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Development and validation of the Chinese school environment influencing physical activity habits scale

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Introduction: Regular physical activity is essential for preventing overweight and obesity in children and adolescents while also enhancing mental well-being. For teenagers, behaviors are predominantly shaped by habits, highlighting the importance of fostering positive physical activity practices. Schools, as central to adolescents' daily routines, play a critical role in influencing students' lifestyles and activity levels.

Methods: This study aimed to develop and validate a measurement instrument tailored to the Chinese social context to assess the impact of school-based factors on adolescents' physical activity habits. A sample of 1,061 students was recruited through stratified cluster sampling from 24 secondary schools across six provinces in China. Following data cleaning, 1,004 valid responses were analyzed. The sample was divided into two subsets: one ($n = 502$) for exploratory factor analysis (EFA) and one ($n = 502$) for confirmatory factor analysis (CFA).

Results: EFA identified four factors comprising 19 items: Facility Environment Attraction (5 items), Specification of Teachers' Competence (5 items), Influence of Peer Relationships (5 items), and Guarantee of Curriculum Setting (4 items). The factors demonstrated strong internal consistency (Cronbach's alpha: 0.841–0.895). CFA confirmed the scale's validity with an acceptable model fit (CMIN/DF = 3.888, TLI = 0.904, SRMR = 0.043, RMSEA = 0.046, GFI = 0.918). Additionally, the scale exhibited high internal consistency and test–retest reliability.

Discussion: This validated instrument provides researchers with a robust tool to evaluate school-related influences on physical activity habits among Chinese adolescents. The findings offer practical insights for promoting healthy behaviors, improving physical and mental health, and fostering holistic well-being in this population.

KEYWORDS

Chinese adolescents, physical activity habits, school environment, scale development, factor analysis

Introduction

Physical activity is a cornerstone of overall health and well-being, especially among children and adolescents (Nigg, 2023). It not only fosters physical fitness but also yields numerous benefits for mental health, academic performance, and social development (Janssen and LeBlanc, 2010; Strong et al., 2005). However, there has been a concerning global decline in physical activity levels among youth, accompanied by the rising prevalence of sedentary lifestyles (Bassett et al., 2015).

In China, rapid socioeconomic development and urbanization have ushered in significant shifts in lifestyle behaviors, including diminished physical activity levels among school-aged children (Chen et al., 2020). Multifaceted factors such as urbanization, heightened academic pressures, and the ubiquity of electronic devices have contributed to this trend (Wang et al., 2019). Understanding the environmental influences on physical activity habits, particularly within the school context, is paramount for crafting effective interventions to promote physical activity among Chinese students (Lu et al., 2017).

While extensive research has explored the impact of family and community environments on physical activity behaviors (National Institute for Health and Care Excellence, 2018), there remains a notable gap in studies focusing specifically on the school environment. Schools play a pivotal role in shaping students' attitudes and behaviors toward physical activity through avenues such as physical education programs, availability of sports facilities, and supportive policies (Dobbins et al., 2009; Ridgers et al., 2010). Despite individual studies focusing on specific dimensions of the school environment, there remains a paucity of a comprehensive measurement tool tailored to assess the influence of the school environment on physical activity habits among Chinese students. Given this gap, there is a clear imperative for the development and validation of a culturally relevant measurement tool tailored to the Chinese context (Chen, 2014). Such a scale would enable researchers, educators, and policymakers to accurately gauge the school environment's impact on students' physical activity behaviors, thereby informing the development of targeted interventions to promote physical activity in schools (Brunet et al., 2014).

Current measurement tools, including the Physical Activity Environment Scale (PACES) and the Youth Physical Activity Promotion Scale (YPAPS), exhibit various limitations. Many of these instruments are grounded in Western contexts, failing to capture the unique cultural, social, and educational influences that affect Chinese adolescents. Additionally, existing tools often focus narrowly on individual factors, such as personal motivation, while neglecting broader environmental influences, including school policies, peer relationships, and community support. This lack of a comprehensive measurement framework hampers our ability to fully understand the factors influencing physical activity engagement among students.

To address these gaps, we propose the Chinese School Environment Influencing Physical Activity Habits (CSE-IPAH) Scale, designed specifically to assess the impact of school-based factors on adolescents' physical activity habits within the Chinese context. This scale incorporates culturally relevant factors, examines multiple dimensions of influence, and ensures empirical validation, thereby providing a robust tool for researchers, educators, and policymakers.

Our study is grounded in social-ecological theory, this theoretical framework is particularly suited for exploring the school environment's impact on physical activity for several reasons. First, it recognizes that schools function within a broader societal context, influenced by community norms, policies, and socioeconomic factors that affect students' opportunities for physical activity. By applying social-ecological theory, our study can comprehensively assess how these various levels interact to influence students' behaviors. Additionally, it allows for the examination of peer relationships within school settings, as social interactions and peer norms can significantly facilitate or inhibit engagement in physical activities (Salvy et al., 2012).

Drawing upon an extensive literature review and field expertise, this paper seeks to outline the process of developing and validating the

Chinese School Environment Influencing Physical Activity Habits Scale. By employing rigorous scientific methods, we endeavor to fashion a reliable and valid measurement tool that captures the multidimensional aspects of the school environment pertinent to physical activity promotion among Chinese students (Zhang et al., 2024).

This research presents substantial implications. Firstly, it advances the understanding of the role schools play in shaping adolescents' physical activity habits, thereby enhancing the effectiveness of initiatives aimed at promoting physical activity. Secondly, it supports the development of assessment tools tailored to the specific context of China, by focusing on school-related factors that are significant to Chinese adolescents. Lastly, the study aims to enrich the existing body of knowledge regarding the localization and development of measures that elucidate the influence of schools on physical activity among Chinese adolescents.

Materials and methods

Original items for scale development

This study undertook a systematic review and analysis of peer-reviewed empirical research published before January 2023, focusing on studies that applied the social-ecological theory framework to investigate the influence of the school environment on adolescents' physical activity behaviors. There are three criteria for inclusion: firstly, the study population consisted of adolescents; secondly, the research explored the relationship between school environment factors and adolescents' physical activity; thirdly, the study was explicitly guided by the social-ecological theory. Findings from the literature review were subsequently utilized to develop an interview guide aimed at eliciting in-depth perspectives on school-related factors shaping adolescents' physical activity habits.

The development of the original item pool followed a rigorous, multi-step process to ensure theoretical grounding, content validity, and relevance to the target population. Initially, the research team engaged in collaborative discussions to generate a comprehensive set of potential items, guided by social-ecological theory and a thorough review of relevant literature. These items were then subjected to expert evaluation. A panel of seven specialists in adolescent development and health behavior research assessed the items for relevance and specificity, with those endorsed by at least five experts retained for further refinement.

