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Perceived Barriers in the Association between Autonomous Motivation and Physical Activity among Chinese University Students: A Structural Equation Modeling Study

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Abstract

This study developed and empirically examined a Self-Determination Theory-based model of physical activity (PA) among Chinese university students, focusing on the relationships between motivational regulation, perceived barriers, and PA and the mediating role of barriers. A cross-sectional survey was conducted among 1,618 university students. PA, motivational regulation, and perceived barriers were assessed using validated instruments. Structural equation modeling was employed to evaluate the measurement and structural models and examine the proposed mediation pathway. In the final model, Autonomous Motivation was negatively associated with perceived barriers (β = −.781, *P* < .001), whereas perceived barriers were strongly and negatively associated with PA (β = −.921, *P* < .001). Autonomous Motivation also showed a positive direct association with PA (β = .115, *P* = .008). The indirect association through perceived barriers was statistically significant (β = .719, 95% CI [.647, .800]) and represented 86.2% of the estimated total association. These findings were consistent with a partial statistical mediation pattern, suggesting that perceived barriers may represent an important pathway linking autonomous motivation with PA. However, the cross-sectional design precludes causal inference, and the findings should therefore be interpreted as statistical associations rather than evidence of a causal mechanism.

Keywords: Physical Activity, Autonomous Motivation, Perceived Barriers, Self-Determination Theory, University Students, Structural Equation Modeling

Introduction

Physical fitness is an important marker of health as young people move from adolescence into adulthood. Physical activity (PA) is one of the main behaviours through which fitness can be maintained or improved, although the two concepts are not interchangeable. PA describes bodily movement that requires energy expenditure, whereas physical fitness refers to the capacity to perform physical activity and includes cardiorespiratory endurance, muscular strength, flexibility, and body composition. The university period deserves particular attention because students are becoming increasingly responsible for managing their own daily routines. At the same time, academic work, social activities, changes in living

arrangements, and other competing demands can make regular exercise difficult to maintain. Globally, this is part of a much larger public health concern. The World Health Organization (WHO, 2022) has identified insufficient physical activity as a persistent problem across age groups, while university students are among the populations for whom establishing and maintaining active lifestyles can be particularly challenging.

The consequences of insufficient PA in university students extend beyond physical fitness alone. Evidence from Chinese university populations suggests that regular PA is associated with physical health as well as psychological and social outcomes. Zhang et al. (2023), for example, found links between PA and several aspects of cognitive and noncognitive development among Chinese university students, including mental health, social relationships, life satisfaction, and academic-related outcomes. Physical fitness itself may also be relevant to students' psychological well-being. In a large cross-sectional study of Chinese college students, Ma et al. (2024) reported significant associations between physical fitness and mental health. These findings place student PA in a broader health context. It is not simply a matter of whether students participate in sport; the extent to which they remain physically active may have implications for their health and adjustment during an important stage of the life course.

The issue is especially relevant in China, where physical fitness among students has been monitored and promoted through national policy for many years. The *National Student Physical Fitness Standards* (NSPFS), revised in 2014, established a common framework for assessing physical fitness across educational stages. The *Healthy China 2030* strategy and the *Healthy China Action (2019–2030)* subsequently reinforced the importance of healthy lifestyles, physical education, and student fitness. The latter set a national target of at least 50% of students achieving good or excellent fitness performance by 2022 and 60% by 2030 (Healthy China Action Promotion Committee, 2019). Yet the available evidence suggests that the situation among older students has been less encouraging. Data from the eighth National Survey of Student Physical Fitness and Health showed that the proportion of students aged 13–22 classified as having good or excellent fitness increased from 14.8% in 2014 to 17.7% in 2019, but the improvement among those aged 19–22 was only 0.2 percentage points (Ministry of Education of the People's Republic of China, 2021). Dong et al. (2023) likewise reported an overall decline in several health-related fitness indicators between 2013 and 2019 among 3,185 male first-year college students. More recently, Huang et al. (2025), using data from 176,373 college students aged 19–22 in Shandong Province, found that exercise frequency, exercise duration, and moderate-to-high-intensity activity were associated with better physical fitness, whereas excessive screen time and other unhealthy lifestyle factors were associated with poorer fitness.

These findings leave a practical question that is not easily answered by policy or access to exercise opportunities alone. If the importance of PA is well established and universities provide physical education and opportunities for exercise, why do many students still struggle to remain active? A systematic review of Chinese university students found that exercise participation is influenced by a mixture of motivational, lifestyle, interpersonal, and environmental factors (Pan et al., 2022). Similar patterns have been observed internationally. Brown et al. (2024) reviewed 39 studies involving 17,771 university students and identified 56 barriers and facilitators across 12 behavioural domains. Environmental context and

resources, social influences, and goals were among the most consistently important areas. Lack of time was particularly common, often because students had to balance academic work with employment, family responsibilities, commuting, or other activities. Access to facilities, financial costs, and opportunities to exercise with others were also relevant. Thus, low PA among university students cannot be reduced to a simple lack of knowledge about the benefits of exercise.

Motivation provides one way of understanding why students choose to exercise, but the quality of that motivation may matter as much as its presence. Self-Determination Theory (SDT) distinguishes different forms of behavioural regulation according to the extent to which an individual experiences an activity as personally meaningful and self-endorsed. Intrinsic motivation, identified regulation, and integrated regulation represent relatively autonomous forms of motivation. This distinction has been increasingly applied to PA research. Xu et al. (2025), in a systematic review of systematic reviews, found evidence supporting competence, intrinsic regulation, and identified regulation as important correlates of PA and highlighted autonomous motivation as a relevant target for promoting longer-term exercise behaviour. Ntoumanis et al. (2021), based on a meta-analysis of 73 SDT-informed health interventions, also found small-to-moderate changes in SDT-related constructs and modest improvements in health behaviours. More recently, Ntoumanis and Moller (2025) concluded that SDT-informed approaches can support PA and exercise, with changes in behaviour often involving autonomous motivation, support for basic psychological needs, and perceived competence.

Nevertheless, motivation does not automatically translate into behaviour. This is particularly apparent in the everyday experiences of university students. A student may believe that exercise is important, enjoy being physically active, or regard an active lifestyle as personally valuable, but still miss planned exercise because of a heavy workload, lack of time, tiredness, social commitments, or limited resources. In other words, there can be a difference between having a reason to exercise and being able to act on that reason consistently. This distinction is important for understanding why a motivational explanation alone may not provide a complete account of university students' PA.

