

Exploring Adolescent Moderate-to-Vigorous Physical Activity in China: Mediating Roles of School Climate, Perceived Barriers, and Physical Education Satisfaction

Qianyuan Li¹, Li Li¹, Xianyi He², Huilin Wang³

¹School of Physical Education, Hunan University of Science and Technology, Xiangtan, 411201, People's Republic of China; ²College of Physical Education, Hunan Normal University, Changsha, 410017, People's Republic of China; ³School of Business, Hunan University of Science and Technology, Xiangtan, 411201, People's Republic of China

Correspondence: Huilin Wang, School of Business, Hunan University of Science and Technology, Xiangtan, 411201, People's Republic of China, Email 1150141@hnust.edu.cn

Background: The lack of physical activity poses a major challenge to adolescents' healthy physical and mental development. Despite growing attention, research on how the school physical activity climate affects Chinese adolescents' participation in moderate-to-vigorous physical activity (MVPA) remains scarce. This study explores this relationship through the lens of ecological systems theory, focusing on the mediating roles of physical education satisfaction and perceived barriers. It also proposes strategies to promote MVPA among Chinese adolescents.

Methods: This cross-sectional study employed convenience and snowball sampling methods to examine the impact of the school physical activity climate on adolescent participation in MVPA. It also explored the mediating roles of physical education satisfaction and perceived barriers. Four variables in the study were measured using established scales: Physical Activity Climate, Perceived Barriers to Physical Activity, Physical Education Satisfaction, and Physical Activity Assessment. The data were analyzed using AMOS v.23 to construct and test a structural equation model.

Results: A total of 612 adolescents aged 12 to 18 from six key middle schools in central China participated in the study. The findings showed that a positive school physical activity climate significantly promotes MVPA participation. Physical education satisfaction positively correlated with MVPA ($\beta = 0.322, p < 0.001$), while perceived barriers negatively correlated with both physical education satisfaction ($\beta = -0.449, p < 0.001$) and MVPA ($\beta = -0.366, p < 0.001$). Satisfaction with physical education and perceived barriers mediated the relationship between the school climate and MVPA, emphasizing their importance in shaping adolescent physical activity behavior. Confirmatory factor analysis (CFA) results ($\chi^2/df = 1.928, GFI = 0.969, AGFI = 0.956, NFI = 0.962, CFI = 0.981, RMSEA = 0.037$) confirmed the model's robustness and good fit.

Conclusion: Adolescents in a positive physical activity climate are more likely to overlook perceived barriers, enjoy higher satisfaction in PE classes, and actively engage in MVPA. Schools and educators are advised to foster a supportive physical activity environment to boost adolescent MVPA participation, considering the unique context of China's educational system.

Keywords: adolescents, physical activity climate, perceived barriers, physical education satisfaction, moderate-to-vigorous physical activity

Introduction

Regular participation in MVPA is widely regarded as crucial for promoting adolescents' physical and mental health.^{1,2} Engaging in adequate MVPA during this developmental stage helps establish healthy habits and attitudes,³ reduces the risk of future mental health issues and chronic diseases, lowers levels of depression,⁴ enhances physical fitness,⁵ and decreases the likelihood of obesity and diabetes.⁶ Since 2010, the WHO and various health authorities have issued public

health recommendations encouraging adolescents to engage in MVPA.⁷ However, less than one-fifth of adolescents globally meet the international guideline of “one hour of MVPA per day”.⁸ With the proliferation of smart devices and increasing academic pressure, screen time and sedentary behavior among adolescents have risen significantly,⁹ while MVPA participation rates have declined by over 5% annually.¹⁰ Clearly, the lack of physical activity has become a significant barrier to adolescents’ healthy development.

