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Exercise Motivation Among Chinese College Students: Levels, Group Differences, and the Predictive Role of Exercise Self-Efficacy From a Self-Determination Theory Perspective

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Abstract

Background

Grounded in self-determination theory (SDT), this study examined the motivational structure of Chinese college students' participation in physical exercise, tested group differences by gender and exercise frequency, and assessed the unique contribution of exercise self-efficacy in predicting exercise motivation.

Methods

A cross-sectional survey was conducted among college students from universities in four Chinese provinces between December 2023 and December 2024, using the Sport Motivation Scale (SMS), together with a self-developed Exercise Self-Efficacy Questionnaire based on Bandura's self-efficacy theory and a self-developed Exercise Outcome Beliefs Questionnaire. Of 838 returned questionnaires, 645 were valid (76.97%) after removing straight-lining and insufficient-time responses.

Results

(1) Exercise motivation displayed a gradient of autonomous motivation (M = 3.86, SD = 0.68) > controlled motivation (3.51 ± 0.73) > amotivation (3.37 ± 0.76), all significantly above the scale midpoint. (2) Exercise self-efficacy was situation-specific: efficacy against psychosocial barriers (3.72) substantially exceeded efficacy against physical/environmental barriers (2.67; dz = 1.218), and correlated more strongly with motivation (r = 0.670 vs. 0.437). (3) In multiple regression controlling for gender and exercise behavior, exercise self-efficacy predicted overall motivation (β = 0.643), autonomous motivation (β = 0.628), and controlled motivation (β = 0.567), all ps < 0.001, explaining 43.7%, 43.2%, and 33.7% of variance, respectively; the initially significant effects of gender and exercise frequency became non-significant once self-efficacy was controlled.

Conclusions

Among the surveyed college students, exercise motivation was predominantly autonomous in quality, and exercise self-efficacy emerged as the strongest and most stable predictor of motivation. The situational differentiation of self-efficacy suggests that psychosocial barrier situations are a key leverage point for intervention. Physical education programs in higher education should prioritize the internalization of exercise value and situation-specific efficacy training.

1 Background

1.1 Background: Physical Exercise Participation Among College Students

Regular physical activity is a fundamental basis for physical and mental health. According to the World Health Organization, approximately 40% of adults worldwide are insufficiently active (less than 150 min of moderate-intensity or 60 min of vigorous-intensity activity per week). In China, data from the Fifth National Physical Fitness Monitoring Bulletin indicate that the fitness qualification rate of people who participate in physical exercise is 6.1 percentage points higher than that of non-participants, and that higher exercise frequency and intensity are associated with better fitness levels.

The physical health status of Chinese college students, however, presents a complicated picture. Prior research suggests that although the overall fitness of college students has improved, endurance and strength remain weak in some groups: many students fail to meet the passing standards in the 1000-m run (males), 800-m run (females), and pull-ups (males), while overweight and obesity rates have risen owing to physical inactivity and poor dietary habits. Extracurricular physical exercise not only satisfies students' physical activity needs and cultivates exercise habits and interest, but also promotes peer interaction and improves adaptation to natural and social environments; moderate extracurricular exercise supports both physical and mental health and enhances the efficiency of study and work. Promoting college students' participation in extracurricular exercise is therefore not merely a matter of physical fitness, but carries comprehensive value for psychological and social development.

1.2 Policy Responses and the Reality Gap

Chinese authorities have long emphasized student physical health. In 2007, the Central Committee of the Communist Party of China and the State Council issued the Opinions on Strengthening School Physical Education and Improving the Health of Young People, requiring that students exercise for one hour daily through the "Sunshine Sports" program. In 2014, the Ministry of Education revised the National Student Physical Fitness Standards, linking fitness test results with scholarship eligibility.

Nevertheless, a gap persists between institutional mandates and voluntary exercise behavior. Policy and curriculum arrangements can secure students' participation during school hours but cannot guarantee continued exercise in their free time or after graduation. Why do students participate when required to, yet often disengage when no one is watching? Answering this question directs attention to the psychological impetus underlying participation—motivation.

1.3 Theoretical Framework: Exercise Motivation From the Perspective of Self-Determination Theory

1.3.1 The Motivation Continuum and Basic Psychological Needs

Self-determination theory (SDT), proposed by Deci and Ryan in the 1980s, is a macro-theory of human motivation, emotion, and personality development. Two core propositions are relevant here.

First, motivation is a dynamic continuum of self-determination. Between amotivation and intrinsic motivation lie intermediate regulations—external, introjected, identified, and integrated—that are hierarchically ordered rather than dichotomous. This continuum structure has received extensive empirical support: a meta-analysis by Howard et al. covering 486 studies and more than 205,000 participants supported the continuum structure and confirmed self-determination as the core of human motivation.