Recent research involving Chinese university students has begun to examine such behavioural processes in greater detail. Wang et al. (2025), for example, reported that interpersonal relationships were associated with PA through pathways involving social support and exercise motivation among 635 university students. Findings such as these move the literature beyond simple correlations and toward questions about how psychological and social factors are translated into actual behaviour. At the same time, different studies have examined different mechanisms, including social support, interpersonal relationships, exercise climate, and self-efficacy. The resulting evidence is informative, but it remains somewhat fragmented. We know that motivation matters, and we know that students face practical and social obstacles to exercise, but considerably less is known about how these two aspects may operate together.

Perceived barriers may be particularly relevant to this question. Motivation concerns the reasons underlying a behaviour, whereas barriers describe the difficulties that may arise when a person attempts to carry out that behaviour. These are related, but they are not the same thing. A student with strong autonomous motivation may still perceive considerable

barriers to regular exercise. Conversely, reducing a particular barrier may not be sufficient if the student has little personal reason to engage in PA. Brown et al. (2024) provide substantial evidence that barriers are embedded in students' everyday environments, while Pan et al. (2022) similarly showed that exercise participation among Chinese university students is shaped by several interacting influences. What remains less clear is whether perceived barriers can help explain the link between motivational orientation and PA rather than simply being treated as another independent predictor.

This issue also points to a limitation in the way the two relevant bodies of literature have generally developed. Barrier studies have tended to focus on identifying, categorizing, and ranking the difficulties students encounter. SDT research, in contrast, has concentrated more heavily on motivational quality, psychological needs, and the social conditions that support autonomous motivation. Both perspectives are useful, but they do not necessarily answer the same question. The former helps explain what makes PA difficult; the latter helps explain why a person may be willing to engage in PA. Bringing them together may therefore provide a more complete account of what happens between motivation and actual behaviour. This is particularly relevant in the university setting, where academic and social demands can change from week to week and where students have substantial control over how they allocate their time.

A barriers-mediated perspective should not be interpreted as assuming that motivation causes perceived barriers or that the relationships are necessarily unidirectional. Barriers may arise from environmental circumstances, psychological states, previous exercise experiences, or several of these factors at the same time. Students who are already less active may also come to perceive more barriers because of fatigue, low fitness, competing routines, or reduced confidence. Such possibilities are important when interpreting cross-sectional findings. Nevertheless, examining perceived barriers as a potential statistical mediator provides a useful way to test whether the association between motivation and PA is partly related to the difficulties students experience when attempting to maintain exercise.

Against this background, the present study develops and examines a barriers-mediated motivation model of PA among Chinese university students. Drawing on SDT, the model brings together motivation, perceived barriers, and PA level within a single framework. Rather than assuming that stronger motivation is directly reflected in higher PA, the study examines whether perceived barriers may account for part of this association. In doing so, the study connects two strands of research that have largely been considered separately: the motivational reasons underlying exercise and the practical difficulties encountered in carrying it out. The findings may contribute to a more nuanced understanding of PA behaviour among Chinese university students and provide a basis for interventions that address not only motivational regulation but also the barriers that can interfere with sustained participation.

Materials and Methods

Study Design and Setting

This study employed a quantitative cross-sectional design to examine physical activity (PA), motivational regulation, and perceived barriers among undergraduate students and to develop a structural model of their relationships. The study was conducted at a teacher

education university in southern China. The analysis included descriptive and correlational analyses, assessment of measurement properties, and structural equation modeling (SEM). SEM was used to examine the statistical associations among motivational regulation, perceived barriers, and PA level, including whether perceived barriers accounted statistically for part of the association between motivational orientation and PA. Given the cross-sectional design, all relationships identified in the model were interpreted as statistical associations rather than causal effects.

Participants and Sampling

The university had approximately 22,970 full-time undergraduate students enrolled across 16 faculties in 2024. A stratified cluster-based recruitment strategy was used to recruit students from classes across the 16 faculties. Questionnaire invitations were distributed through WeChat, and students who agreed to participate accessed the online questionnaire through the Wenjuanxing survey platform. Participation was voluntary.

A total of 1,776 questionnaires were returned. After screening for incomplete or invalid responses, including patterned responses, inappropriate information, and completion times of less than 200 s, 158 responses were excluded. The final analytical sample consisted of 1,618 undergraduate students, including 512 males (31.64%) and 1,106 females (68.36%). The final sample included students from the first three academic years. Senior students were excluded because many were undertaking off-campus teaching practice or internship activities during the data-collection period.

Ethical approval for this study was granted by the Human Research Ethics Committee of Universiti Pendidikan Sultan Idris (UPSI; Approval No. 2024-0348-01). The study was conducted in accordance with the ethical standards applicable to research involving human participants. All participants were informed about the study procedures and provided informed consent before participation. Participation was voluntary, and participants were informed that they could withdraw from the study at any time without penalty.

Instruments

Three standardized questionnaires were used: the International Physical Activity Questionnaire–Long Form Chinese version (IPAQ-LC), the Behavioural Regulation in Exercise Questionnaire–3 Chinese version (BREQ-3C), and the Barriers to Being Active Quiz Chinese version (BBAQ-C).

The IPAQ-LC was used to assess PA across different domains and intensities. The long form has demonstrated acceptable reliability and validity internationally (Craig et al., 2003), and previous studies have supported the reliability and validity of its Chinese version (Jia et al., 2008; Macfarlane et al., 2011). PA was expressed as metabolic equivalent task minutes per week (MET-min/week). Walking, moderate-intensity, vigorous-intensity, and total PA were examined as continuous measures, and PA was also categorized as low, moderate, or high according to the IPAQ scoring procedures. The IPAQ-LC had previously demonstrated acceptable reliability and validity among Chinese university students in the same research context (Chen & Kasim, 2025).