Previous research has sought to improve adolescent physical activity levels through interventions such as enhancing physical education (PE) classes or implementing school-based initiatives.¹¹ However, in the context of Asia-Pacific schools, the impact of the school physical activity climate on adolescent participation in MVPA remains underexplored. In China, while the Ministry of Education’s recently issued *Curriculum Standards (2022)* has increased PE class hours and included activities aligned with MVPA,¹² the unique social, cultural, and educational systems still impose considerable academic pressure and physical activity restrictions on adolescents.^{13,14}

Firstly, exam-oriented family environments in China often prioritize academic achievement over physical activity, with parents placing higher expectations on grades while neglecting their children’s physical fitness and participation in sports.^{15,16} Secondly, due to limited educational resources, Chinese adolescents face significant pressure from competitive entrance exams for higher education.^{17,18} Under this academic burden, adolescents may perceive the time, energy, and costs associated with physical activity as outweighing its potential benefits, weakening their motivation to engage in MVPA.¹⁹ Finally, as in many developing countries, schools in China often prioritise academic success over building sports facilities, and this lack of infrastructure further limits opportunities for physical activity.²⁰

According to ecological systems theory, understanding an individual’s behavior requires a comprehensive examination of their surrounding environment.²¹ Development occurs within multiple system levels (micro-, meso-, exo-, and macro-systems), which interact to influence individuals in different ways.²² In China, heavy academic demands mean that schools serve as the primary activity setting for adolescents, with limited opportunities to engage with the broader community.²³ Within this theoretical framework, schools can be considered the macro-system in which adolescents are situated. The school physical activity climate, encompassing attitudes towards physical activity, availability of facilities, resource allocation, and support, represents the exo-system.²⁴ Perceived barriers to physical activity and satisfaction with PE classes are part of the meso- and micro-systems, respectively, while adolescents’ MVPA behaviour is the behavioral outcome of these interconnected systems.

Perceived barriers to physical activity refer to individual, social, and environmental factors that hinder a person’s ability or willingness to engage in physical activity.²⁵ Influenced by Confucian values, Chinese adolescents are more inclined to follow the instructions of parents, teachers, and school administrators.²⁶ Studies focusing on Chinese adolescents have shown that the attitudes of school administrators and teachers towards physical activity are the only significant school-level factors affecting adolescents’ participation in MVPA.²⁷ Moreover, teacher autonomy support can enhance adolescents’ intrinsic motivation to engage in MVPA,²⁸ thereby mitigating perceived barriers to participation. From the perspective of ecological systems theory, the physical activity climate created by the school environment can significantly shape adolescents’ perception of barriers to physical activity.²⁹ A positive school physical activity climate can effectively reduce various barriers faced by students when engaging in physical activities, such as lack of time, skills, or facilities.³⁰ Additionally, when school administrators, teachers, and peers actively encourage and support adolescents’ participation in physical exercise, it can help alleviate social and emotional barriers, such as lack of confidence, peer pressure, and fear of embarrassment.³¹ In reality, adolescent participation in physical activity is a complex behavior influenced by multiple factors, including external social constructs, organizational environments, and individual physical and psychological needs.³² Compared to adults, adolescents lack autonomy and control over their external environment, meaning that environmental barriers have a stronger inhibitory effect on their willingness to engage in physical activity.³¹ Furthermore, even highly skilled adolescents may encounter internal barriers, such as negative self-perceptions, which can reduce their activity levels.³³

PE classes are the fundamental form of organized sports education for adolescents, providing an optimal environment for their early participation in physical activities.³⁴ Influenced by an exam-oriented education system, school-aged adolescents in China spend almost their entire day in a campus environment,³⁵ making PE classes potentially their only opportunity to engage in physical activity. Within this context, their satisfaction with PE classes can more directly

reflect their subjective attitudes toward PE and participation in physical activities. When adolescents perceive various barriers to physical activity—such as lack of time, poor physical fitness, peer pressure, or limited access to facilities—these factors negatively affect their overall satisfaction with physical activities.³⁶ Such barriers can undermine adolescents' intrinsic motivation, reduce their interest, and foster a negative attitude toward physical education,³⁷ ultimately influencing their perceptions of PE classes and lowering their satisfaction with physical education activities. On the other hand, access to sufficient sports facilities and resources within a supportive environment, along with strong administrative and peer support, can enable teachers to offer more engaging, diverse, and inclusive PE classes.³⁸ This, in turn, can foster students' sense of enjoyment, competence, and belonging, thereby enhancing their satisfaction with the PE class experience.³⁹ Furthermore, a positive physical activity environment that emphasizes inclusive practices, skill development, and constructive feedback helps improve students' perceived abilities and self-efficacy in physical activities, which are critical determinants of their satisfaction with PE classes.⁴⁰ Moreover, numerous studies have shown that satisfaction with a course has a significant positive impact on students' classroom engagement. When adolescents are satisfied with their physical education experiences, they tend to display more positive attitudes and greater intrinsic motivation toward physical activities. They are also more likely to accept the knowledge, skills, and strategies imparted during PE classes, turning them into tools and confidence for engaging in MVPA.⁴¹