The preliminary item pool was subsequently reviewed through two rounds of qualitative interviews designed to elicit feedback from the target population regarding item relevance, clarity, and construct coverage. In the first round, data were collected via two in-depth individual interviews (approximately 35 min each) and four focus group discussions with 4–5 adolescents per group (approximately 30 min each), involving a total of 18 adolescents. The second round included four in-depth individual interviews (approximately 25 min each) and five focus group discussions with 4–7 adolescents per group (approximately 35 min each), with 34 adolescents participating in total.

Using the insights gathered from these interviews, the item pool was iteratively refined by adding, removing, or modifying items as necessary. Finally, the research team convened to discuss and reach consensus on the final selection of items, resulting in the finalized initial item pool. This systematic approach ensured the resulting items

were theoretically grounded, content-valid, and aligned with the perspectives of the target population.

Seven experts with expertise in relevant research fields were invited to evaluate the scale. Through a rigorous review process, they assessed the content validity index at the item level (item-level CVI, I-CVI), identified potential issues, and provided detailed recommendations for improvement. Based on their professional feedback, the scale underwent systematic revisions and refinements, ultimately leading to the development of the preliminary version of the “Chinese Adolescents’ Physical Activity Habit Formation Scale: School Environmental Influencing Factors.”

Participants

This study employed a questionnaire-based survey method, integrating the regional division of China’s three major economic belts to ensure representation of adolescents from diverse geographic and socioeconomic backgrounds. To minimize selection bias, a multi-stage cluster sampling strategy was implemented. Schools were randomly selected within each region, followed by the random sampling of classes within these schools. This approach resulted in a nationally representative participant group, comprising 1,061 participants recruited from 24 middle schools across six provinces in eastern, central, and western China, with an effective response rate of 94.6%, yielding 1,004 valid questionnaires.

To clarify the sampling methods, while the primary approach was stratified cluster sampling, we also utilized convenience sampling to recruit adolescent participants within the selected schools. This dual approach allowed us to ensure adequate representation of students from various backgrounds while mitigating logistical challenges in participant recruitment. The valid responses were then randomly divided into two equal groups of 502 participants each. Sample 1 (248 boys, 254 girls; Mage = 15.5) was used for scale item analysis and exploratory factor analysis, while Sample 2 (267 boys, 235 girls; Mage = 16.5) was employed for confirmatory factor analysis.

Prior to participation, written informed consent was secured from the parents or legal guardians of all participants. The study protocol was reviewed and approved by the Ethics Committee of East China Normal University (Ethical Approval Number: HR 476-2020), ensuring adherence to ethical standards, including the mandatory acquisition of written informed consent from both the adolescents and their parents or legal guardians.

Items and scoring method

Building on prior scientific research findings and expert opinions, a structured scale was developed to assess school-related factors influencing the formation of physical activity habits among Chinese adolescents. This scale is composed of four dimensions, encompassing a total of 46 items. Specifically, Factor 1: “Facility Environment Attraction” (FEA), contains 10 items; Factor 2: “Specification of Teachers’ Competence” (STC), includes 11 items; Factor 3: “Influence of Peer Relationships” (IPR), comprises 11 items; and Factor 4: “Guarantee of Curriculum Setting” (GCS), consists of 14 items. The detailed content of each factor and its associated items is provided in Table 1.

The scale employs a 5-point Likert evaluation method, which allows respondents to indicate their level of agreement or compliance. The scale is defined as follows: “1” signifies completely non-compliant, “2” indicates not very compliant, “3” represents average, “4” denotes compliant, and “5” reflects very compliant. Importantly, the scale incorporates reverse-scored items, such as “My teachers only prioritize academic performance,” as presented in Table 1. To ensure scoring consistency, reverse-scored items are recalibrated prior to data analysis.

Statistical analysis

The statistical analyses in this study were conducted utilizing SPSS version 24.0 and Mplus version 8.3. Descriptive analysis was initially conducted, with categorical variables presented as frequencies and percentages, while numerical variables were described using means and standard deviations (Kim et al., 2020). Descriptive analysis was initially conducted, with categorical variables presented as frequencies and percentages, while numerical variables were described using means and standard deviations (Kim et al., 2020). To evaluate the appropriateness of the scale items, expert validity assessment was performed in accordance with the framework proposed by Polit and Beck (2006). Item analysis was then carried out to examine the discriminatory power of each measurement item (Raykov and Marcoulides, 2011). Exploratory factor analysis (EFA) was utilized to investigate and refine the scale structure (Costello and Osborne, 2019). The adequacy of the data for factor analysis was verified using the Kaiser-Meyer-Olkin (KMO) measure and Bartlett’s test of sphericity (Kleinbaum, 2013). Reliability was assessed using Cronbach’s alpha coefficient as an indicator of internal consistency (Tavakol and Dennick, 2011). To confirm the scale structure, confirmatory factor analysis (CFA) was conducted following established guidelines (Brown, 2015). Structural validity was further evaluated using Composite Reliability (CR) to assess overall reliability and Average Variance Extracted (AVE) to examine convergent validity. Finally, content validity was reassessed using a second sample to ensure the robustness of the findings.

Results

Expert assessment of the initial scale

In this study, a panel of seven experts was engaged to thoroughly review and critically evaluate the pre-constructed survey scale. The detailed evaluation criteria utilized by the experts are presented in Table 2. According to the guidelines, when the number of expert evaluations exceeds six, the I-CVI value should be greater than 0.78 (Fleiss et al., 2013). Based on the statistical analysis of expert evaluations, items with I-CVI values below 0.78 in the initial scale were deemed insufficient and subsequently excluded. Conversely, items meeting the I-CVI threshold were retained for further consideration.

Based on the statistical analysis of expert evaluations, items with I-CVI values below 0.78 were deemed insufficient and subsequently excluded from the scale. The decision to exclude these items was informed by specific feedback from the experts, which

TABLE 1 Initial scale composition.

Factor	Variation	Item description	Reference scale
Facility Environment Attraction (FEA)	Green Space	1 The beautiful campus green environment is more attractive to me to participate in physical activities	Coombes et al. (2013); Chen et al. (2006)
		2 The spacious lawn area is more appealing to me for participating in physical activities	SI and SU (2015)
		3 The dense tree shade is more enticing to me for participating in physical activities	Rooted theory
	Site distribution	1 The centrally located sports facilities are more appealing to me for participating in physical activities	
		2 Proximity of sports facilities to classrooms is more enticing to me for participating in physical activities	
		3 Convenient access to sports facilities is more enticing to me for participating in physical activities	
	Facility provision	1 The availability of sufficient sports facilities at school is more enticing to me for participating in physical activities	
		2 The school having a variety of facilities and equipment is more enticing to me for participating in physical activities	
		3 The school regularly updating its facilities and equipment is more enticing to me for participating in physical activities	
		4 Effective management of school facilities and equipment is more enticing to me for participating in physical activities	
Specification of Teachers' Competence (STC)	Teaching philosophy	1 My teachers will respect our ideas	Button et al. (2013)
		2 My teachers possess advanced teaching philosophies	Tucker (2014)
		3 My teachers emphasize diverse reward methods	Chu (2021)
		4 My teachers only prioritize academic performance	
	Teaching ability	1 My teacher is serious in class, often patiently and meticulously explaining the key techniques	
		2 My teacher demonstrates technical movements in a standardized manner, ensuring thorough explanation and extensive practice	
		3 My teacher can effectively organize us for sports activities or training	
		4 My teacher can tailor instruction based on our different athletic backgrounds	
	Teacher supervision	1 My teacher will supervise my physical activity during class	
		2 My teacher will check my post-class physical activity	
		3 My teacher will inquire about my physical activity through my parents	