The BREQ-3C was used to assess motivational regulation toward exercise. The BREQ was developed to assess behavioral regulation along the self-determination continuum, with amotivation incorporated in the BREQ-2 and integrated regulation added in the BREQ-3 (Markland & Tobin, 2004; Wilson et al., 2006). The 24-item Chinese version comprised six dimensions: amotivation, external regulation, introjected regulation, identified regulation, integrated regulation, and intrinsic regulation, with four items per dimension. The psychometric properties of the Chinese version were previously examined in the same research context. Cronbach's α coefficients ranged from .690 to .938, composite reliability values from .757 to .939, and standardized factor loadings from .716 to .935. Confirmatory factor analysis supported the factorial structure of the instrument (Chen & Kasim, 2025).

The BBAQ-C was used to assess perceived barriers to PA. The instrument assesses common barriers to physical activity, including time, social influence, energy, willpower, fear of injury, Lack of skill, and lack of resources. The Chinese version used in this study comprised seven barrier categories. Its psychometric properties had previously been examined in the same research context, with an overall Cronbach's α of .908 and a KMO value of .958. Factor loadings ranged from .536 to .774, composite reliability values from .66 to .77, and AVE values from .369 to .50. These findings supported its use in university students (Chen & Kasim, 2025).

Data Collection

Data were collected in 2024 through an online questionnaire survey. The questionnaire link was distributed to undergraduate students through WeChat, and participants completed the three questionnaires through Wenjuanxing after providing voluntary informed consent. A total of 1,776 responses were obtained. Responses containing incomplete or invalid information, highly uniform response patterns, or completion times of less than 200 s were excluded. After screening, 1,618 valid responses remained.

Data Analysis

Data were analyzed using IBM SPSS Statistics Version 27.0 and IBM SPSS AMOS Version 26.0. SPSS was used for data screening, descriptive statistics, and correlation analyses, whereas AMOS was used for confirmatory factor analysis and SEM.

Because the study relied on self-report questionnaire measures, common method bias (CMB) was examined using Harman's single-factor approach as a diagnostic procedure, while recognizing the limitations of this method as a stand-alone assessment (Podsakoff & Organ, 1986). The analysis yielded 16 factors with eigenvalues greater than 1, which together explained 63.08% of the total variance. The first factor accounted for 25.21% of the variance, indicating that a single factor did not account for the majority of the covariance among the measures. The distributions of the principal variables were also examined using skewness and kurtosis statistics and were considered sufficiently close to approximate normality for the subsequent analyses. Means and standard deviations were used to summarize PA, motivational regulation, and perceived barriers. Independent-samples *t* tests and one-way analyses of variance (ANOVAs) were conducted where appropriate to examine group differences. Pearson correlation coefficients were calculated to examine associations among PA, motivational regulation, and perceived barriers.

SEM was conducted using AMOS Version 26.0 with maximum likelihood estimation. SEM was selected to examine the measurement and structural relationships among the study constructs simultaneously (Kline, 2023). The initial model comprised three latent constructs: Motivation, Perceived Barriers, and PA Level. The initial Motivation construct was represented by six BREQ-3C indicators: amotivation, external regulation, introjected regulation, identified regulation, integrated regulation, and intrinsic regulation. Perceived Barriers were represented by seven BBAQ-C indicators: lack of time, social influence, lack of energy, lack of willpower, fear of injury, lack of skill, and lack of resources. PA Level was represented by walking, moderate-intensity, and vigorous-intensity PA derived from the IPAQ-LC. The structural model specified associations among Motivation, Perceived Barriers, and PA Level, with Perceived Barriers specified as a potential statistical mediator.

Model refinement was conducted iteratively rather than through modification-index-driven model searching. Indicators were considered for removal based on their standardized factor loadings, statistical performance, contribution to the corresponding latent construct, and theoretical relevance. When an indicator showed a comparatively weak or unstable contribution, it was removed individually and the model was re-estimated before further decisions were made. Modification indices were not used to introduce additional structural paths or correlated error terms. The refinement therefore focused primarily on obtaining a more parsimonious and theoretically coherent measurement structure while retaining the theoretically specified structural relationships.

Model fit was evaluated using multiple complementary indices, including χ^2, degrees of freedom (df), χ^2/df, GFI, CFI, TLI, NFI, RMSEA, and SRMR. Model evaluation considered the overall pattern of fit indices, sample size, model complexity, measurement quality, and theoretical plausibility rather than relying on a single cutoff criterion (Kline, 2023). The mediating role of Perceived Barriers was examined using a bootstrap procedure within the SEM framework. Five thousand bootstrap resamples were used to estimate the indirect effect and its 95% bias-corrected confidence interval. An indirect effect was considered statistically significant when its confidence interval did not include zero. Direct and total effects were also estimated. Bootstrap confidence intervals were used because the sampling distribution of an indirect effect need not be normally distributed (Hayes, 2022). Given the cross-sectional design, the mediation findings were interpreted as a statistical mediation pattern rather than evidence of a temporal or causal mechanism.

Research Results

Structural Model Development

Following the measurement assessment, an initial structural equation model was specified to examine the associations among motivation, perceived barriers, and physical activity (PA) level. The initial model included three latent constructs. Motivation was represented by six indicators: amotivation, external regulation, introjected regulation, identified regulation, integrated regulation, and intrinsic regulation. Perceived Barriers were represented by seven indicators: lack of time, social influence, lack of energy, lack of willpower, fear of injury, lack of skill, and lack of resources. PA Level was represented by walking, moderate-intensity, and vigorous-intensity PA expressed as MET-minutes per week.

As illustrated in Figure 1, the initial model showed considerable variation in the standardized factor loadings across indicators. The loadings for the Motivation indicators ranged from −.891 to .861, whereas those for the Perceived Barriers indicators ranged from .261 to .865. The three PA indicators showed comparatively modest loadings, ranging from .453 to .598. The Motivation indicators also showed mixed loading directions, with amotivation, external regulation, and introjected regulation loading positively and identified, integrated, and intrinsic regulation loading negatively. Because the direction of a latent factor is arbitrary, these opposite signs should not be interpreted as indicating that autonomous forms of motivation were negatively related to motivation itself. Rather, the pattern suggested that the six motivational indicators did not form a directionally coherent single latent construct under the initial specification.

The structural paths in the initial model showed a positive association between the initial Motivation construct and Perceived Barriers (β = .87), whereas Perceived Barriers were negatively associated with PA Level (β = −.70). The direct association between the initial Motivation construct and PA Level was negative (β = −.28). Together with the mixed orientation of the motivational indicators and the inadequate overall model fit, these findings indicated that refinement of the initial measurement structure was necessary.