Second, satisfaction of three basic psychological needs is the precondition for the internalization of motivation. The needs for autonomy (experiencing volition in one's actions), competence (experiencing mastery), and relatedness (experiencing care and support from others) are universal across cultures and contexts, and their satisfaction is essential for optimal development, integration, and well-being. Need satisfaction in a given activity is strongly associated with positive outcomes, a finding replicated in both educational and sport-training settings.

Following SDT, this study classified exercise motivations in descending order of autonomy: intrinsic motivation (driven by the enjoyment and satisfaction inherent in the activity, including the subtypes of knowledge, accomplishment, and stimulation), identified regulation (recognizing the personal value of the behavior), introjected regulation (acting to maintain self-worth or avoid guilt), external regulation (acting for rewards or to avoid punishment), and amotivation (lacking intention to act).

1.3.2 Applications of SDT in Sport and Exercise

In sport and exercise contexts, SDT has become the dominant theoretical framework for motivation research. The Sport Motivation Scale (SMS) developed by Pelletier et al. [1] on the basis of SDT was the first instrument to measure all seven regulations along the continuum simultaneously and has served as a standardized tool for subsequent research. A systematic review of 63 competitive sport motivation studies (1995–2016, cumulative N = 12,440) identified SDT and achievement goal theory as the two leading frameworks [2], with 32 studies grounded in SDT, providing the disciplinary warrant for adopting SDT here.

1.4 Research Gaps

1.4.1 Samples Skew Toward the Competitive End; Ordinary College Students Are Understudied

The same review noted that more than half of the existing studies described their samples as "high-level"—that is, primarily competitive athletes. A direct consequence is that although the motivational structure of competitive athletes is relatively well understood, far less is known about ordinary college students—a population that is vast, whose exercise behavior is highly unstable, and that most needs intervention. Athletes' motivation is embedded in training and competition systems, and its formation

mechanisms may differ systematically from those of students whose primary occupation is academic study and whose exercise is largely self-directed.

Domestic research on ordinary college students has accumulated some evidence. A survey by Chen et al. [3] of 2,072 students from 15 universities found that exercise motives ranked from strongest to weakest as health, enjoyment, socializing, appearance, and fitness/competence, with competence motivation weakest—suggesting insufficient internal exercise motivation. Zhang's survey [4] of 923 students at 10 universities in Harbin found that internal exercise motivation was generally high, with health, enjoyment, and competence motives prominent, and that male students scored higher than female students on health, enjoyment, and internal motivation. Li's survey [5] of 1,644 students at 12 Harbin universities found that only about one-third of students had developed good exercise habits, with males more frequently active than females. These studies mostly addressed the *content* of motivation; fewer have systematically examined the relative strength and gradient of the regulation types within the SDT autonomy continuum, and fewer still have included exercise self-efficacy as an antecedent of motivation within the same model.

1.4.2 Small Samples Limit Stability of Findings

The review further reported an average sample size of only 197 in this literature. Small samples constrain statistical power—particularly when multiple group comparisons and regression analyses are performed simultaneously—and thus the robustness of conclusions.

1.4.3 The Motivation–Antecedent Link Awaits Simultaneous Testing

Exercise motivation does not arise in a vacuum. Bandura's self-efficacy theory [6] holds that what drives motivation is not the abilities individuals actually possess but their perceived capability to execute the behavior; individuals with higher self-efficacy display higher intrinsic motivation and more positive affect during the behavior. In exercise contexts this construct manifests as exercise self-efficacy—confidence in one's ability to persist in exercise when facing barriers such as fatigue, time conflicts, or bad weather. Existing research has provided preliminary evidence linking self-efficacy and motivation, but the two constructs have typically been examined in separate studies rather than within the same theoretical framework and dataset. Hence a practically crucial question remains insufficiently answered: after controlling for gender and current exercise behavior, does exercise self-efficacy independently predict exercise motivation?

1.5 Aims and Research Questions

This study therefore used SDT as its framework and conducted a relatively large cross-sectional survey to describe the motivational structure of ordinary college students and test the predictive contribution of exercise self-efficacy, with the aim of providing evidence for motivating and sustaining exercise in higher education physical education (PE).

- • Q1 (Description): What are the overall levels of exercise motivation, exercise self-efficacy, and exercise outcome beliefs among college students? Do motivational subtypes show the gradient predicted by the SDT continuum?
- • Q2 (Group differences): Do these variables differ by gender and by weekly extracurricular exercise frequency?
- • Q3 (Prediction): After controlling for gender and exercise behavior, does exercise self-efficacy significantly predict exercise motivation, and how strong is its predictive power relative to other variables?

Hypotheses: H1, autonomous motivation would dominate, with scores descending along the autonomous–controlled–amotivated gradient; H2, male students would score higher than female students on motivation, self-efficacy, and outcome beliefs; H3, exercise self-efficacy would positively predict exercise motivation after controlling for gender, weekly frequency, and session duration.

