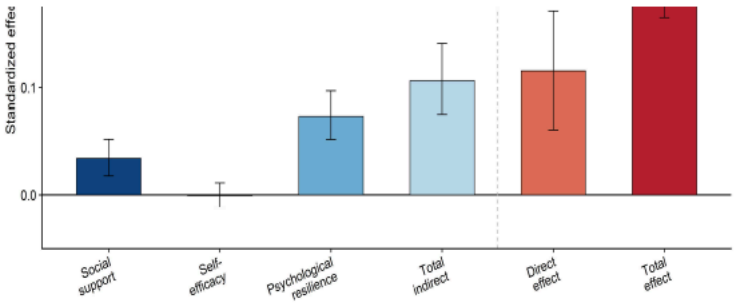


Figure 2 B

Figure 2

2A. Parallel multiple mediation model linking physical exercise to well-being through perceived social support, self-efficacy, and psychological resilience. The figure illustrates the overall model structure and standardized paths; exact covariate-adjusted inferential estimates are reported in Table 4.

2B. Specific indirect effects, total indirect effect, direct effect, and total effect of physical exercise on well-being in the parallel multiple mediation model. Error bars represent 95% bootstrap confidence intervals.