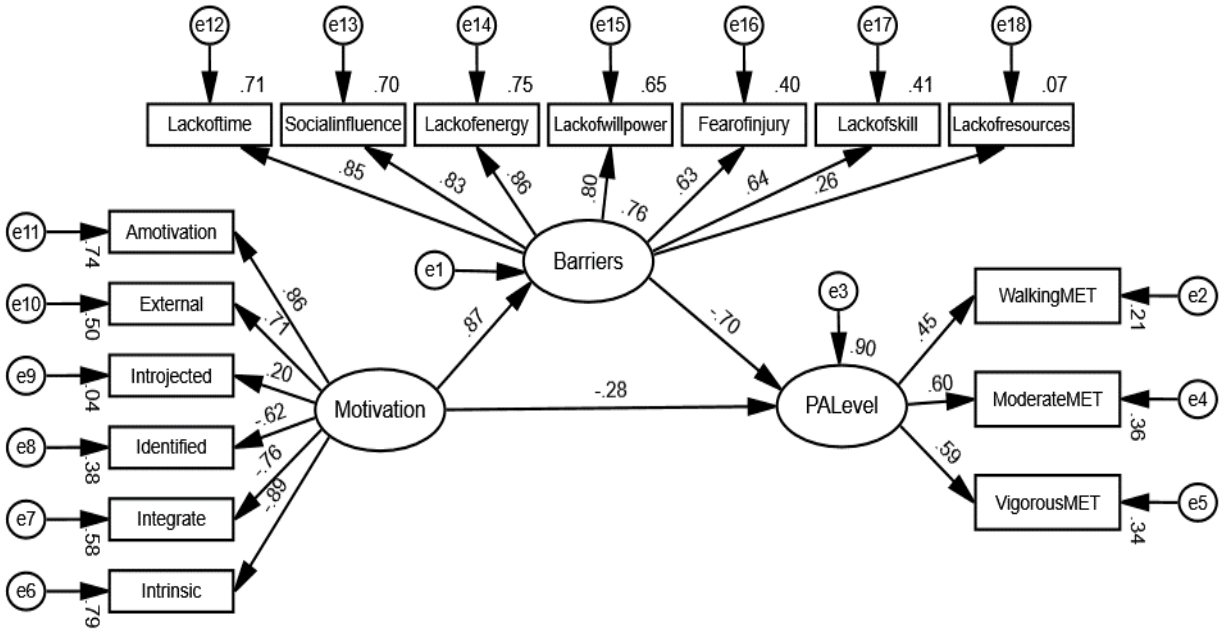

Figure 1 Initial Model of Barriers-Mediated Motivation to Physical Activity

The initial model fit indices are presented in Table 1. The initial model also showed inadequate overall fit to the observed data. The model produced a χ^2/df ratio of 36.843, RMSEA = .149, SRMR = .090, GFI = .713, CFI = .782, NFI = .777, and TLI = .741. The pattern of these indices indicated that the initial specification did not adequately reproduce the observed covariance structure.

Table 1
Model Fit of Initial Model

Indicators	χ^2	df	P	χ^2/ df	GFI	RMSEA	SRMR	CFI	NFI	TLI
Reference criteria	-	-	>0.05	<3	>0.9	<0.10	<0.05	>0.9	>0.9	>0.9
value	3721.165	101	-	36.843	0.713	0.149	0.090	0.782	0.777	0.741

Iterative Model Refinement

Model refinement was conducted iteratively. Observed indicators showing weak or unstable contributions to their respective latent constructs were examined and considered for removal. After each indicator was removed, the model was re-estimated and the factor loadings, structural coefficients, and overall model fit were examined again. This process was repeated until a stable and theoretically interpretable model was obtained.

As shown in Table 2, the indicators of motivation did not contribute equally to the construct. Identified regulation, integrated regulation, and intrinsic regulation indicated relatively strong and consistent loadings (−.615 to −.891), whereas amotivation, external regulation, and introjected regulation displayed more variable loadings (.199 to .861).

Table 2
Factor Loading Coefficient of Initial Model

Factors	Variables	UnStd	Std	S.E.	C.R.	*P*
Motivation	Amotivation	1	0.861			
	External regulation	0.812	0.709	0.025	32.995	***
	Introjected regulation	0.219	0.199	0.028	7.781	***
	Identified regulation	-0.495	-0.615	0.018	-27.163	***
	Integrated regulation	-0.829	-0.76	0.023	-36.524	***
	Intrinsic regulation	-1.222	-0.891	0.026	-47.446	***
Barriers	Lack of time	1	0.845			
	Social influence	1.059	0.835	0.025	41.784	***
	Lack of energy	1.086	0.865	0.025	44.286	***
	Lack of willpower	0.975	0.804	0.025	39.309	***
	Fear of injury	0.739	0.633	0.026	28.022	***
	Lack of skill	0.765	0.641	0.027	28.458	***
	Lack of resources	0.254	0.261	0.024	10.359	***
PA Level	Walking-MET	1	0.453			
	Moderate-MET	1.433	0.598	0.091	15.742	***
	Vigorous-MET	1.883	0.586	0.121	15.595	***

Note, UnStd, Un-Standardized factor loading coefficient, Std, Standardized factor loading coefficient, S.E., Standard Error, C.R., Critical Ratio, ***, 0.000.

The refinement primarily involved the measurement structure rather than changing the proposed structural relationships among the three latent constructs. Indicators associated with amotivation, external regulation, and introjected regulation were removed from the

motivation construct, leaving identified regulation, integrated regulation, and intrinsic regulation. For perceived barriers, the indicators fear of injury, Lack of skill, and lack of resources were removed, leaving lack of time, social influence, lack of energy, and lack of willpower. The three PA indicators were retained because they represented distinct levels of physical activity intensity and remained theoretically relevant to the construct. The indicators were removed sequentially based on comparatively weak or unstable standardized loadings and their limited contribution to the coherence of the retained construct, rather than on modification indices or post hoc structural paths.

No modification indices were used to introduce additional structural paths or correlated error terms. Instead, the refinement was based on the observed measurement properties of the indicators and the conceptual coherence of the resulting model. The final model therefore represented a more parsimonious specification of the original theoretical structure.