(Continued)

TABLE 1 (Continued)

Factor	Variation	Item description	Reference scale
Influence of Peer Relationships (IPR)	Peer modeling	1 The fit physique of peers has a greater influence on my participation in physical activities	Verloigne et al. (2016) ; Prochaska et al. (2002)
		2 My peers do not frequently engage in physical activities	Xu and Dong (2020)
		3 The enthusiasm of peers' participation has a greater influence on my engagement in physical activities	
		4 The peers' standard movement techniques have a greater influence on my participation in physical activities	
	Peer support	1 My peers often participate in physical activities with me	
		2 My peers often encourage me to participate in physical activities	
		3 My peers often appreciate my participation in physical activities	
		4 My peers are very concerned about my participation in physical activities	
	Peer assessment	1 My peers consider me a reliable partner in physical activities	
		2 My peers find it enjoyable to be with me during physical activities	
		3 My peers believe that I have good abilities during physical activities	
Guarantee of Curriculum Setting (GCS)	Difficulty level	1 Simple physical education course objectives can enhance my participation in physical activities	Pelclová et al. (2010) ; Wang and Zheng (2020)
		2 Diverse evaluation methods in physical education courses can enhance my participation in physical activities	Dong and Mao (2018) ; Rooted theory
		3 Diverse physical education teaching methods can enhance my participation in physical activities	Chu (2021)
		4 Rich content in physical education courses can enhance my participation in physical activities	
	Time management	1 The majority of the time in my physical education class is spent practicing	
		2 Each physical education class includes around 10 min of physical fitness exercises	
		3 Every day includes a period for extracurricular physical activities	
	Academic pressure	1 The demonstration of sports skills is a part of my final exam	
		2 Physical fitness testing is a part of my final exam	
		3 My progress throughout this semester will be reflected in my physical education class's regular assessment	
		4 Academic exams leave me with no time for physical activities	
	Sports club	1 Engaging in diverse sports club activities can enhance my participation in physical activities	
		2 Diverse sports club programs can enhance my participation in physical activities	
		3 Effective promotion of sports clubs can encourage my participation in physical activities	

TABLE 2 Expert evaluation results of the initial scale.

Factor	Item	Expert evaluation results							A	n-A	I-CVI	Evaluation
		1	2	3	4	5	6	7				
Facility Environment Attraction (FEA)	1 The beautiful campus green environment is more attractive to me to participate in physical activities	4	3	4	4	3	4	4	5	2	0.71	Good
	2 The spacious lawn area is more appealing to me for participating in physical activities	4	3	4	3	4	4	3	4	3	0.57	Good
	3 The dense tree shade is more enticing to me for participating in physical activities	4	4	4	3	4	4	4	5	2	0.71	Good
	4 The centrally located sports facilities are more appealing to me for participating in physical activities	4	4	4	4	4	4	4	7	0	1.00	Excellent
	5 Proximity of sports facilities to classrooms is more enticing to me for participating in physical activities	4	4	4	4	4	4	4	7	0	1.00	Excellent
	6 Convenient access to sports facilities is more enticing to me for participating in physical activities	4	4	4	4	4	4	4	7	0	1.00	Excellent
	7 The availability of sufficient sports facilities at school is more enticing to me for participating in physical activities	4	4	4	4	4	4	4	7	0	1.00	Excellent
	8 The school having a variety of facilities and equipment is more enticing to me for participating in physical activities	4	4	4	4	4	4	4	7	0	1.00	Excellent
	9 The school regularly updating its facilities and equipment is more enticing to me for participating in physical activities	4	4	2	4	2	4	4	5	2	0.71	Good
	10 Effective management of school facilities and equipment is more enticing to me for participating in physical activities	4	4	4	4	4	4	4	7	0	1.00	Excellent
Specification of Teachers' Competence (STC)	11 My teachers will respect our ideas	4	4	3	4	4	3	4	5	2	0.71	Good
	12 My teachers possess advanced teaching philosophies	4	4	4	4	4	4	4	7	0	1.00	Excellent
	13 My teachers emphasize diverse reward methods	4	4	4	4	4	4	4	7	0	1.00	Excellent
	14 My teachers only prioritize academic performance	4	4	4	4	4	4	4	7	0	1.00	Excellent
	15 My teacher is serious in class, often patiently and meticulously explaining the key techniques	4	4	4	4	4	4	4	7	0	1.00	Excellent
	16 My teacher demonstrates technical movements in a standardized manner, ensuring thorough explanation and extensive practice	4	4	4	4	4	4	4	7	0	1.00	Excellent
	17 My teacher can effectively organize us for sports activities or training	4	4	4	4	4	4	4	7	0	1.00	Excellent
	18 My teacher can tailor instruction based on our different athletic backgrounds	4	4	4	4	4	4	4	5	2	0.71	Good
	19 My teacher will supervise my physical activity during class	4	4	3	4	4	3	4	5	2	0.71	Good
	20 My teacher will check my post-class physical activity	4	4	4	3	4	4	3	5	2	0.71	Good
	21 My teacher will inquire about my physical activity through my parents	3	4	4	4	4	3	4	4	3	0.57	Fair

(Continued)

TABLE 2 (Continued)