Previous studies have primarily focused on improving adolescents' levels of MVPA through classroom styles in PE classes⁴² and the overall physical activity content within the school environment.^{11,43} However, since adolescents' participation in physical activities is a complex behavior influenced by multiple factors,³² and their emotions are particularly sensitive during this developmental stage, psychological factors play a crucial role in the relationship between adolescents and physical activities.⁴⁴ Even minor perceived barriers can serve as significant negative predictors of their participation in physical activities.⁴⁵ Therefore, this study integrates perspectives from schools, PE classes, and individual psychology, drawing on ecosystem theory to examine the impact of the school physical activity environment on adolescents' physical activity behaviors. It shifts the focus toward the psychological mediators that adolescents experience when facing physical activities within the school environment. Based on these insights, the study aims to develop strategies to promote adolescents' participation in MVPA in China.

In summary, this study proposes the following hypotheses:

Hypothesis 1 (H1): The physical activity climate has a significant negative impact on perceived barriers.

Hypothesis 2 (H2): The physical activity climate has a significant positive impact on physical education satisfaction.

Hypothesis 3 (H3): Perceived barriers have a significant negative impact on physical education satisfaction.

Hypothesis 4 (H4): Perceived barriers have a significant negative impact on MVPA.

Hypothesis 5 (H5): Physical education satisfaction has a significant positive impact on MVPA.

Hypothesis 6 (H6): Perceived barriers and physical education satisfaction mediate the relationship between the physical activity climate and MVPA.

An overview of all hypotheses is illustrated in [Figure 1](#).

Methodology

Participants and Procedure

This study used snowball and convenience sampling to recruit adolescents aged 12 to 18 for a survey. From January 1, 2024, to February 29, 2024, a total of 700 questionnaires were distributed to adolescents from six key middle schools in the Central China region, one of China's seven geographical regions (comprising Hunan Province, Hubei Province, and Henan Province). After removing damaged, duplicate, or incomplete responses, 612 questionnaires were deemed valid, resulting in a 95% response validity rate.

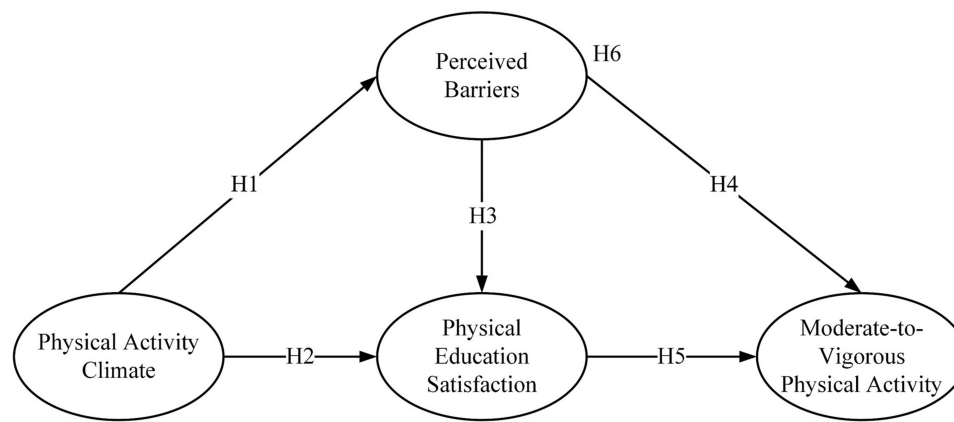


Figure 1 The Conceptual Model.

Researchers reached out to school leaders and administrators at the six middle schools from January to February 2024. Before administering the questionnaires, the objectives and importance of the study were explained to the participating adolescents and their guardians. Adolescents who completed the questionnaire with informed consent were allowed to choose a sports item (basketball, soccer ball, volleyball, etc). as a reward. The completed questionnaires were collected by the school administrators and sent back to the researchers in a single batch.