2 Method

2.1 Participants

Using convenience sampling, an electronic questionnaire was distributed to college students through the Wenjuanxing survey platform in batches between December 2023 and December 2024; 838 questionnaires were returned.

Invalid responses were removed according to two criteria: (a) straight-lining—identical responses across all 49 scale items (150 removed); and (b) completion time under 60 s (43 further removed). The use of a minimum completion time threshold has

precedent in comparable research which used 120 s [5]. The final valid sample comprised 645 questionnaires (valid return rate = 76.97%).

The valid sample included 431 male (66.8%) and 214 female (33.2%) students. Exercise behavior characteristics are shown in Table 1. Based on the IP location recorded by the platform, students came mainly from universities in Guangdong (57.4%), Jiangsu (16.1%), Hubei (13.6%), and Shanxi (11.9%)—99.1% in total—with a small number from Beijing, Henan, Anhui, and Chongqing (0.9% combined). IP locations were used solely to describe sample origin; no individual identity information was involved, and participation was anonymous and voluntary.

Table 1
Characteristics of the valid sample (n = 645)

Variable	Category	n	%
Gender	Male	431	66.8
	Female	214	33.2
Weekly extracurricular exercise frequency	1	207	32.1
	2	194	30.1
	3	136	21.1
	4	50	7.8
	≥ 5	58	9.0
Duration per session	0–30 min	97	15.0
	31–60 min	211	32.7
	61–90 min	170	26.4
	91–120 min	103	16.0
	≥ 120 min	64	9.9

2.2 Measures

The questionnaire comprised four parts: demographic and exercise behavior information, the exercise self-efficacy questionnaire, the exercise motivation questionnaire, and the exercise outcome beliefs questionnaire. All scale items used 5-point Likert scoring (1 = completely inconsistent, 5 = completely consistent), with higher scores indicating higher levels of the construct.

2.2.1 Exercise Motivation

The Sport Motivation Scale (SMS) [1] served as the template, with item wording translated and culturally adapted for the target population. The SMS, built on SDT, simultaneously measures the seven regulations along the continuum from intrinsic motivation to amotivation. The original scale contains 28 items; upon item-by-item inspection, two items that conflated two questions in a single stem were removed, leaving 24 items covering intrinsic motivation (to know, toward accomplishment, to experience stimulation), identified regulation, introjected regulation, external regulation, and amotivation.

Following the continuum hypothesis of SDT and the recommendation of Clancy et al. [7] that SMS subscale scores may be aggregated into higher-order composites, the seven regulations were combined into three composite dimensions:

- • Autonomous motivation (16 items, α = 0.956): intrinsic motivation (three subtypes) plus identified regulation;
- • Controlled motivation (5 items, α = 0.796): introjected plus external regulation;
- • Amotivation (3 items, α = 0.545).

The internal consistency of the amotivation subscale was low, which is consistent with the performance of the SMS in previous applications—the α of the identified regulation subscale in the original development study was only 0.63, and subscale αs in

subsequent applications ranged from 0.65 to 0.90 [7]. Results involving this subscale are therefore interpreted cautiously and acknowledged in the limitations.

2.2.2 Exercise Self-Efficacy

A questionnaire was developed by the authors based on the principles of Bandura's self-efficacy theory [6], measuring perceived capability to persist in exercise when facing diverse barriers. The initial 11-item pool was reduced to 10 items after one double-barreled item was removed.

Item analysis and exploratory factor analysis (EFA) were conducted on the valid sample (n = 645): item–total correlations ranged from 0.548 to 0.698, and deleting any item did not increase the total-scale α. The Kaiser–Meyer–Olkin measure was 0.889, and Bartlett's test of sphericity was significant, $\chi^2(45) = 3{,}122.9$, $p < 0.001$. Principal-axis factoring with parallel analysis yielded two factors explaining 56.19% of cumulative variance, with all loadings above 0.50 and no serious cross-loadings. Two subscales were thus formed:

- • Self-efficacy against subjective and social barriers (7 items, α = 0.872): confidence in exercising when facing fatigue, low mood, more interesting alternatives, absence of friends, pending homework, weekends, and family chores;
- • Self-efficacy against physical and environmental barriers (3 items, α = 0.840): confidence when ill, in bad weather, or feeling unwell.

The total-scale α was 0.888.

2.2.3 Exercise Outcome Beliefs

A self-developed 12-item questionnaire measuring cognitive appraisal of the physical, psychological, and social benefits of regular exercise. On the valid sample (n = 645): item–total correlations ranged from 0.689 to 0.831; KMO = 0.936; Bartlett's $\chi^2(66) = 7{,}948.1$, $p < 0.001$; principal-axis factoring with parallel analysis extracted a single factor explaining 66.44% of variance, with loadings from 0.699 to 0.900. Total-scale α = 0.957.

2.2.4 Demographic and Behavioral Variables

Gender, weekly extracurricular exercise frequency (5 bands), session duration (5 bands), and subjective exercise intensity (5 bands). Intensity was used only for descriptive purposes and not in the hypothesis-testing models (preliminary analysis showed negligible associations with the main variables).