Final Model

The final model retained three indicators for the Motivation construct, four indicators for Perceived Barriers, and three indicators for PA Level (Figure 2). Because the three retained Motivation indicators—identified regulation, integrated regulation, and intrinsic regulation—represent autonomous forms of behavioral regulation within Self-Determination Theory, the refined latent construct is referred to as Autonomous Motivation in the text. The label "Motivation" is retained in the tables and figures to facilitate direct comparison between the initial and final model specifications.

The standardized factor loadings for Autonomous Motivation were .930 for intrinsic regulation, .860 for integrated regulation, and .685 for identified regulation. For Perceived Barriers, the standardized loadings were .887 for lack of energy, .830 for lack of time, .819 for lack of willpower, and .798 for social influence. The standardized loadings for PA Level were .593 for moderate-intensity PA, .583 for vigorous-intensity PA, and .461 for walking PA. All retained factor loadings were statistically significant.

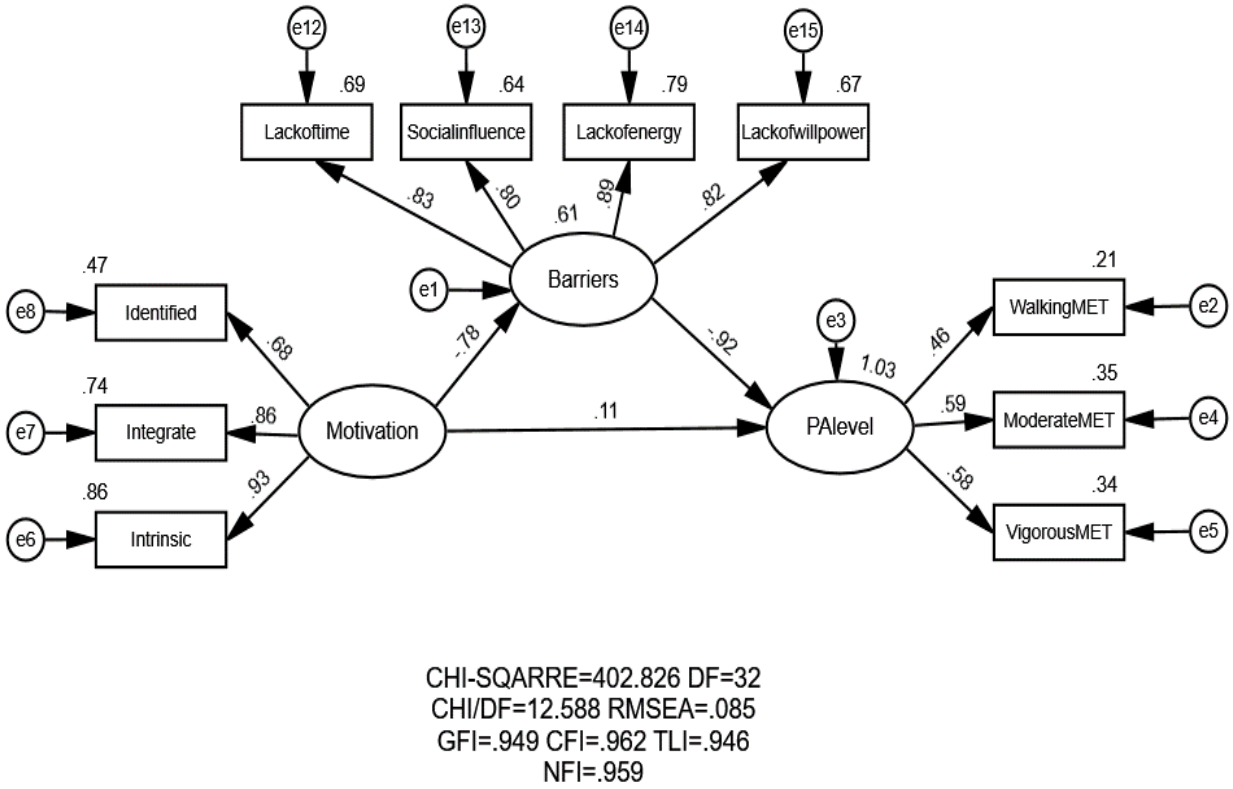

Figure 2 Final Model of Barriers-Mediated Motivation Promoting PA Level

Table 3 presents the standardized parameter estimates for the final model. Autonomous Motivation was negatively associated with Perceived Barriers (β = −.781, $p < .001$). Perceived Barriers showed a strong negative association with PA Level (β = −.921, $p < .001$). The direct association between Autonomous Motivation and PA Level was positive but comparatively small (β = .115, $p = .008$).

The final model showed substantial improvement in fit relative to the initial model (Table 4). The final model yielded $\chi^2(32) = 402.826$, $\chi^2/df = 12.588$, RMSEA = .085, SRMR = .035, GFI = .949, CFI = .962, NFI = .959, and TLI = .946. The CFI, TLI, NFI, and GFI values were above .90, while the SRMR was .035. The RMSEA was .085. Although the χ^2/df ratio remained elevated, the remaining fit indices indicated substantial improvement in model fit, particularly for the comparative and residual-based indices. Contemporary SEM reporting guidance recommends considering several complementary fit indices rather than relying on a single criterion.

Table 3
Path Coefficient Estimates of the Final Model

Factors	Variables	UnStd	Std	S.E.	C.R.	*P*
Motivation	Barriers	-0.302	-0.781	0.009	-32.004	***
Motivation	PA level	6.701	0.115	2.536	2.643	0.008
Barriers	PA level	-138.661	-0.921	9.186	-15.096	***
PA level	Walking-MET	1	0.461			
	Moderate-MET	1.399	0.593	0.084	16.661	***
	Vigorous-MET	1.842	0.583	0.112	16.52	***
Motivation	Intrinsic regulation	1	0.93			
	Integrated regulation	0.736	0.86	0.016	46.988	***
	Identified regulation	0.431	0.685	0.013	32.515	***
Barriers	Lack of time	1	0.83			
	Social influence	1.03	0.798	0.027	37.563	***
	Lack of energy	1.134	0.887	0.026	44.049	***
	Lack of willpower	1.012	0.819	0.026	39.069	***

Note, UnStd, Un-Standardized factor loading coefficient, Std, Standardized factor loading coefficient, S.E., Standard Error, C.R., Critical Ratio, ***, 0.000.