Table 1 presents the demographic characteristics of the 612 participating adolescents. Key findings include: (1) Approximately 68% of the adolescents were aged between 15 and 18 years, with an estimated average age of 15.38 years. (2) The gender ratio was about 4:3, with more males than females. (3) A significant proportion, around 60%, participated in sports such as basketball, track and field, and badminton. (4) About 46% of the participants engaged in physical activities four to five times a week over the past year.

Instruments

To collect the target data, we compiled a questionnaire consisting of 19 established items selected from five existing scales. To ensure the quality of the collected data, multiple measures were implemented throughout the research process.

Table 1 Demographic Overview of Survey Participants (N=612)

Profiles		n	%
Age	12–14	196	32.0
	15–16	204	33.3
	17–18	212	34.6
Gender	Male	350	57.2
	Female	262	42.8
Sports Activities	Basketball	136	22.2
	Athletics	122	19.9
	Badminton	108	17.6
	Soccer	62	10.2
	Table Tennis	54	8.8
	Volleyball	40	6.5
	Bodybuilding	29	4.7
	Swimming	17	2.8
	Other	44	7.2
Exercise Frequency per Week	1–3	206	33.7
	4–5	280	45.8
	6–7	126	20.6

Note: Age Question 1. Gender Question 2. Sports Activities Question 3. Exercise Frequency per Week Question 4.

The questionnaire is composed of five sections, totaling 19 items, carefully selected to balance comprehensiveness and respondent burden.

The first section requires participants to provide detailed demographic information, including age, gender, types of sports frequently participated in, and the average frequency of participation in physical activities per week over the past year (see Table 1). The subsequent sections use established scales from notable researchers to collect nuanced data on specific aspects (see Table 2).

For sections two to five, we adopted scales designed by Ribisl, Reischl,⁴⁶ Arzu, Tuzun, Eker⁴⁷, Lemes, Araujo Gaya, Brand, Dias, Cristi-Montero, Mota, Gaya,⁴⁸ and Sallis, Haskell, Wood, Fortmann, Rogers, Blair, Paffenbarger.⁴⁹ All four scales utilize a five-point Likert scale, ranging from 1 (strongly disagree) to 5 (strongly agree). For measuring MVPA, we referred to prior studies employing self-reported measures,^{14,50} aiming to obtain results as close to reality as possible.

To adapt the scales for the Chinese context, researchers followed a systematic process that included both cultural adaptation and translation.^{51,52} Initially, the scales were translated into Chinese, and then back-translated to ensure accuracy and consistency with the original meaning. Following the translation, some items were modified to better align with Chinese cultural norms and values. This adaptation process involved consulting with experts in the field to ensure that the items were both culturally relevant and retained the integrity of the constructs they were intended to measure. To validate these modifications, a pilot test was conducted in two middle schools in Xiangtan City, Hunan Province, resulting in 96 valid responses. The pilot test confirmed the reliability of the adapted scales, with all Cronbach's alpha coefficients exceeding 0.8.⁵³

To maintain the quality of the responses, specific criteria were applied to exclude invalid questionnaires. These criteria included eliminating questionnaires with incomplete responses, inconsistent patterns, and those failing embedded attention check items. Additionally, responses completed in an unrealistically short time were also excluded to ensure that only engaged and thoughtful responses were included in the final analysis. After data collection, a thorough cleaning process was conducted to remove any remaining invalid responses, further ensuring the reliability of the data.

Data Analysis

In this study, we used AMOS v23 to build a structural equation model (SEM) to examine the influence of physical activity climate on adolescents' physical education satisfaction and their perceived barriers, ultimately affecting their