2.3 Data Analysis

Invalid-case screening was completed at the data-cleaning stage (criteria in 2.1). Analysis proceeded in six steps:

1. 1. Common method bias: Harman's single-factor test on all scale items; the first unrotated factor explained 46.78% of variance, slightly above the 40% criterion—acceptable given the single-timepoint self-report nature of the survey, with the potential influence acknowledged in interpretation and the limitations.
2. **2. Reliability: Cronbach's α per scale and subscale (see 2.2).**
3. 3. Descriptive statistics: means (M) and standard deviations (SD), and the gradient of motivational dimensions.
4. 4. Difference tests: independent-samples *t* tests for gender (with Cohen's *d*), and one-way ANOVA for exercise frequency (with η^2), applying Welch correction when homogeneity of variance was violated.
5. 5. Correlations: Pearson product–moment correlations among all main variables.
6. 6. Regression: multiple linear regression (forced entry) predicting overall motivation, autonomous motivation, and controlled motivation separately from exercise self-efficacy, gender, weekly frequency, and session duration, reporting standardized βs, R^2, *F* tests, and variance inflation factors (VIFs).

Data cleaning and analysis were performed in Python 3.13 (NumPy, SciPy, pandas). Continuous data are reported as M ± SD, and the significance level was set at α = 0.05.

3 Results

3.1 Overall Status of Exercise Motivation and Self-Efficacy

Overall exercise motivation averaged 3.73 (SD = 0.64), above the theoretical midpoint of 3, t = 28.918, p < 0.001. Under the SDT trichotomy, scores followed the gradient autonomous (3.86 ± 0.68) > controlled (3.51 ± 0.73) > amotivation (3.37 ± 0.76); all three differed significantly from the midpoint (ts = 32.160, 17.782, and 12.257, respectively, ps < 0.001), and adjacent dimensions differed significantly from each other (autonomous vs. controlled: t = 18.819, dz = 0.741; controlled vs. amotivation: t = 5.770, dz = 0.227). Thus, the motivational structure of this sample was dominated by autonomous motivation, with overall quality tilted toward the self-determined end of the continuum.

Overall exercise self-efficacy averaged 3.41 (SD = 0.76), above the midpoint (t = 13.652, p < 0.001), but the two subscales diverged sharply: efficacy against subjective and social barriers (3.72 ± 0.78) far exceeded efficacy against physical and environmental barriers (2.67 ± 1.02), t = 30.922, p < 0.001, dz = 1.218. Item-level results (Table 2) revealed a clear situational pattern:

- • Efficacy was high in social and temporal barrier situations: weekend (3.92), friends unavailable (3.92), fatigue (3.84), and low mood (3.80) all significantly exceeded the midpoint;
- • Efficacy was insufficient in physical barrier situations: feeling unwell (2.47) and illness (2.57) fell significantly below the midpoint, while bad weather (2.97) did not differ from it (t = − 0.724, p = 0.469);
- • Notably, efficacy in the "having homework" situation (3.44) was significantly above the midpoint (t = 9.616, p < 0.001)—academic workload did not appreciably undermine exercise confidence.

Table 2
Item-level exercise self-efficacy by situation (n = 645)

Situation	M	SD	t	p	95% CI
When I feel tired	3.84	1.02	20.865	< 0.001	[3.76, 3.92]
When I am in a bad mood	3.80	0.99	20.671	< 0.001	[3.73, 3.88]
When there are more interesting things to do	3.66	1.04	16.281	< 0.001	[3.58, 3.74]
When my friends cannot join me	3.92	0.99	23.537	< 0.001	[3.84, 3.99]
When I have homework to do	3.44	1.15	9.616	< 0.001	[3.35, 3.53]
When I am sick	2.57	1.16	−9.484	< 0.001	[2.48, 2.66]
On weekends	3.92	0.97	24.149	< 0.001	[3.85, 4.00]
When there are family chores	3.49	1.06	11.615	< 0.001	[3.40, 3.57]
When the weather is bad	2.97	1.20	−0.724	0.469	[2.87, 3.06]
When I feel unwell	2.47	1.15	−11.648	< 0.001	[2.38, 2.56]

Note. One-sample *t* tests against the midpoint of 3.

3.2 Gender Differences

Male students scored significantly higher than female students on exercise self-efficacy (d = 0.320), overall motivation (d = 0.317), autonomous motivation (d = 0.305), controlled motivation (d = 0.252), and outcome beliefs (d = 0.312)—small-to-medium effects throughout. Two findings merit emphasis.

First, gender differences were concentrated in the psychosocial domain. Efficacy against subjective and social barriers differed by gender (males 3.82 ± 0.72 vs. females 3.53 ± 0.85, Welch t = 4.278, p < 0.001, d = 0.379), whereas efficacy against physical and environmental barriers did not (t = 1.445, p = 0.149). Male and female students reported comparable confidence when facing illness or bad weather; differences arose in mood-, social-, and academic-related situations.