Table 4
Final Model Fit Index

Indicators	χ^2	df	P	χ^2/ df	GFI	RMSEA	SRMR	CFI	NFI	TLI
Reference criteria	-	-	>0.05	<3	>0.9	<0.10	<0.05	>0.9	>0.9	>0.9
value	402.826	32	-	12.588	0.949	0.085	0.035	0.962	0.959	0.946

Mediation Analysis

A bootstrap procedure was used to examine whether Perceived Barriers statistically accounted for part of the association between Autonomous Motivation and PA Level. The analysis estimated the direct, indirect, and total associations, with statistical significance determined from bias-corrected 95% confidence intervals.

As shown in Table 5, the direct association between Autonomous Motivation and PA Level was positive and statistically significant (β = .115, 95% BC CI [.022, .211]). The standardized indirect association through Perceived Barriers was also statistically significant (β = .719, 95% BC CI [.647, .800]). The estimated total association was β = .834 (95% BC CI [.780, .889]). Because the confidence intervals for the direct and indirect associations did not include zero, the findings were consistent with a partial statistical mediation pattern.

Table 5
Mediation Effect Test in Final Model

Path	Effect	Std Effects	Product of coefficient		Bias-corrected 95% CI		Percentile 95% CI	
			S.E.	Z	Lower	Upper	Lower	Upper
Motivation→ PA level	Direct effects	0.115	0.048	2.39	0.022	0.211	0.019	0.209
Motivation→ PA level	Indirect effects	0.719	0.038	18.92	0.647	0.800	0.646	0.798
Motivation→ PA level	Total effects	0.834	0.028	29.79	0.780	0.889	0.779	0.887

Note, Std, Standardized factor loading coefficient, S.E., Standard Error, Z, Z-value, 5000 Bootstrap, ***, 0.000.

The indirect pathway represented approximately 86.2% of the estimated total association and was substantially larger than the direct association. Within the statistical structure of the model, most of the estimated association between Autonomous Motivation and PA Level was therefore represented by the indirect pathway through Perceived Barriers. Given the cross-sectional design, this pattern should be interpreted as a statistical mediation association rather than evidence of a temporal or causal mechanism.

In summary, the initial model showed inadequate fit and a motivational measurement structure that was not directionally coherent as a single latent construct. Through sequential assessment of indicator performance and theoretical coherence, a more parsimonious model was obtained in which identified, integrated, and intrinsic regulation formed the Autonomous Motivation construct. The final model showed that Autonomous Motivation was associated with lower Perceived Barriers and higher PA Level, whereas Perceived Barriers were strongly associated with lower PA Level. The indirect statistical association through Perceived Barriers was substantially larger than the direct association between Autonomous Motivation and PA Level. These findings support considering motivational orientation and perceived barriers together when examining PA among Chinese university students, while recognizing that the cross-sectional design does not permit causal or temporal conclusions.

Discussion

The Barriers-Mediated Motivation Model

The present study developed and empirically examined a barriers-mediated Autonomous Motivation model of physical activity (PA) among Chinese university students. The final model consisted of three latent constructs: Autonomous Motivation, Perceived Barriers, and PA Level. Autonomous Motivation was represented by identified, integrated, and intrinsic regulation; Perceived Barriers by lack of time, social influence, lack of energy, and lack of willpower; and PA Level by walking, moderate-intensity, and vigorous-intensity physical activity. For consistency with the initial model, the latent variable is labeled “Motivation” in the tables and figures, whereas “Autonomous Motivation” is used in the text to reflect the composition of the final construct. The final model showed substantial improvement in fit over the initial specification while retaining the original conceptual relationships among motivation, barriers, and PA.

An important feature of the final model was the retention of three relatively autonomous forms of motivation: identified, integrated, and intrinsic regulation. This pattern is broadly consistent with Self-Determination Theory, which distinguishes motivation according to the extent to which behaviour is experienced as self-endorsed and personally meaningful (Ryan & Deci, 2020). Recent research among Chinese university students has also demonstrated the relevance of motivational processes to PA. Guo et al. (2026), using data from 1,024 Chinese undergraduates, found that motivation for PA was positively associated with PA and that environmental support strengthened this association. Similarly, Liu et al. (2023) reported significant relationships among exercise motivation, PA, and physical fitness in 2,544 Chinese college students.

The present findings extend this literature by considering motivation alongside perceived barriers. Previous research has often examined motivation as a predictor of exercise behaviour or physical fitness, whereas barrier-focused studies have concentrated on factors that discourage PA. A systematic review of 22 university-student studies involving 15,411 participants identified lack of time, lack of motivation, and lack of accessible places among the most frequently reported barriers to PA (Silva et al., 2022). The present model brings these two lines of evidence together by examining whether perceived barriers form a statistical pathway linking motivational orientation with PA.

The excluded indicators also require cautious interpretation. Amotivation, external regulation, and introjected regulation were not retained in the final Motivation construct, while fear of injury, Lack of skill, and lack of resources were excluded from the Barriers construct. Their exclusion does not indicate that they are theoretically unimportant; rather, these indicators did not make sufficiently stable contributions to the latent constructs under the measurement conditions of this study. This distinction is important because SDT does not imply that all regulatory forms contribute equally to autonomous motivation. Likewise, perceived barriers may differ according to students' social, institutional, and cultural circumstances. Recent research has shown that barriers are multidimensional and may reflect psychological, social, environmental, and physiological conditions rather than a single homogeneous constraint (Akil, 2025; Silva et al., 2022).

The retained barrier indicators further highlight the behavioural context of university students. Lack of time, lack of energy, lack of willpower, and social influence represent different forms of constraint, but all are related to the everyday circumstances in which students attempt to maintain PA. The importance of time-related and motivational barriers is consistent with Silva et al. (2022), while recent research has linked fatigue with greater perceptions of personal and social barriers among university students (Akil, 2025). Akil also found that intrinsic motivation was negatively associated with perceived barriers, whereas extrinsic motivation and amotivation were positively associated with barriers. These findings support examining Motivation and Barriers as interconnected constructs.

The final model should nevertheless be viewed as a context-specific empirical representation rather than a universal structure of university students' PA behaviour. It was developed using data from one Chinese university and relied on cross-sectional self-report measures. The retained indicators also reflect the measurement properties of the Chinese versions of the instruments used. Thus, the model demonstrates statistical connections among these

constructs within the present sample but does not establish that the same measurement structure or structural relationships would emerge in other universities, countries, or educational systems.