Table 2 questionnaire

Items	Loadings	C α	CR	AVE
Physical Activity Climate (PAC)		0.843	0.845	0.577
PAC1: Schools provide a wealth of information about exercise.	0.783			
PAC2: Schools and teachers provide social support for us to participate in exercise.	0.781			
PAC3: Our classmates provide social support for us to participate in exercise.	0.745			
PAC4: The school sets norms for exercise.	0.729			
Perceived Barriers (PB)		0.838	0.840	0.567
PB1: I have never energy as much as to able to do exercise.	0.799			
PB2: There is no fitness center that I could get to.	0.722			
PB3: My parents give academic success priority over exercise.	0.727			
PB4: I have no leisure time for exercise because of my busy lesson schedule.	0.762			
Physical Education Satisfaction (PES)		0.845	0.846	0.578
PES1: I think time goes fast during PE.	0.754			
PES2: I find PE interesting.	0.800			
PES3: I like PE.	0.767			
PES4: I think PE is fun.	0.718			
Moderate-to-Vigorous Physical Activity (MVPA)		0.783	0.784	0.548
MVPA1: During the past week, I actively participated in various forms of moderate physical activity, including tasks like sweeping and mopping, as well as engaging in sports such as brisk walking, Ping-Pong, and similar activities.	0.721			
MVPA2: During the past week, I actively participated in various forms of hard physical activity, including tasks like scrubbing floors, as well as engaging in sports such as tennis doubles, folk dancing, and similar activities.	0.725			
MVPA3: During the past week, I actively participated in various forms of very hard physical activity, including tasks like carrying heavy loads, as well as engaging in sports such as jogging, soccer, and similar activities.	0.774			

Note: PAC Question 5–8. PB Question 9–12. PES Question 13–16. MVPA Question 17–19.

MVPA engagement. The analysis followed a two-step approach, evaluating both the measurement and structural models. Initially, we assessed the model's reliability and validity, followed by an analysis of fit indices and path coefficients to explore potential mediation effects.

To address common method variance (CMV) associated with self-reported data, we implemented the method suggested by Mossholder, Bennett, Kemery, Wesolowski.⁵⁴ We compared two models, focusing on changes in degrees of freedom and chi-square values. Model one recorded a chi-square of 1770.740 with 90 degrees of freedom and a significant *p*-value, while model two had a chi-square of 135.518 with 84 degrees of freedom, also significant. The comparison confirmed the proportional fit between the models, indicating no significant CMV issues in this study.

Results

Mvpa

As shown in Table 3, 27% of adolescents reported that they actively participated in various forms of moderate physical activity in the past week, 26.7% of adolescents reported that they actively participated in various forms of hard physical activity in the past week, and 32.5% of adolescents reported that they actively participated in various forms of very hard physical activity in the past week.

Measurement Model

Using confirmatory factor analysis (CFA) with AMOS v.23, the study evaluated the reliability and validity of its latent variables. Results in Table 2 show that all variables achieved Cronbach's α values above 0.7, indicating substantial internal consistency as noted by Fornell, Larcker.⁵⁵ Furthermore, the average variance extraction (AVE). Additionally, each variable's AVE surpassed 0.5 and the composite reliability (CR) exceeded 0.7, confirming strong convergent validity. Factor loadings ranged from 0.718 to 0.800, reinforcing the construct validity of the measurement model. Discriminant validity was verified, as documented in Table 4, where the square roots of the AVE values on the diagonal exceeded inter-construct correlations, confirming the uniqueness of the constructs within the model.

Structural Model

After confirming the reliability and validity of its measurement model, the study used AMOS v.23 to test the structural model and hypotheses. CFA with 5000 bootstrap samples indicated a good model fit ($\chi^2/df = 1.928$, GFI = 0.969, AGFI = 0.956, NFI = 0.962, CFI = 0.981, RMSEA = 0.037). According to standard thresholds ($\chi^2/df < 3$, GFI, AGFI, NFI > 0.9, CFI > 0.95, RMSEA < 0.06),⁵⁶ the model demonstrated a good fit with the data.

Based on Pearson correlation coefficients, Table 4 reveals significant correlations among the independent variables, mediating variables, and dependent variables in this study. Specifically, the atmosphere of physical activity was significantly negatively correlated with perceived barriers and positively correlated with both satisfaction with physical

Table 3 Reports of MVPA

Questions	Categories (%)				
	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
MVPA1: During the past week, I actively participated in various forms of moderate physical activity, including tasks like sweeping and mopping, as well as engaging in sports such as brisk walking, Ping-Pong, and similar activities.	13.9%	19.7%	39.3%	11.4%	15.6%
MVPA2: During the past week, I actively participated in various forms of hard physical activity, including tasks like scrubbing floors, as well as engaging in sports such as tennis doubles, folk dancing, and similar activities.	11.9%	26.9%	34.6%	18.4%	8.3%
MVPA3: During the past week, I actively participated in various forms of very hard physical activity, including tasks like carrying heavy loads, as well as engaging in sports such as jogging, soccer, and similar activities.	9.5%	18.8%	39.2%	17.5%	15.0%