Second, males also scored higher on amotivation (3.43 vs. 3.23, *t* = 3.173, *p* = 0.002; see Table 3)—that is, males scored higher on all motivation dimensions as well as on amotivation. Given the low reliability of the amotivation subscale (α = 0.545), this result

should be interpreted with caution (see Limitations).

Table 3
Gender differences in study variables (males n = 431, females n = 214)

Variable	Male M ± SD	Female M ± SD	t	p	d
Exercise self-efficacy	3.49 ± 0.72	3.25 ± 0.81	3.815	< 0.001	0.320
Subjective/social barrier efficacy	3.82 ± 0.72	3.53 ± 0.85	4.278□	< 0.001	0.379
Physical/environmental barrier efficacy	2.71 ± 1.04	2.59 ± 0.96	1.445	0.149	0.121
Overall exercise motivation	3.79 ± 0.62	3.59 ± 0.66	3.781	< 0.001	0.317
Autonomous motivation	3.93 ± 0.65	3.72 ± 0.72	3.506□	< 0.001	0.305
Controlled motivation	3.57 ± 0.73	3.39 ± 0.73	3.013	0.003	0.252
Amotivation	3.43 ± 0.75	3.23 ± 0.75	3.173	0.002	0.266
Exercise outcome beliefs	4.09 ± 0.65	3.87 ± 0.76	3.725	< 0.001	0.312

Note. □ Welch-corrected *t* test (Levene's p < 0.05).

3.3 Differences by Exercise Frequency

One-way ANOVA with weekly extracurricular exercise frequency (bands 1–5) as the grouping variable is summarized in Table 4.

Table 4
Differences by weekly exercise frequency (one-way ANOVA)

Variable	F(4, 640)	p	η²	1/wk	2/wk	3/wk	4/wk	≥ 5/wk
Exercise self-efficacy	19.624□	< 0.001	0.109	3.16	3.32	3.55	3.86	3.88
Subjective/social barrier efficacy	20.409□	< 0.001	0.113	3.44	3.66	3.89	4.19	4.17
Physical/environmental barrier efficacy	9.438	< 0.001	0.056	2.51	2.52	2.75	3.07	3.23
Overall exercise motivation	8.302	< 0.001	0.049	3.56	3.72	3.80	4.06	3.87
Autonomous motivation	9.495	< 0.001	0.056	3.67	3.88	3.93	4.23	4.02
Controlled motivation	7.269	< 0.001	0.043	3.36	3.46	3.61	3.87	3.70
Amotivation	0.503	0.733	0.003	3.35	3.34	3.39	3.49	3.34
Exercise outcome beliefs	12.454□	< 0.001	0.072	3.78	3.99	4.18	4.27	4.29

Note. □ Welch-corrected results were consistent (Fs = 17.944, 19.006, 10.824, ps < 0.001). Group columns are means.

All variables except amotivation differed significantly across frequency groups. Exercise self-efficacy showed the largest effect (η^2 = 0.109, medium) and rose monotonically with frequency (3.16 → 3.88): students exercising more frequently reported greater confidence in persisting. Overall, autonomous, and controlled motivation also rose with frequency, peaking at four sessions per week and dipping slightly at five or more.

By contrast, amotivation did not differ across frequency groups (F = 0.503, p = 0.733, η^2 = 0.003): students' amotivation was essentially flat regardless of exercise frequency. The differentiation wrought by exercise frequency thus operated on the *quality* of motivation rather than its *absence*.

3.4 Correlations

Table 5 **presents the correlation matrix.**

Table 5
Correlations among main variables (n = 645)

Variable	1	2	3	4	5	6	7	8	9	10
1. Exercise self-efficacy	1									
2. Subjective/social barrier efficacy	0.943**	1								
3. Physical/environmental barrier efficacy	0.805**	0.562**	1							
4. Overall exercise motivation	0.656**	0.670**	0.437**	1						
5. Autonomous motivation	0.650**	0.679**	0.405**	0.972**	1					
6. Controlled motivation	0.579**	0.574**	0.415**	0.886**	0.781**	1				
7. Amotivation	0.378**	0.339**	0.335**	0.657**	0.507**	0.618**	1			
8. Exercise outcome beliefs	0.614**	0.645**	0.375**	0.786**	0.807**	0.663**	0.366**	1		
9. Weekly exercise frequency	0.326**	0.330**	0.223**	0.198**	0.208**	0.192**	0.024	0.258**	1	
10. Session duration	0.247**	0.251**	0.166**	0.220**	0.242**	0.174**	0.044	0.242**	0.176**	1

Note. * $p < 0.05$, ** $p < 0.01$ (two-tailed).