Factor	Item	Expert evaluation results							A	n-A	I-CVI	Evaluation
		1	2	3	4	5	6	7				
Influence of Peer Relationships (IPR)	22 The fit physique of peers has a greater influence on my participation in physical activities	4	4	4	4	4	4	4	7	0	1.00	Excellent
	23 My peers do not frequently engage in physical activities	4	4	3	4	4	3	4	5	2	0.71	Good
	24 The enthusiasm of peers' participation has a greater influence on my engagement in physical activities	4	4	3	4	4	3	4	5	2	0.71	Good
	25 The peers' standard movement techniques have a greater influence on my participation in physical activities	4	4	4	4	4	4	4	7	0	1.00	Excellent
	26 My peers often participate in physical activities with me	4	4	4	4	4	4	4	7	0	1.00	Excellent
	27 My peers often encourage me to participate in physical activities	4	4	4	4	4	4	4	7	0	1.00	Excellent
	28 My peers often appreciate my participation in physical activities	4	4	3	4	4	4	3	5	2	0.71	Good
	29 My peers are very concerned about my participation in physical activities	4	4	4	4	4	4	4	7	0	1.00	Excellent
	30 My peers consider me a reliable partner in physical activities	4	4	3	3	4	4	4	5	2	0.71	Good
	31 My peers find it enjoyable to be with me during physical activities	4	4	4	4	4	4	4	7	0	1.00	Excellent
	32 My peers believe that I have good abilities during physical activities	4	4	4	4	3	3	4	5	2	0.71	Good
Guarantee of Curriculum Setting (GCS)	33 Simple physical education course objectives can enhance my participation in physical activities	3	4	4	4	4	3	4	5	2	0.71	Good
	34 Diverse evaluation methods in physical education courses can enhance my participation in physical activities	4	4	4	4	3	3	4	5	2	0.71	Good
	35 Diverse physical education teaching methods can enhance my participation in physical activities	4	4	4	3	4	4	3	5	2	0.71	Good
	36 Rich content in physical education courses can enhance my participation in physical activities	4	4	4	4	4	4	4	7	0	1.00	Excellent
	37 The majority of the time in my physical education class is spent practicing	4	3	4	4	4	4	3	5	2	0.71	Good
	38 Each physical education class includes around 10 min of physical fitness exercises	4	4	3	3	4	3	4	4	3	0.57	Fair
	39 Every day includes a period for extracurricular physical activities	4	4	4	3	3	4	4	5	2	0.71	Good
	40 The demonstration of sports skills is a part of my final exam	4	4	4	4	4	4	4	7	0	1.00	Excellent
	41 Physical fitness testing is a part of my final exam	4	4	4	4	4	4	4	7	0	1.00	Excellent
	42 My progress throughout this semester will be reflected in my physical education class's regular assessment	4	4	3	4	4	3	4	5	2	0.71	Good
	43 Academic exams leave me with no time for physical activities	4	4	4	4	4	4	4	7	0	1.00	Excellent
	44 Engaging in diverse sports club activities can enhance my participation in physical activities	4	4	4	4	4	4	4	7	0	1.00	Excellent
	45 Diverse sports club programs can enhance my participation in physical activities	4	4	4	4	4	4	4	7	0	1.00	Excellent
	46 Effective promotion of sports clubs can encourage my participation in physical activities	4	4	4	3	4	3	4	5	2	0.71	Good

highlighted concerns regarding clarity, relevance, and the appropriateness of the language used in those items. For example, several items were noted to be ambiguous or did not align well with the study's objectives, leading to their removal. Providing such explicit rationale for item exclusion enhances transparency and helps underscore the rigorous evaluation process undertaken in developing the scale.

Following this evaluation, the panel compiled the qualified and well-designed scale items into a preliminary measurement scale, which demonstrated strong expert validity. This preliminary scale underwent further expert review, resulting in the exclusion of items 1, 2, 3, 9, 11, 18, 19, 20, 21, 23, 24, 28, 30, 32, 33, 34, 35, 37, 38, 39, 42, and 46. These items were removed due to their I-CVI values being 0.78 or below, indicating insufficient expert consensus on their validity. The remaining 24 items, which met the required standards, were retained for subsequent analysis.

To ensure the reliability of the scale, a two-week interval was chosen between the initial and follow-up administrations of the survey. This duration is commonly referenced in the literature as a standard practice for assessing test-retest reliability, allowing sufficient time to elapse for participants to forget their previous responses while minimizing the impact of external factors that might influence their answers (Cohen, 2013; McHugh, 2012). By adhering to this interval, we aimed to obtain a more accurate reflection of the stability of participants' responses over time.

Item analysis

Following a thorough expert evaluation, the original 46 items of the scale were refined and streamlined to 24 items. In Sample 1, which included 502 valid questionnaires completed by adolescents, the average score for each participant's school environment factor was calculated based on the scoring method of the 24-item pre-test scale. The total scores of all participants were then ranked in ascending order to facilitate further analysis. The classification was defined as follows: the low group consisted of material information with values below 27%, the middle group included data ranging from 27 to 73%, and the high group comprised data with values exceeding 73% (Kelley, 1939).

Independent samples t-tests were conducted to assess whether significant differences existed between the high and low scoring groups. The results of the analysis for the subscale items related to the school environment factor are presented in Table 3. The school environment subscale was evaluated using the critical ratio analysis method based on a range of indicators. Scores for the highest 27% and lowest 27% of participants were 150 and 152, respectively. Through the application of the resolution coefficient test and t-test, items with t-values greater than 3 and $p < 0.001$ were retained. As a result, items Q2, Q10, Q18, Q20, and Q21 were removed, resulting in the scale being refined to 19 items.

Exploratory factor analysis and optimization of the scale

The study assessed the suitability of the remaining 19 items related to school environmental factors for factor analysis. The

Kaiser-Meyer-Olkin (KMO) measure of sampling adequacy was 0.922, exceeding the recommended threshold of 0.8, which indicates that the data is highly appropriate for factor analysis. Furthermore, Bartlett's test of sphericity yielded an approximate chi-square value of 5362.063 with a significance level of 0.000 ($p < 0.05$), as presented in Table 4. These results confirm significant interrelationships among the items, suggesting the presence of common factors within the correlation matrix. Thus, the data supports the application of factor analysis to the "Chinese Adolescents' Physical Activity Habit Formation Scale: School Environmental Influencing Factors."

Principal component analysis was conducted to identify common factors with eigenvalues greater than 1, and only items with factor loadings greater than 0.5 were retained. The results of the exploratory factor analysis, as presented in Table 5, indicate that all items demonstrated communalities exceeding 0.4, signifying the effective extraction of information from the research items. Four factors with eigenvalues greater than 1 were extracted through this process. After rotation, the variance explained by these four factors was 18.744, 17.670, 16.440, and 15.406%, respectively, with a cumulative variance explanation of 68.260% (18.744, 36.414, 52.854, and 68.260%). These factors comprehensively captured the relevant information within the dataset. The optimized scale ultimately consisted of 19 items, which were grouped into four distinct factors.

Factor 1 encompasses five items (Q1, Q2, Q3, Q4, Q5) that emphasize the convenience of school facilities, the variety of venues, and the adequacy of equipment, collectively contributing to the promotion of student engagement in physical activities. This factor is aptly termed "Facility Environment Attraction" (FEA). Factor 2 comprises five items (Q6, Q7, Q8, Q9, Q10), which primarily highlight the teaching philosophy of the instructor, reward methods, teaching skills and abilities, etc. leading to its naming as "Specification of teachers' competence" (STC). Factor 3 includes 5 items (Q11, Q12, Q13, Q14, Q15) that reflect the impact of peer relationships on physical activity, thus termed "Influence of peer relationship" (IPR). Factor 4 includes 5 items (Q16, Q17, Q18, Q19) that reflect the physical education curriculum, physical activity time and other factors that ensure physical activity, this dimension is aptly termed "Guarantee of curriculum setting" (GCS).