Table 4 Pearson Correlation

Construct	Mean	Standard Deviation	PAC	PB	PES	MVPA
PAC	2.975	1.042	(0.760)			
PB	3.125	1.001	-0.307 **	(0.753)		
PES	2.918	1.013	0.347 **	-0.461 **	(0.760)	
MVPA	2.963	0.972	0.373 **	-0.433 **	0.414 **	(0.740)

Note: The square root of the AVE is in diagonals; off diagonals are a Person's corrections of contracts. ** $p < 0.01$.

Abbreviations: PAC, Physical Activity Climate; PB, Perceived Barriers; PES, Physical Education Satisfaction; MVPA, Moderate-to-Vigorous Physical Activity.

education and MVPA. Meanwhile, perceived barriers were significantly negatively correlated with satisfaction with physical education and MVPA. Lastly, satisfaction with physical education was significantly positively correlated with MVPA. These findings provide preliminary support for the study's hypotheses.

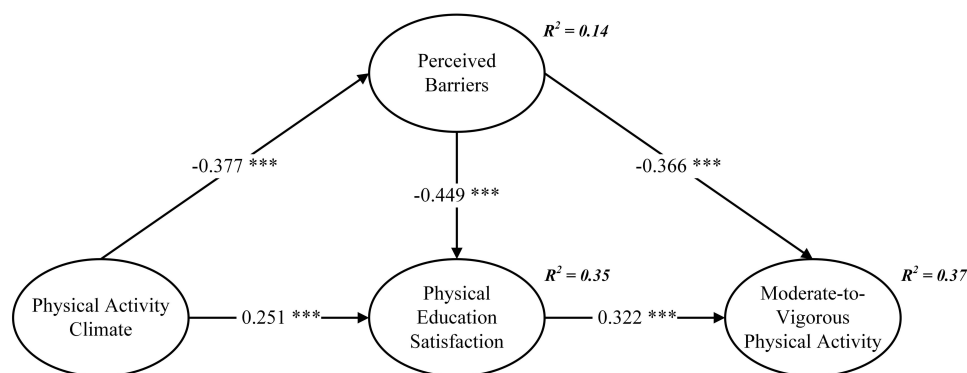
Figure 2 visually represents the structural path model, illustrating the standardized coefficients for each hypothesized relationship. The physical activity atmosphere demonstrated a significant negative correlation with perceived barriers ($r = -0.377$) and a significant positive correlation with satisfaction with physical education ($r = 0.251$), supporting H1 and H2, respectively. Additionally, perceived barriers showed significant negative correlations with satisfaction with physical education ($r = -0.449$) and MVPA ($r = -0.366$), supporting H3 and H4. Finally, satisfaction with physical education was significantly positively correlated with MVPA ($r = 0.322$), confirming H5.

Table 5 details the analysis of mediating effects using bootstrap estimation with 5000 resamples and 95% bias-corrected confidence intervals, clearly showing the indirect effect of physical activity climate on MVPA through perceived barriers and physical education satisfaction. This effect is quantified at 0.273 (SE = 0.033, CI = [0.210, 0.339], $p < 0.001$), strongly supporting H6.

Discussion

Theoretical Contributions

Previous research incorporating ecosystem theory into studies of the campus environment has primarily focused on students' mental health issues within schools.⁵⁷ Subsequently, researchers have applied ecosystem theory to explore adolescents' physical activity behaviors in school settings.^{58,59} However, most of these studies are based on the socio-cultural and educational systems of Western or other non-Chinese contexts, where adolescents often have ample time after school to interact with peers, communities, and social organizations outside the campus environment. Consequently, in these studies, schools are typically situated at the meso or micro level of the ecosystem.

**Figure 2** Structural path model.

Note: *** $p < 0.001$.