Three patterns emerged. First, exercise self-efficacy correlated moderately-to-strongly with overall motivation (r = 0.656), and the two subscales diverged: subjective/social barrier efficacy correlated more strongly with motivation (r = 0.670) than physical/environmental barrier efficacy (r = 0.437), echoing the situational differentiation in 3.1. Second, outcome beliefs correlated strongly with overall motivation (r = 0.786) and especially with autonomous motivation (r = 0.807): students who more keenly appreciated the benefits of exercise reported more self-determined motivation. Third, amotivation was uncorrelated with weekly frequency (r = 0.024) and session duration (r = 0.044), and the remaining correlations with behavioral indicators were significant but modest (rs = 0.166–0.330), indicating substantial attenuation between psychological variables and actual behavior.

3.5 Regression Analysis

Multiple linear regressions (forced entry) predicting overall, autonomous, and controlled motivation from exercise self-efficacy, gender, weekly frequency, and session duration are reported in Table 6.

Table 6
Multiple regression predicting exercise motivation (n = 645)

Predictor	Model 1: Overall	Model 2: Autonomous	Model 3: Controlled
	B (SE) / β	B (SE) / β	B (SE) / β
Exercise self-efficacy	0.542 (0.027) / 0.643***	0.564 (0.029) / 0.628***	0.549 (0.034) / 0.567***
Gender (1 M, 2 F)	−0.074 (0.041) / −0.055	−0.068 (0.044) / −0.047	−0.051 (0.051) / −0.033
Weekly frequency	−0.018 (0.016) / −0.035	−0.012 (0.018) / −0.022	−0.003 (0.020) / −0.006
Session duration	0.034 (0.017) / 0.064*	0.050 (0.018) / 0.087**	0.020 (0.021) / 0.033
R^2	0.437	0.432	0.337
Adjusted R^2	0.434	0.428	0.333
F	124.310***	121.446***	81.231***

Note. VIFs ranged from 1.05 to 1.18, indicating no multicollinearity. * p < 0.05, p < 0.01, * p < 0.001.

All three models were significant (ps < 0.001). Exercise self-efficacy was the sole stable and powerful predictor: its standardized coefficients were 0.643, 0.628, and 0.567 for overall, autonomous, and controlled motivation (ps < 0.001), with the models explaining 43.7%, 43.2%, and 33.7% of variance, respectively. Session duration had small but significant positive effects on overall (β = 0.064, p = 0.039) and autonomous (β = 0.087, p = 0.005) motivation; its effect on controlled motivation, and the effects of gender and weekly frequency, were non-significant.

Notably, gender and weekly frequency—significant in the univariate tests—became non-significant once exercise self-efficacy was controlled. This pattern suggests that their associations with motivation may be partially transmitted through exercise self-efficacy (discussed in Section 4).

4 Discussion

4.1 Autonomous Motivation Dominates

Exercise motivation followed the gradient autonomous (3.86) > controlled (3.51) > amotivation (3.37), with all dimensions significantly above the midpoint and adjacent dimensions differing significantly. This gradient is consistent with the SDT continuum hypothesis: the sample as a whole tilted toward the self-determined end, supporting H1.

This finding converges with prior domestic research: Zhang likewise found generally high internal motivation among Harbin college students [4]. The present study extends this knowledge in two ways. First, prior domestic studies using content-oriented instruments (e.g., MPAM-R) addressed *what* motives students hold; using the SMS within the SDT framework, this study addressed *how autonomous* those motives are—the two perspectives are complementary. Content-oriented research found competence motives weakest among Chinese students, whereas the present autonomy-oriented analysis shows that students have, on the whole, moved beyond externally driven participation and identify with the value of exercise. Second, the simultaneous measurement of seven regulations in a sample of 645 exceeds the average sample size of 197 in this literature, providing greater statistical power.

It is nonetheless notable that amotivation (3.37) was also significantly above the midpoint: a substantial proportion of students lack clear intention to exercise. Given the male-heavy sample (66.8%) and prior evidence that males are more active, amotivation might be higher in a gender-balanced sample. This estimate must also be read against the low reliability of the amotivation subscale (α = 0.545) and is offered as a directional indication only.

4.2 Situational Differentiation of Exercise Self-Efficacy: Psychosocial Situations Are the Key Variable

The divergence between the two efficacy subscales was among the most informative findings. Against psychosocial barriers—fatigue, low mood, absent friends, weekends, chores—students reported fairly high confidence (3.72); against physical and environmental barriers—illness, feeling unwell, bad weather—confidence was markedly insufficient (2.67; dz = 1.218). This accords with Bandura's proposition [6] that efficacy judgments are domain- and situation-specific: confidence in "persisting in exercise" is not a monolithic judgment but varies systematically with the barrier at hand.