Structural Relationships

The first structural relationship was between Motivation and perceived Barriers. The final model showed a strong negative standardized association (β = −.781, $p < .001$), indicating that higher Motivation was associated with lower perceived barriers. This finding is consistent with recent university-student research linking motivational quality with perceptions of barriers. Akil (2025), for example, found that intrinsic motivation was negatively associated with personal, social, and physical-environmental barriers, whereas extrinsic motivation and amotivation were associated with greater perceived barriers.

The finding is also consistent with the SDT perspective because the retained Motivation construct comprised identified, integrated, and intrinsic regulation. These forms of motivation reflect relatively autonomous reasons for engaging in exercise. Behaviour experienced as personally valued or inherently enjoyable may be more likely to be maintained with greater volition and persistence (Ryan & Deci, 2020). Students with stronger autonomous motivation may therefore be more willing to organize their schedules around PA, seek opportunities for participation, and persist when difficulties arise.

However, the magnitude of the association was considerably larger than that reported in recent regression-based research. Akil (2025) reported relatively small negative coefficients between intrinsic motivation and different barrier categories, approximately −.13 to −.21, with motivation explaining only a small proportion of variance in perceived barriers. The much larger coefficient in the present model should therefore not be interpreted as evidence that motivation alone determines students' perceptions of barriers. One possible explanation is methodological. The present analysis estimated associations between latent constructs represented by multiple indicators, whereas Akil examined individual motivation dimensions as predictors of specific barrier categories. Differences in measurement structure, samples, analytical methods, and operational definitions may therefore account for part of the difference.

The strong negative association may also reflect the close relationship between motivational orientation and perceived behavioural difficulty. Students who are committed to PA may be better able to organize their schedules and persist when difficulties arise, whereas those experiencing substantial difficulties may gradually perceive exercise as less attainable. Because the present study was cross-sectional, however, the temporal direction cannot be determined. The coefficient should therefore be interpreted as a strong statistical association rather than evidence that increasing motivation will necessarily reduce perceived barriers.

Recent Chinese research further highlights the importance of contextual conditions. Guo et al. (2026) found that motivation for PA was positively associated with PA among Chinese undergraduates and that environmental support strengthened this association. Whereas Guo et al. examined environmental support as a moderator, the present study examined perceived barriers as a mediator. The findings are therefore complementary rather than

equivalent and both suggest that motivational processes operate within conditions that may facilitate or constrain behaviour.

The second structural relationship concerned perceived Barriers and PA Level. The final model produced a strong negative standardized coefficient (β = −.921, p < .001), the largest structural coefficient in the model, indicating that higher perceived barriers were strongly associated with lower PA. The direction of this relationship is consistent with previous research. Silva et al. (2022), in a systematic review covering 38,319 high school and university students across 31 countries, identified lack of time, lack of motivation, and lack of accessible places among the most frequently reported barriers to PA. Psychological, sociocultural, and environmental factors were also repeatedly identified across university-student studies. Similarly, Kundakcı et al. (2024) reported a significant relationship between perceived PA barriers and PA-related outcomes among university students.

The magnitude of the present coefficient nevertheless warrants caution. A standardized coefficient of β = −.921 represents an exceptionally strong statistical association and should not be interpreted as evidence that perceived barriers independently explain almost all PA behaviour or exert a causal effect. Some retained barrier indicators are behaviourally proximal to PA. Lack of time, lack of energy, and lack of willpower may be experienced precisely when students are attempting to engage in exercise but are unable to sustain it. Perceived barriers and low PA may therefore partly reflect the same underlying behavioural circumstances.

This issue is particularly relevant to lack of energy. Fatigue may function both as a perceived obstacle to PA and as an experience associated with low activity or demanding daily routines. Akil (2025) found that physical and mental fatigue were associated with greater perceptions of PA barriers, while intrinsic motivation was associated with lower barrier perceptions. Thus, the strong Barriers–PA association may capture a combination of environmental constraints, psychological perceptions, and behavioural experiences rather than a single independent causal pathway.

Time constraints similarly represent more than an individual limitation. Silva et al. (2022) identified lack of time as one of the most frequently reported barriers, while academic requirements, examinations, commuting, social activities, and institutional schedules may all reduce students' discretionary time for exercise. The present finding therefore suggests that PA promotion should not be viewed solely as a matter of individual willingness.

Social influence also remained in the final Barriers construct. This is consistent with evidence that social and interpersonal conditions can facilitate or constrain university students' PA. Silva et al. (2022) identified sociocultural factors, including social support, as important aspects of PA barriers, while Guo et al. (2026) emphasized the role of environmental and interpersonal conditions in translating motivation into PA among Chinese university students.

Overall, these findings support an ecological interpretation of student PA. Students may be motivated to exercise but still encounter circumstances that make regular participation difficult. Conversely, reducing barriers without addressing motivational orientation may also be insufficient for sustained engagement. The relatively large Barriers–PA association

therefore highlights the value of considering both individual and contextual conditions in university-based PA interventions.

In contrast to the strong associations involving perceived Barriers, the direct association between Motivation and PA Level was positive but comparatively small (β = .115, *p* = .008). This finding provides a more differentiated view of the role of motivation in PA. The positive direction is consistent with previous research among Chinese college students. Liu et al. (2023) found significant positive relationships between exercise motivation, PA, and physical fitness among 2,544 college students and showed that PA mediated part of the relationship between exercise motivation and physical fitness. Similarly, a study of 641 Chinese college students reported that exercise motivation was directly associated with exercise behaviour and cardiovascular fitness, with exercise behaviour partially mediating the relationship between motivation and fitness (Li et al., 2022). These findings support the relevance of motivation to university students' exercise behaviour.

The relatively small direct coefficient, however, differs from interpretations that position motivation as the primary determinant of PA. Once perceived barriers were incorporated into the model, the Motivation–PA association remained significant but was substantially weaker than the Barriers–PA association. This suggests that motivation may be important but insufficient on its own to translate willingness into sustained behaviour.

This interpretation is compatible with Guo et al. (2026), who found that motivation was positively associated with PA and that environmental support strengthened this relationship among 1,024 undergraduates. Their findings suggest that motivational processes are more likely to be expressed behaviourally when supportive conditions are available. The present study offers a related perspective by suggesting that perceived barriers may represent one mechanism through which motivational orientation is connected with PA.