Table 5 Standardized Indirect Effect

	Point Estimate	Product of Coefficients		Bootstrapping		
				Bias-Corrected 95% CI		Two-Tailed Significance
		SE	Z	Lower	Upper	
PAC → MVPA	0.273	0.033	8.273	0.210	0.339	p < 0.001

In contrast, this study, grounded in the unique sociocultural and educational context of China as described earlier, conceptualizes the school environment as a complex ecosystem for Chinese adolescents.^{60,61} By integrating individual and environmental factors, the study reveals that a positive school physical activity atmosphere not only directly promotes participation in MVPA but also indirectly influences MVPA through reducing perceived barriers and increasing satisfaction with PE classes. This finding suggests that isolated environmental improvements may have limited effects and that collective cognitive and individual psychological factors must also be addressed simultaneously. This aligns with the integrated intervention strategies proposed by Telama, Yang, Viikari, Välimäki, Wanne, Raitakari⁶² and further validates the nested systems interaction described in ecosystem theory, where various levels of the system interact and collectively impact individuals.^{22,63}

Additionally, the findings highlight that perceived barriers exert a stronger negative impact on MVPA among Chinese adolescents,¹⁹ which may be related to the high level of obedience to parents and teachers observed in prior studies on Chinese adolescents.²⁶ The study also confirms that negative attitudes from school leaders and teachers towards physical activity can significantly affect adolescents' MVPA levels.²⁷ This underscores the critical role of creating a supportive school physical activity environment to alleviate perceived barriers^{31,33} and enhance physical activity levels.³⁰ Furthermore, compared to previous strategies focused on increasing MVPA content in PE classes,⁶⁴ satisfaction with PE classes in this study demonstrated a stronger influence on adolescents' MVPA levels. To improve overall physical activity levels, it is essential not only to focus on rigid indicators such as activity duration, intensity, and frequency but also to emphasize psychological satisfaction with the activities.⁶⁵ Worryingly, the MVPA levels of Chinese adolescents have already fallen below predicted trends from earlier studies.⁷ When asked about their participation in moderate-to-vigorous physical activities, many adolescents exhibited neutral attitudes. This neutrality could stem from factors such as uncertainty about what constitutes moderate-to-vigorous activities, memory bias, or a lack of confidence in accurately assessing their own activity levels. Additionally, some adolescents may lack motivation or interest in physical activities, making it challenging to classify their participation as "active". Social pressure and concerns about meeting expectations might also lead students to provide neutral responses, as they may wish to avoid judgment for admitting to overly high or low levels of physical activity. Understanding these potential reasons is crucial for developing accurate assessment tools and strategies to promote physical activity among adolescents.

Practical Implications

The results of this study provide important practical guidance for promoting adolescent participation in MVPA. Considering that promoting MVPA among adolescents is not a short-term endeavor but rather a long-term commitment, this study offers practical guidance from three perspectives: short-term, medium-term, and long-term.

In the short term, schools should immediately optimize the physical activity climate to enhance the convenience and attractiveness of student use. For example, increasing the quantity and quality of sports facilities, implementing scientific management mechanisms for their use, and ensuring students can conveniently participate in various sports activities. Simultaneously, schools should implement targeted support measures to help students overcome perceived barriers such as insufficient time scheduling and inadequate athletic abilities. Additionally, schools should provide professional training for physical education teachers to enhance their teaching skills and communication abilities, thus enhancing students' positive experiences.

In the medium term, schools should prioritize optimizing physical education curricula to improve student satisfaction with physical education classes. This can involve adjusting the content and teaching methods of classes based on student interests, encouraging physical education teachers to be proactive in innovating teaching methods, and enhancing the attractiveness of classes. Additionally, schools should foster a school-wide culture of physical activity by organizing

various sports and cultural activities and mobilizing resources from parents, the community, and other stakeholders to create a supportive climate for students.

From a long-term perspective, schools should establish robust sports management mechanisms to lay the foundation for students' lifelong participation in physical activity. This includes developing clear school sports development plans and policies, recruiting professional physical education teachers and administrators, and ensuring the sustainability of sports programs. Moreover, schools should integrate physical education into the daily teaching process to guide students in developing good exercise habits and enhancing their willingness to participate in MVPA in the long term. For instance, schools can establish pathways for the professional development of physical education teachers, attract and train outstanding teachers, and provide students with professional and enjoyable physical education courses.