Item-level results sharpened the practical implications. Efficacy in the "having homework" situation (3.44) was significantly above the midpoint—academic workload did not undermine exercise confidence as commonly presumed; students evidently view the trade-off between coursework and exercise as manageable. Conversely, "bad weather" (2.97) did not differ from the midpoint, and "illness" and "feeling unwell" (2.47–2.57) fell significantly below it: what truly shakes confidence are conditions students perceive as beyond their control. In short, college students do not lack confidence against everyday hassles; they lack confidence against hard, objective barriers.

More importantly, the two subscales related differently to motivation: psychosocial barrier efficacy correlated with motivation at r = 0.670 versus 0.437 for physical/environmental barrier efficacy. Combined with 4.1, a coherent picture emerges: among students whose motivation is predominantly autonomous, motivation is bound more to subjectively controllable situations (mood, socializing, time management) than to objective circumstances (weather, illness). This is a leverage point for intervention design: pedagogy

targeting emotion regulation, peer organization, and time management may reach students' motivational systems more effectively than hardware improvements alone.

4.3 Gender and Exercise Frequency

4.3.1 Gender Differences Concentrate in the Psychosocial Domain

H2 was supported at the overall level: males scored higher on self-efficacy, overall, autonomous, and controlled motivation, and outcome beliefs—consistent with prior findings that male students show higher internal motivation and greater participation. The present study adds that the gender difference is not uniform: efficacy against physical and environmental barriers showed no gender difference; the difference concentrated in psychosocial situations ($d = 0.379$). The mechanism of gender differences thus likely lies more in psychosocial factors (emotion-regulation styles, social exercise orientations) than in differential tolerance of objective obstacles. For promoting exercise among female students, peer support and emotion regulation may matter more than exhortations to "overcome objective difficulties."

That said, males also scored higher on amotivation—males scored higher on all dimensions as well as amotivation. This pattern may partly reflect measurement error in the amotivation subscale ($\alpha = 0.545$) or gender differences in response style (e.g., extremity bias), and should be interpreted cautiously.

4.3.2 Exercise Frequency Differentiates Motivational Quality, Not Absence

Self-efficacy rose monotonically with weekly frequency ($\eta^2 = 0.109$, medium), and autonomous and controlled motivation rose likewise; yet amotivation did not differ across frequency groups ($F = 0.503$, $p = 0.733$). This dissociation is interpretively valuable: frequent exercisers hold more self-determined motivation, but infrequent exercisers are not motivationally "empty"—their amotivation matches that of frequent exercisers; what they may lack is not motivation itself but the conditions that convert motivation into behavior (time, facilities, habit). This echoes Li's finding [5] that only about one-third of students developed sound exercise habits, and suggests that for low-frequency students the intervention priority is not persuasion but lowering the behavior threshold.

Cross-sectional data permit an alternative reading, however: self-selection—students with higher efficacy and motivation choose to exercise more in the first place. The two explanations cannot be distinguished here; the relationship between behavior and psychological variables is likely bidirectional and dynamic.

4.4 The Unique Predictive Contribution of Exercise Self-Efficacy

After controlling for gender, weekly frequency, and session duration, exercise self-efficacy predicted overall ($\beta = 0.643$), autonomous ($\beta = 0.628$), and controlled ($\beta = 0.567$) motivation (ps < 0.001), explaining 43.7%, 43.2%, and 33.7% of variance—supporting H3. This directly answers the gap identified in the introduction: within a single dataset and theoretical framework, the independent predictive contribution of exercise self-efficacy was tested and found to far exceed that of gender and current exercise behavior.

This aligns with Bandura's expectation that perceived—not actual—capability drives motivation, and with Liang et al.'s observation [8] that stronger sport self-efficacy accompanies stronger activity motivation; the present study advances these to net-effect estimates controlling for gender and behavior.

Most strikingly, gender and weekly frequency—significant in univariate tests—became non-significant once self-efficacy was controlled, suggesting that their influence on motivation may be partially transmitted through exercise self-efficacy: the male advantage in motivation may stem from higher efficacy, and the frequency–motivation association may partly reflect mastery experiences accumulated through frequent exercise feeding back into efficacy. It must be stressed, however, that this study used a cross-sectional design and single-equation regression without formal mediation testing; this interpretation is a theoretical conjecture, not a statistically tested conclusion, and awaits longitudinal or experimental verification.

The strong correlation between outcome beliefs and autonomous motivation ($r = 0.807$) also merits note within SDT: the more deeply students internalize the benefits of exercise, the more self-determined their motivation—consistent with the proposition that recognizing an activity's value is the precondition for the internalization from introjected to identified regulation. The same-source inflation of correlations (see common method bias) again counsels restraint.

4.5 Implications for College Physical Education

Four recommendations follow.

First, shift the focus of motivation-building from external mandate to value internalization. These students have largely moved beyond externally driven participation; controlled motivation is comparatively weak. The pedagogical task is not to add external constraints but to help students convert diffuse endorsement of exercise ("exercise matters to me") into concrete reasons for action—for example, linking exercise to academic performance, emotion regulation, and social life. That efficacy in the homework situation remained above the midpoint suggests students do not regard exercise as inherently subordinate to study.