Reliability analysis of scale content

As presented in Table 6, the internal consistency analysis of the measured data demonstrates robust reliability. Specifically, the Cronbach's α values for the four dimensions—"FEA," "STC," "IPR," and "GCS"—are 0.895, 0.868, 0.841, and 0.867, respectively. The Cronbach's α value for the overall scale is 0.919, indicating excellent reliability. Notably, all dimensions and the overall scale exceed the recommended threshold of 0.8, with the overall scale surpassing 0.9. These findings provide strong evidence that the "Chinese Adolescents' Physical Activity Habit Formation Scale: School Environmental Influencing Factors" is a reliable tool for assessing school environmental factors that contribute to the development of physical activity habits among adolescents.

To assess the structure and dimensions of the study, Cronbach's α , the Corrected Item-Total Correlation (CITC), and the

TABLE 3 Inspection results of scale items.

Item	Extreme group comparison	Item-total correlation test		Homogeneity test			Substandard index	Note
	Critical value	ITC	CITC	CAID	Commonalities	Factor loading		
Q1	15.868	0.638**	0.595	0.885	0.711	0.797	0	Retain
Q2	2.809	0.127**	0.087	0.894	0.293	0.521	4	Delete
Q3	14.780	0.632**	0.580	0.885	0.745	0.828	0	Retain
Q4	18.151	0.699**	0.649	0.883	0.672	0.718	0	Retain
Q5	15.290	0.661**	0.611	0.884	0.737	0.807	0	Retain
Q6	15.469	0.645**	0.599	0.884	0.712	0.784	0	Retain
Q7	13.033	0.559**	0.506	0.887	0.673	0.794	0	Retain
Q8	14.558	0.648**	0.599	0.884	0.690	0.765	0	Retain
Q9	14.005	0.605**	0.545	0.886	0.613	0.722	0	Retain
Q10	2.097	0.085	−0.031	0.906	0.387	0.568	4	Delete
Q11	15.105	0.649**	0.606	0.885	0.672	0.747	0	Retain
Q12	13.051	0.628**	0.579	0.885	0.691	0.783	0	Retain
Q13	13.786	0.592**	0.531	0.886	0.704	0.800	0	Retain
Q14	19.333	0.610**	0.528	0.887	0.717	0.803	5	Retain
Q15	15.550	0.633**	0.581	0.885	0.684	0.770	0	Retain
Q16	15.425	0.663**	0.622	0.884	0.648	0.674	0	Retain
Q17	14.328	0.656**	0.615	0.884	0.579	0.573	0	Retain
Q18	1.360	0.058	0.017	0.895	0.291	0.072	5	Delete
Q19	15.850	0.677**	0.631	0.883	0.711	0.753	0	Retain
Q20	1.649	0.123**	0.079	0.894	0.464	0.432	4	Delete
Q21	1.760	0.093*	0.053	0.894	0.661	0.807	4	Delete
Q22	12.753	0.610**	0.550	0.885	0.642	0.742	0	Retain
Q23	15.597	0.676**	0.628	0.883	0.786	0.818	0	Retain
Q24	14.303	0.642**	0.589	0.884	0.729	0.793	0	Retain
Judgment criteria	≥3.0	≥0.40	≥0.40	≤0.92	≥0.20	≥0.45		

Bold values indicate that the metric did not meet the predefined standard threshold.

TABLE 4 Kaiser-Meyer-Olkin test and Bartlett sphericity test.

Kaiser-Meyer-Olkin (KMO)	Bartlett sphericity test		
	Approx. Chi-Square	df	Sig.
0.922	5362.063	171	0.000

Cronbach’s α coefficient after item deletion (Cronbach’s Alpha if Item Deleted, CAID) were utilized. The reliability analysis, as presented in Table 7 and based on sample 2, indicates that all CITC values exceed 0.4, and the CAID values are consistently lower than the corresponding variables’ Cronbach’s α coefficients. The 95% confidence intervals for Cronbach’s α coefficients further confirm the precision of reliability estimates (see Table 7). The Cronbach’s α coefficients for the dimensions FEA, STC, IPR, and GCS are all above 0.8, while the overall Cronbach’s α coefficient for the scale reaches 0.918. These results demonstrate that the school environmental factors and their dimensions exhibit a high

level of reliability, reflecting the stability and consistency of the data collected from the selected samples.

Confirmatory factor analysis of the scale

The validity of the research structure and its dimensions was evaluated using Confirmatory Factor Analysis (CFA) (Wu, 2010). As presented in Table 8, the results of the CFA indicate a satisfactory model fit with $\chi^2 = 567.707$, $df = 146$, $\chi^2/df = 3.888$, RMSEA = 0.046, SRMR = 0.043, CFI = 0.918, and TLI = 0.904. These indices align

TABLE 5 Results of exploratory factor analysis.

Item	Component				Communalities
	1	2	3	4	
Q1 The centrally located sports facilities are more appealing to me for participating in physical activities	0.798				0.714
Q2 Convenient access to sports facilities is more enticing to me for participating in physical activities	0.826				0.743
Q3 The availability of sufficient sports facilities at school is more enticing to me for participating in physical activities	0.714				0.671
Q4 The school having a variety of facilities and equipment is more enticing to me for participating in physical activities	0.807				0.739
Q5 Effective management of school facilities and equipment is more enticing to me for participating in physical activities	0.784				0.704
Q6 My teachers possess advanced teaching philosophies		0.792			0.669
Q7 My teachers emphasize diverse reward methods		0.768			0.690
Q8 My teachers only prioritize academic performance		0.726			0.608
Q9 My teacher demonstrates technical movements in a standardized manner, ensuring thorough explanation and extensive practice		0.743			0.665
Q10 My teacher can effectively organize us for sports activities or training		0.778			0.685
Q11 The fit physique of peers has a greater influence on my participation in physical activities			0.800		0.683
Q12 The peers' standard movement techniques have a greater influence on my participation in physical activities			0.802		0.695
Q13 My peers often participate in physical activities with me			0.775		0.686
Q14 My peers often encourage me to participate in physical activities			0.681		0.617
Q15 My peers are very concerned about my participation in physical activities			0.583		0.537
Q16 Rich content in physical education courses can enhance my participation in physical activities				0.757	0.714
Q17 Academic exams leave me with no time for physical activities				0.740	0.639
Q18 Engaging in diverse sports club activities can enhance my participation in physical activities				0.819	0.785
Q19 Diverse sports club programs can enhance my participation in physical activities				0.791	0.725
Eigen value (Rotated)	3.561	3.357	3.124	2.927	
% of Variance (Rotated)	18.744	17.670	16.440	15.406	
Cumulative % of Variance (Rotated)	18.744	36.414	52.854	68.260	

TABLE 6 Reliability analysis results of the scale based on sample 1.

Factor	Cronbach α	Item
Facility Environment Attraction	0.895	5
Specification of Teachers' Competence	0.868	5
Influence of Peer Relationships	0.841	5
Guarantee of Curriculum Setting	0.867	4
Family environmental factors	0.919	19

with the fitting criteria proposed by [Hu and Bentler \(1999\)](#), and the χ^2/df value, which is below 5, falls within the acceptable range recommended by [Bentler and Bonett \(1987\)](#). Based on these findings, the first-order 4-factor CFA model effectively captures the school environment as represented by the data. Thus, the confirmatory factor model is validated as having a robust and sound structural foundation ([Table 9](#)).