The small direct coefficient should not therefore be interpreted as indicating that motivation is unimportant. It remained statistically significant after barriers were included. Rather, the finding suggests that part of the contribution of motivation to PA may be shared with, or transmitted through, students' perceptions of the barriers they encounter. This provides a more differentiated account of the motivation–behaviour relationship than the assumption that stronger motivation necessarily produces proportionally greater PA.

Mediating Role of Perceived Barriers

The mediation analysis represents the central contribution of the model. The direct association between Autonomous Motivation and PA Level was positive and statistically significant (β = .115, 95% BC CI [.022, .211]), while the standardized indirect association through Perceived Barriers was also significant (β = .719, 95% BC CI [.647, .800]). The estimated total association was β = .834 (95% BC CI [.780, .889]). The nonzero confidence intervals for the direct and indirect effects were consistent with a partial statistical mediation pattern.

The indirect pathway was substantially larger than the direct association and represented approximately 86.2% of the estimated total association. Within the statistical structure of the model, most of the estimated Autonomous Motivation–PA association was therefore

represented by the pathway through Perceived Barriers. This finding extends previous research by integrating evidence that has often been examined separately. Liu et al. (2023) examined a mediation model in which PA transmitted part of the association between exercise motivation and physical fitness, whereas Guo et al. (2026) reported an indirect association between autonomy support and PA through motivation and highlighted the role of environmental support. Barrier-focused research has separately identified time constraints, motivational difficulties, fatigue, social influences, and environmental limitations as relevant obstacles to student PA (Akil, 2025; Silva et al., 2022). The contribution of the present study therefore lies primarily in integrating Autonomous Motivation, Perceived Barriers, and PA within a single structural framework.

At the same time, the magnitude of the indirect association and its estimated 86.2% contribution should be interpreted cautiously. Because the data were cross-sectional, the mediation analysis cannot establish temporal ordering. The model statistically represents a pattern in which Autonomous Motivation is associated with lower Perceived Barriers and Perceived Barriers are associated with higher PA, but alternative explanations remain possible. Physically active students may perceive fewer barriers because exercise has become integrated into their routines, whereas students with lower PA may subsequently experience greater fatigue, scheduling difficulty, or perceptions that exercise is difficult to maintain. Motivation may also change following repeated success or failure in maintaining PA. The observed pattern should therefore be understood as a statistical mediation association rather than evidence of a causal mechanism.

The strong indirect pathway may also partly reflect conceptual overlap between some barrier indicators and motivational or behavioral states. Lack of willpower may represent a perceived barrier while also reflecting difficulties in behavioral regulation, and lack of energy may reflect both a perceived constraint and the consequences of demanding routines or insufficient physical conditioning. The model should therefore not be interpreted as demonstrating that Perceived Barriers constitute a completely independent causal mechanism between motivation and behavior. Rather, the findings suggest that perceived difficulty is closely intertwined with the statistical relationship between motivational orientation and PA in the present sample.

Practical and theoretical Implications

The findings have practical implications for intervention design. Motivation-centred interventions may be insufficient when students already possess relatively autonomous reasons for exercise but continue to experience substantial practical or psychological barriers. University-based interventions may therefore benefit from combining motivational strategies with barrier-reduction approaches, such as providing flexible opportunities for short-duration exercise, improving access to facilities, reducing scheduling conflicts, incorporating social forms of exercise, and helping students maintain activity during academically demanding periods.

Such recommendations do not imply that universities can eliminate all barriers. Some arise from broader academic, social, and institutional conditions that cannot be addressed through a single intervention. Nevertheless, the findings highlight an important distinction between wanting to be active and being able to act consistently on that motivation. This distinction is

particularly relevant in university settings, where students may recognize the value of exercise while facing competing academic and social demands.

The model also has implications for the interpretation of SDT in the university context. SDT emphasizes autonomous motivation, but autonomous motivation does not operate independently of the conditions in which behaviour occurs (Ryan & Deci, 2020). The present findings suggest that motivational orientation and perceived behavioural constraints may need to be considered together when explaining PA. In this respect, the model does not challenge SDT but offers a more context-sensitive interpretation of how motivational orientation may be translated into behaviour.

Limitations and Future Research

Several limitations should be considered when interpreting these findings. First, the cross-sectional design prevents conclusions about temporal ordering or causality. Although the statistical model was specified with Perceived Barriers as a mediator, the observed associations could reflect reciprocal or alternative relationships among motivation, barriers, and PA. Longitudinal and experimental studies are needed to test whether the proposed structural ordering is supported over time.

Second, the participants were recruited from a single teacher education university in southern China. The findings may therefore reflect institutional, regional, or cultural characteristics that are not representative of university students elsewhere. Replication across universities, regions, and educational systems is needed to evaluate the generalizability of the measurement and structural model.

Third, PA, motivation, and perceived barriers were assessed using self-report questionnaires. Although established instruments were used and common method bias was examined as a diagnostic procedure, self-report measures remain susceptible to recall, response, and social desirability biases. Future studies could combine questionnaire measures with objective indicators of PA, such as accelerometry or other activity-monitoring methods.

Fourth, the final measurement structure was obtained through iterative indicator refinement. Although the refinement was guided by measurement performance and theoretical coherence and did not involve modification-index-driven additions of structural paths or correlated errors, the resulting model should be considered a context-specific empirical representation rather than a universal structure. Independent-sample validation and cross-validation are needed before the model can be regarded as a stable general model of university students' PA.

Conclusion

The present study suggests that Autonomous Motivation and Perceived Barriers should be considered together when examining PA among Chinese university students. The refined structural model showed that more autonomous forms of motivation were associated with lower perceived barriers, whereas greater perceived barriers were strongly associated with lower PA. Autonomous Motivation also retained a significant positive direct association with PA, although this association was substantially smaller than the indirect statistical pathway through Perceived Barriers. The findings therefore suggest that motivational orientation

alone may not fully capture the conditions associated with university students' PA. An integrated approach that supports autonomous motivation while also identifying and addressing relevant barriers may provide a more context-sensitive basis for PA promotion. Because the study was cross-sectional, these findings should be interpreted as statistical associations rather than evidence of causal mechanisms.

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