Second, make efficacy training situational and specific. Generic confidence-building exhortation has limited effect. For psychosocial situations (mood, peers, time), teach concrete strategies: low-intensity starting points on low-mood days, buddy mechanisms, homework–exercise time planning. For physical/environmental situations (weather, mild discomfort), help students establish sensible adjustment rules (when to postpone exercise), avoiding both the false model of "training through illness" and the misreading of sensible adjustment as weak will.

Third, for low-frequency students, lower the behavioral threshold rather than persuade. Amotivation did not vary with frequency, so what infrequent exercisers lack is not the judgment that they *should* exercise but workable conditions for *getting started*. Setting micro-goals attainable from "three sessions a week" downward lets students accumulate efficacy through repeated success—efficacy that, per these results, then exerts a stable and powerful effect on motivation.

Fourth, target psychosocial mechanisms in interventions for female students. Since gender differences concentrate in the psychosocial domain, organize female peer exercise groups, offer activities female students prefer, and frame exercise within emotion regulation.

5 Conclusions

This survey of 645 college students from four provinces, framed by self-determination theory, yielded three conclusions.

First, exercise motivation was predominantly autonomous, with a gradient consistent with the SDT continuum (autonomous 3.86 > controlled 3.51 > amotivation 3.37, all above the midpoint). Students have largely moved beyond externally driven participation, although amotivation remains non-trivial.

Second, exercise self-efficacy exhibited clear situational differentiation, with psychosocial situations the principal source of efficacy and of its association with motivation. Confidence against psychosocial barriers (3.72) far exceeded that against physical/environmental barriers (2.67); efficacy in the homework situation exceeded the midpoint while bad-weather efficacy did not differ from it; and the psychosocial subscale correlated with motivation more strongly ($r = 0.670$ vs. 0.437). Gender differences likewise concentrated in the psychosocial domain.

Third, exercise self-efficacy was the strongest and most stable predictor of exercise motivation ($\beta = 0.643/0.628/0.567$ for overall/autonomous/controlled motivation; $R^2 = 0.437/0.432/0.337$), with the initially significant effects of gender and frequency becoming non-significant after controlling for self-efficacy—suggesting, though not testing, partial transmission through self-efficacy.

Limitations

Four limitations qualify these conclusions. (1) Amotivation reliability was low ($\alpha = 0.545$, below the 0.70 convention and below the 0.65–0.90 range of prior SMS applications); results involving this subscale are directional indications only. (2) Common method bias cannot be excluded: all variables came from a single-timepoint self-report survey, and Harman's single factor explained 46.78% of variance; given the known low sensitivity of Harman's test [9], some same-source inflation of correlations (e.g., $r = 0.807$ between outcome beliefs and autonomous motivation) is plausible. (3) The cross-sectional design precludes causal inference: "prediction" is statistical only; the efficacy–motivation relationship may run either direction or be reciprocally reinforcing, and the mediation suggestion in Section 4 is conjecture pending longitudinal or experimental designs. (4) Sample representativeness is limited: males

comprised 66.8% and 99.1% of the sample came from four provinces; motivation estimates may be inflated, and generalization beyond "the surveyed college students" requires caution.

Future Directions

Future research should (1) adopt the SMS-II [10] or SMS-6 [11] to improve subscale reliability, and validate the self-developed efficacy questionnaire's two-factor structure in independent samples with confirmatory factor analysis, adding items targeting physical/environmental barriers; (2) employ multi-wave longitudinal designs and objective behavioral data (e.g., wearables) to establish temporal order and formally test the self-efficacy mediation hypothesis; and (3) replicate the study in gender-balanced, geographically broader samples, with attention to the intervention value of psychosocial barrier efficacy among female students, and extend comparisons across institution types.

Abbreviations

SDT
Self-determination theory
SMS
Sport Motivation Scale
EFA
Exploratory factor analysis
ANOVA
Analysis of variance
SD
Standard deviation
VIF
Variance inflation factor

Declarations

Ethics approval and consent to participate

This study was conducted in accordance with relevant ethical guidelines, including the guidelines of the Ethics Committee of Harbin Institute of Technology, Shenzhen, and no ethical concerns were identified. All participants were informed of the purpose of the study, the voluntary nature of their participation, and their right to withdraw at any time. Informed consent was obtained from all participants, and completion and return of the questionnaire was taken as consent to participate. All data were collected anonymously, treated confidentially, and used solely for research purposes.

Consent for publication

Not applicable.

Competing interests

The authors declare that they have no competing interests.

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Author Contribution

KX designed the study, collected and analysed the data, and drafted the manuscript. HL and WZ contributed to the study design and revised the manuscript. All authors read and approved the final manuscript.

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Availability of data and materials

The datasets used and/or analysed during the current study are available from the corresponding author on reasonable request.

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