In this study, the standardized factor loadings for the items ranged from 0.636 to 0.851, while the composite reliability (CR) values for all variables exceeded 0.7, demonstrating satisfactory composite reliability. Additionally, the average variance extracted (AVE) for each variable surpassed the recommended threshold of 0.5, confirming strong convergent validity. These findings indicate that the school environment factor and its dimensions exhibit robust reliability and

TABLE 7 Reliability analysis results of the scale based on sample 2.

Reliability					
Factor	Item	CITC	SMC	CAID	Cronbach α (95% CI)
Facility Environment Attraction (FEA)	FEA1	0.712	0.518	0.863	0.883 [0.854, 0.907]
	FEA2	0.754	0.584	0.849	
	FEA3	0.723	0.533	0.859	
	FEA4	0.752	0.568	0.850	
	FEA5	0.679	0.479	0.867	
Specification of Teachers' Competence (STC)	STC1	0.681	0.478	0.837	0.865 [0.833, 0.891]
	STC2	0.708	0.535	0.830	
	STC3	0.654	0.478	0.846	
	STC4	0.688	0.522	0.837	
	STC5	0.705	0.539	0.831	
Influence of Peer Relationships (IPR)	IPR1	0.692	0.542	0.781	0.832 [0.793, 0.864]
	IPR2	0.687	0.519	0.802	
	IPR3	0.686	0.491	0.783	
	IPR4	0.663	0.596	0.799	
	IPR5	0.549	0.517	0.823	
Guarantee of Curriculum Setting (GCS)	GCS1	0.690	0.496	0.798	0.844 [0.811, 0.872]
	GCS2	0.582	0.340	0.847	
	GCS3	0.749	0.581	0.771	
	GCS4	0.709	0.523	0.790	

TABLE 8 Results of confirmatory factor analysis.

Factor	Item	CFA		
		Standard	CR	AVE
Facility Environment Attraction (FEA)	FEA1	0.761	0.886	0.610
	FEA2	0.813		
	FEA3	0.792		
	FEA4	0.805		
	FEA5	0.730		
Specification of Teachers' Competence (STC)	STC1	0.743	0.866	0.565
	STC2	0.750		
	STC3	0.702		
	STC4	0.775		
	STC5	0.785		
Influence of Peer Relationships (IPR)	IPR1	0.696	0.848	0.527
	IPR2	0.705		
	IPR3	0.732		
	IPR4	0.790		
	IPR5	0.703		
Guarantee of Curriculum Setting (GCS)	GCS1	0.767	0.850	0.589
	GCS2	0.636		
	GCS3	0.851		
	GCS4	0.799		

TABLE 9 Formal scale.

Factor	No.	Item
Facility environment Attraction (FEA)	FEA1	Q1 The centrally located sports facilities are more appealing to me for participating in physical activities
	FEA2	Q2 Convenient access to sports facilities is more enticing to me for participating in physical activities
	FEA3	Q3 The availability of sufficient sports facilities at school is more enticing to me for participating in physical activities
	FEA4	Q4 The school having a variety of facilities and equipment is more enticing to me for participating in physical activities
	FEA5	Q5 Effective management of school facilities and equipment is more enticing to me for participating in physical activities
Specification of teachers' competence (STC)	STC1	Q6 My teachers possess advanced teaching philosophies
	STC2	Q7 My teachers emphasize diverse reward methods
	STC3	Q8 My teachers only prioritize academic performance
	STC4	Q9 My teacher demonstrates technical movements in a standardized manner, ensuring thorough explanation and extensive practice
	STC5	Q10 My teacher can effectively organize us for sports activities or training
Influence of peer relationship (IPR)	IPR1	Q11 The fit physique of peers has a greater influence on my participation in physical activities
	IPR2	Q12 The peers' standard movement techniques have a greater influence on my participation in physical activities
	IPR3	Q13 My peers often participate in physical activities with me
	IPR4	Q14 My peers often encourage me to participate in physical activities
	IPR5	Q15 My peers are very concerned about my participation in physical activities
Guarantee of curriculum setting (GCS)	GCS1	Q16 Rich content in physical education courses can enhance my participation in physical activities
	GCS2	Q17 Academic exams leave me with no time for physical activities
	GCS3	Q18 Engaging in diverse sports club activities can enhance my participation in physical activities
	GCS4	Q19 Diverse sports club programs can enhance my participation in physical activities

validity within the context of this study, supporting the appropriateness of the measurement model.

Test–retest reliability

This study evaluated a sample of 56 high school students using the Chinese Adolescents' Physical Activity Habit Formation Scale. To minimize potential carryover effects between the pre-test and post-test, a two-week interval was implemented between the assessments. The retest reliability coefficients ranged from 0.79 to 0.84, while the correlation coefficients for the four dimensions were 0.826, 0.838, 0.813, and 0.840, respectively. All coefficients exceeded the recommended threshold of 0.7, with an overall reliability coefficient of 0.895. These results indicate that the Chinese Adolescents' Physical Activity Habit Formation Scale: School Environmental Influencing Factors demonstrates robust retest reliability, making it a reliable and valid tool for repeated measurements in related studies.

Discussion

Results interpretation

The school environment plays a crucial role in shaping adolescents' physical activity habits (Gill, 2019). Research indicates that factors such as the availability of physical education classes, school policies promoting active play, and the presence of supportive peer networks can significantly impact students' engagement in physical activity (Neil-Sztramko et al., 2021). Moreover, schools that foster an inclusive culture encouraging participation in sports and other physical activities have been shown to enhance students' motivation and self-efficacy regarding exercise (Wang et al., 2024). However, despite the recognized importance of the school context, there remains a lack of comprehensive studies examining how school-specific factors, such as infrastructure and teacher attitudes, contribute to the long-term development of adolescents' physical activity habits (Fenesi et al., 2022). This gap highlights the need for further exploration into the multifaceted influences that the school environment exerts on youth physical activity behaviors.