In conclusion, promoting adolescent participation in MVPA requires schools to adopt systematic intervention measures from short-term, medium-term, and long-term perspectives. These measures include optimizing the physical climate, alleviating perceived barriers, enhancing satisfaction with physical education classes, and establishing long-term mechanisms to effectively promote the cultivation of students' lifelong participation in physical activity.

Limitations

Firstly, the study examined only two mediating variables in the relationship between the school physical activity climate and adolescent MVPA, and did not fully elaborate on the connections between them. Future researchers could explore additional mediating variables (eg, autonomous motivation, social support) and other dependent variables (eg, light physical activity) to provide alternative models and uncover more possibilities beyond the current research model. The study employed a cross-sectional method, lacking a temporal dimension. Future research could utilize longitudinal methods to deepen the research and introduce moderating variables to further explore the potential of this research direction. Additionally, future studies could explore the impact of light physical activity on adolescent health behaviors, complementing the focus on MVPA. At the same time, our study explores how the broader school physical activity climate promotes adolescent physical activity behavior. Future research could further supplement our findings by designing need-support/motivation interventions to enhance the intrinsic motivation for physical activity among adolescents, focusing on the mesosystem to microsystem levels.

Secondly, due to the limitations of our practical research capabilities, this study relied on self-reported measures of MVPA from adolescents. Self-reports can be subject to recall bias and inaccuracies. Future research should consider using wearable activity monitors to obtain more objective and accurate measurements of physical activity intensity. This would enhance the reliability of the data and provide a more precise understanding of adolescents' MVPA levels. Additionally, future studies could expand the sample size and improve sampling methods to further enhance the generalizability of the research findings.

Thirdly, the measurement of the physical activity climate in this study was not sufficiently rigorous and comprehensive. This area of research is still in its infancy but is critically important for understanding the role of school environments in promoting physical activity. Future studies should focus on developing robust and well-validated scales to measure physical activity climate. A more thorough and precise measurement tool would enable a deeper understanding of how different aspects of the school environment influence students' physical activity behaviors, thereby providing more actionable insights for improving school physical education programs.

Additionally, the study involves multiple environmental factors (such as school, family, and community) that influence adolescents' physical activity, reflecting the complexity of their daily lives. While this approach provides a comprehensive view, it also introduces potential overlap or ambiguity in interpreting the results. The integration of these varied environments might affect the consistency of measurements, as the interactions between different environmental factors are complex and not entirely isolated. Future research should aim to disentangle these environmental influences to provide a clearer understanding of their individual and combined impacts on physical activity behavior.

Conclusion

Overall, the school physical activity atmosphere is a significant factor influencing the MVPA levels of Chinese adolescents. Grounded in ecosystem theory and China's unique sociocultural and educational context, this study confirms the positive impact of a supportive physical activity atmosphere on adolescents' participation in MVPA. It also explores

how the physical activity atmosphere indirectly influences MVPA by reducing perceived barriers and enhancing satisfaction with physical education.

The findings indicate that a supportive school environment helps alleviate common barriers to physical activity faced by Chinese adolescents while increasing their enjoyment of PE classes, thereby improving their MVPA levels. Based on these results, we recommend that schools and educators adopt short-, medium-, and long-term strategies to foster a positive physical activity atmosphere and actively work to enhance students' satisfaction with PE classes. By creating such an environment, schools can more effectively encourage adolescents to engage in higher levels of MVPA.

Institutional Review Board Statement

The studies involving humans were approved by the Academic Committee of the School of Physical Education of Hunan University of Science and Technology. The studies were conducted in accordance with local legislation, institutional requirements, and the principles of the Declaration of Helsinki.

Data Sharing Statement

The data that support findings and conclusions of this study will be available from the corresponding author upon a reasonable request.

Informed Consent Statement

Informed consent was obtained from all subjects involved in the study.

Author Contributions

All authors made a significant contribution to the work reported, whether that is in the conception, study design, execution, acquisition of data, analysis and interpretation, or in all these areas; took part in drafting, revising or critically reviewing the article; gave final approval of the version to be published; have agreed on the journal to which the article has been submitted; and agree to be accountable for all aspects of the work.

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Disclosure

The author(s) report no conflicts of interest in this work.

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