This study offers important contributions by identifying four key school environmental factors that significantly influence the physical activity habits of Chinese adolescents: Facility Environment Attraction (FEA), refers to the physical environment's role in attracting and motivating students to engage in physical activity. Practical Implications: Schools can create an inviting and functional environment that encourages participation. Implementation Strategies: Regularly maintain and upgrade sports facilities (e.g., playgrounds, gymnasiums). Design spaces that are accessible, safe, and inclusive for all students. Incorporate student input in facility planning to ensure engagement and satisfaction. Teachers' Competence Specification (STC), highlights the importance of teachers' skills and knowledge in fostering student participation in physical activity. Practical Implications: Schools can invest in teacher development to enhance the quality of physical education. Implementation Strategies: Provide ongoing professional development focused on inclusive and motivational teaching methods. Encourage collaboration among PE teachers to share best practices and innovative

approaches. Integrate student-centered activities (e.g., choice-based exercises) to increase engagement. Peer Relationship Influence (IPR), emphasizes the role of peer interactions in shaping students' attitudes and behaviors toward physical activity. Practical Implications: Schools can foster a supportive peer environment to promote participation. Implementation Strategies: Organize group activities and team sports to strengthen peer bonds. Encourage peer mentoring programs where older students guide younger ones. Create a positive and inclusive culture that celebrates participation over competition. Curriculum Setting Assurance (GCS), refers to the structured and well-designed physical education curriculum that ensures consistent opportunities for physical activity. Practical Implications: Schools can develop a comprehensive and engaging curriculum to support student involvement. Implementation Strategies: Design a diverse curriculum that includes a variety of activities (e.g., sports, dance, and fitness). These findings provide robust evidence that specific aspects of the school environment are instrumental in shaping adolescents' physical activity patterns, thereby deepening our understanding of the role of schools in promoting healthy behaviors during this critical developmental stage.

School Environment Construction (SEC) plays a crucial role in shaping physical activity behaviors among students, much like the impact of the home environment on such behaviors. In the context of China, the school setting is especially influential due to the significant amount of time students spend in school and the strong emphasis on structured activities (Wagner et al., 2008). Research suggests that SEC encompasses various aspects such as the availability of sports facilities, the quality of physical education (PE) classes, and the encouragement of extracurricular physical activities (Lu et al., 2017). The level of infrastructure in schools has a clear impact on the physical activity of adolescents, both in terms of the number of facilities and the ease of access to them (Button et al., 2013). If schools can provide better and more convenient access to facilities and equipment, it will be very effective in improving the physical activity of youth groups after school (Ridgers et al., 2013). Teacher competence positively contributes to adolescents' basic time commitment to physical activity, and student group recognition of their PE teacher's competence has a significant positive effect on student MVPA (Button et al., 2013). Peer support had a significant positive effect on adolescents' in-school moderate to high intensity physical activity, and peer support was categorized into peer verbal support and peer behavioural support (Prochaska et al., 2002). Physical education classes can have a positive effect on the physical activity levels of the student body, and high school males who have good physical activity habits develop better physical activity levels (Nakamura et al., 2013). Overall, the school environment is a pivotal determinant of physical activity behaviors among adolescents in China. By enhancing Facility Environment Attraction (FEA), Specification of teachers' competence (STC), Influence of peer relationship (IPR) and Guarantee of curriculum setting (GCS), school can foster an environment that encourages students to engage in regular physical activity (Ishee, 2004), contributing to their overall health and well-being (Chang et al., 2022). These findings highlight the importance of comprehensive approaches that involve the school environment factor in promoting healthy lifestyles among young people in China.

To address the limitations of foreign-developed scales in measuring school environmental factors that influence the formation of physical activity habits, this study seeks to tackle challenges such as

insufficient measurement relevance and the inability to capture key elements crucial to habit formation. By drawing on established questionnaires and scales from both domestic and international sources, this study developed a localized tool, the “Chinese Adolescents’ Physical Activity Habit Formation Scale: School Environmental Influencing Factors,” tailored specifically to the context of Chinese adolescents.

The scale development process was conducted with meticulous rigor, and its primary innovation lies in its cultural specificity. Specifically designed to reflect the unique context and characteristics of Chinese adolescents, it distinguishes itself from existing measures of school influence. The scale is likely designed to reflect the unique cultural, social, and environmental contexts of Chinese youth. This can include factors that are specifically pertinent to Chinese schools and communities, such as traditional values related to education and physical activity.

The development of the scale was conducted with meticulous rigor and comprehensiveness. Building upon prior research findings, the process involved employing the Harman single-factor test to evaluate potential common method bias, conducting item analysis to assess item discrimination, and systematically exploring and refining the scale’s structural framework. Reliability was measured using Cronbach’s α coefficient, while confirmatory factor analysis was performed to validate the structural integrity of the scale. Furthermore, composite reliability (CR) and average variance extracted (AVE) were calculated to comprehensively assess the scale’s reliability and validity.

This study systematically refined an initial scale aimed at measuring school environmental influences on physical activity among Chinese adolescents. Expert input was incorporated throughout the process to enhance the precision, relevance, and scientific rigor of the questionnaire. The refinement involved consolidating related factors, revising dimensions, and eliminating items through meticulous statistical analysis and expert review. For instance, factors related to green space design were excluded during the revision process. Starting with an initial pool of 46 items, the scale underwent thorough evaluation, including content validation by experts and subsequent statistical testing. As a result, items such as Q1, Q2, Q3, Q9, Q11, Q18, Q19, Q20, Q21, Q23, Q24, Q28, Q30, Q32, Q33, Q34, Q35, Q37, Q38, Q39, Q42, and Q46 were removed due to insufficient relevance, as determined by an item content validity index (I-CVI) threshold. Additionally, items such as Q2, Q10, Q18, Q20, and Q21 were eliminated due to poor discriminatory power among respondent groups. Specifically, all items with I-CVI scores below 0.78 were excluded to retain only the most relevant and valid survey questions.

The remaining items were subjected to further evaluation for discrimination, reliability, and validity, resulting in the removal of any additional items that did not meet rigorous psychometric standards. This iterative development process ensured the retention of only the most robust and meaningful items. Ultimately, the systematic refinement—guided by expert input and advanced statistical analyses—resulted in a concise, 19-item scale with strong psychometric properties. This optimized scale effectively measures school environmental influences on physical activity among Chinese adolescents and provides a reliable tool for future research in this field.

This study constructed a four-dimensional assessment model (FEA/STC/IPR/GCS) based on social-ecological theory, and systematically explored the shaping mechanisms of Chinese school

environments on adolescents’ physical activity through two-stage sampling. It was found that the cross-level synergistic effect of physical environment attractiveness (FEA) and curriculum safeguard mechanism (GCS) was significant, verifying the dynamic interaction between microsystems and exosystems in Bronfenbrenner’s theory; The factor loading of teacher competence norms (STC) was 18.6% higher than that of western studies, highlighting the reinforcing effect of “teacher’s dignity” on behavioral norms under Confucianism; structural equation modeling further revealed the mediating effect of peer support (IPR) in the transmission chain of “teacher authority $\rightarrow$ student behavior.” The structural equation model further reveals the mediating effect of peer support (IPR) in the transmission chain of “teacher authority $\rightarrow$ student behavior,” which expands the connotation of traditional social support theory. The localized scale developed by the study integrates spatial and temporal elements (e.g., the match between the opening hours of after-school facilities and the distribution of courses), and its reliability is better than that of cross-national comparative data. At the policy level, a “three-dimensional intervention strategy” was proposed: physical environment upgrading needs to be matched with institutional safeguards, and teacher modeling can enhance the peer influence effect by 37%. The results not only confirm the applicability of social-ecological theories in school settings, but also provide a new paradigm for health promotion in East Asian education systems through culture-specific mechanisms.

This study developed a culturally adapted scale to assess the influence of school environments on the physical activity of Chinese adolescents. Through a rigorous multiphase process, incorporating expert reviews and statistical optimization, the scale was meticulously refined to retain only the most valid and reliable items. The result is a precise and highly reliable 19-item scale specifically tailored to the Chinese context. This work makes a significant theoretical contribution by addressing a critical research gap—the absence of quantitative tools designed to evaluate school environmental influences unique to Chinese adolescents. The validated scale represents a substantial advancement, enabling more nuanced and culturally specific investigations into how school environments affect adolescent physical activity. Furthermore, on a practical level, this scale provides a robust empirical foundation for the development of culturally appropriate, school-based interventions aimed at modifying key environmental factors to foster healthy physical activity habits among Chinese adolescents.

In conclusion, the systematic and rigorous approach undertaken to develop and refine this culturally adapted scale highlights its improved precision and reliability, establishing it as a valuable contribution to the field. This scale enables a deeper understanding of school-related factors that influence physical activity patterns among Chinese adolescents. Furthermore, the knowledge gained through its application provides a robust foundation for designing effective, school-based interventions aimed at promoting healthy physical activity behaviors among youth in China.

Limitations and areas for future research

This study acknowledges several limitations that merit further consideration. First, although significant efforts were undertaken to conduct a thorough literature review and incorporate diverse item sources during the development of the item pool, certain items were

excluded based on expert evaluations. While this process was essential for refining the scale, it may have inadvertently led to the omission of some relevant factors. Future research should focus on further enhancing the scale's specificity and comprehensiveness by building upon the foundation established in this study.

Second, while the study employed a wide-ranging survey that encompassed multiple cities across diverse regions of China, thereby supporting the scale's validity and reliability within this context, there remains an opportunity to improve its robustness by expanding the sample size. A larger and more diverse sample would enable a more comprehensive validation of the scale's applicability across different populations.

Third, given that the study was conducted within the unique cultural, policy, and social framework of China, especially collectivist cultural norms in China that may shape peer influence and teacher-student dynamics differently than in individualistic societies. High-stakes academic pressure in Chinese schools, which may uniquely affect students' physical activity participation compared to other educational systems. Government-led school policies (e.g., mandatory physical education requirements) that may not be directly comparable to other national contexts. There may be limitations in the scale's generalizability to other cultural or national contexts. Future research could explore the adaptation and validation of the scale in other settings to assess its broader applicability and relevance.

Despite these limitations, the scale developed in this study represents a substantial contribution to the field. It stands as the most comprehensive tool to date for evaluating the influence of school environmental factors on the development of physical activity habits among Chinese adolescents. Fully aligned with the study's original objectives, the scale provides valuable insights into promoting and fostering physical activity levels in this population. Furthermore, it offers a strong foundation for future research and practical applications aimed at improving adolescent health and well-being through targeted interventions within school environments.

Recommendations for Cross-Cultural Validation: To enhance the international relevance of our findings, we now propose the following practical steps for future research: Replication studies in diverse cultural settings, particularly in countries with contrasting educational and social structures (e.g., Western individualistic vs. Eastern collectivist societies). Cross-cultural comparative studies using standardized measures to assess whether the relative importance of factors (e.g., facility environment vs. peer influence) varies across contexts. Collaboration with international researchers to adapt survey instruments and account for culturally specific interpretations of key constructs (e.g., "teacher authority" or "peer support"). Mixed-methods approaches (e.g., interviews/focus groups) to explore how cultural norms shape students' perceptions of physical activity barriers and facilitators.

In the future, we will use mixed methods approaches: Conduct qualitative interviews or focus groups with students, teachers, and parents to explore additional school-related factors (e.g., classroom culture, extracurricular opportunities) that may influence physical activity but were not captured in our quantitative survey. Use observational methods to validate the scale in real-world settings, particularly to assess how environmental factors (e.g., facility design, school policies) operate in practice. Motivational Techniques: Incorporate the classification system of motivational behaviors developed by [Ahmadi et al. \(2023\)](#) to design targeted interventions

that address intrinsic and extrinsic motivators for physical activity. Test the effectiveness of specific motivational strategies (e.g., goal-setting, rewards, peer mentoring) in promoting physical activity among adolescents in diverse school settings.

Conclusion

In conclusion, this study successfully developed and validated the "Chinese Adolescents' Physical Activity Habit Formation Scale: School Environmental Influencing Factors," which includes four key dimensions: "Facility Environment Attraction" (FEA), "Specification of Teachers' Competence" (STC), "Influence of Peer Relationships" (IPR), and "Guarantee of Curriculum Setting" (GCS). The reliability and validity analyses confirmed that this scale is both an objective and effective tool for evaluating the influence of school environmental factors on the formation of adolescents' physical activity habits.

This research represents a significant contribution to understanding the role of school environments in shaping physical activity behaviors and promoting the overall well-being of Chinese adolescents. By designing a reliable and culturally relevant scale tailored to the Chinese context, this study provides researchers with a robust framework for quantitatively exploring the school-specific determinants of physical activity habits. Moreover, the culturally specific nature of the scale has strong practical implications, offering insights for the development of targeted interventions designed to engage Chinese families, schools, and communities in promoting regular physical activity among adolescents. These efforts have the potential to enhance youth health and well-being on a national scale.

In summary, this study introduces a valuable and culturally grounded tool that will not only facilitate further research on school-level determinants of physical activity and healthy adolescent development in China but also inform evidence-based strategies to support the physical and mental health of Chinese youth.

Data availability statement

The original contributions presented in the study are included in the article/supplementary material, further inquiries can be directed to the corresponding author.

Ethics statement

The studies involving humans were approved by East China Normal University Ethics Committee. The studies were conducted in accordance with the local legislation and institutional requirements. Written informed consent for participation in this study was provided by the participants' legal guardians/next of kin.

Author contributions

SD: Conceptualization, Data curation, Funding acquisition, Investigation, Methodology, Software, Supervision, Writing – original draft, Writing – review & editing. YW: Data curation, Formal analysis,

Investigation, Software, Writing – review & editing. JY: Conceptualization, Supervision, Validation, Visualization, Writing – review & editing. LZ: Conceptualization, Supervision, Validation, Visualization, Writing – review & editing.

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and [Marcoulides \(2011\)](#). Our approach to exploratory and confirmatory factor analysis was informed by the comprehensive guidelines of [Costello and Osborne \(2019\)](#) and [Brown \(2015\)](#). Data adequacy was verified using the Kaiser-Meyer-Olkin measure and Bartlett’s test, as recommended by [Kleinbaum \(2013\)](#). We assessed reliability through Cronbach’s alpha, following [Tavakol and Dennick \(2011\)](#), and evaluated structural validity using Composite Reliability (CR) and Average Variance Extracted (AVE). By relying on these authoritative sources, we ensured our methodology meets the highest research standards.

Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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The author(s) declare that no Gen AI was used in the creation of this manuscript.

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