



OPEN Exploring factors influencing sustainable behaviors in undergraduate students' sports participation through model development and validation

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Sustained participation in sports yields substantial benefits for students, both physically, psychologically, and socially. However, long-term engagement in sports activities remains a persistent challenge in higher education contexts. This study aimed to develop and validate a comprehensive model that identifies and explains the key factors influencing sustainable sports participation behaviors among Chinese undergraduate students. A sequential mixed-methods design was employed. In the qualitative phase, semi-structured interviews were conducted with 13 experts purposively selected for their knowledge in sports education and policy. Thematic analysis identified five core dimensions influencing sports participation: attitudinal, behavioral, environmental, cultural, and technical. Based on these findings, a structured 31-item Likert-scale questionnaire was developed and administered to 384 undergraduate students from the College of Physical Education and Health at East China Normal University. Quantitative data were analyzed using Partial Least Squares Structural Equation Modeling (PLS-SEM) to validate the model. The instrument demonstrated strong content validity (CVR = 0.99; CVI = 0.99) and internal consistency (Cronbach's $\alpha = 0.88$). PLS-SEM results confirmed the model's structural integrity, with attitude and environmental support emerging as the most influential predictors of sustained participation. Additionally, technical skills and cultural perceptions played mediating roles in facilitating long-term sports engagement. This study presents a theoretically and empirically grounded model for understanding sustainable sports participation among undergraduate students in China. The findings underscore the importance of developing multidimensional, context-sensitive strategies to promote long-term participation in sports. For practice, the study suggests tailored institutional interventions that enhance environmental support and promote positive cultural attitudes toward physical activity. For research, it advocates cross-cultural replication and longitudinal investigations to generalize and extend the model's applicability.

Keywords Sustainable behaviors, Sports participation, Mixed-methods, Student engagement, PLS-SEM, China

Participation in sports is a key indicator of well-being in contemporary society. Physical activity benefits mental and social well-being, functional ability, and overall quality of life, while also reducing the risk of coronary artery disease and certain types of cancer¹. Exercise refers to any bodily movement generated by skeletal muscles that results in energy expenditure². In contrast, physical inactivity presents a major public health concern, contributing to obesity, hypertension, diabetes, back pain, reduced joint mobility, and psychosocial complications³. In recent decades, physical inactivity has been increasingly recognized as one of the leading modifiable risk factors for non-communicable diseases, prompting the World Health Organization (WHO) to classify it as a global health crisis⁴.

Populations in both developed and developing nations are increasingly falling short of physical activity guidelines, leading to obesity, a primary risk factor for numerous diseases, notably in countries such as the United States and Australia⁵. Inactivity has been linked to chronic diseases and premature mortality. From

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a public health perspective, encouraging physical activity is critical¹⁶. Evidence suggests that participation in club sports, particularly team sports, enhances social and psychological well-being more significantly than individual physical activities.⁷ Research among adults, adolescents, and children supports the notion that sports participation contributes positively to socio-psychological well-being, although a detailed understanding of institutionalized participation remains limited^{8–13}.

Given the substantial benefits of sports participation, institutionalizing physical activity is essential¹⁴. Enhancing youth participation in school-based activities remains a priority, despite declines in both overall and school-related physical activity levels¹⁵. Many educational institutions have reduced opportunities for student activity¹⁶. Over recent decades, there has been a paradigm shift in addressing student health—from diagnosing and treating infectious diseases to promoting physical health and preventing illness¹⁷. This shift has been reinforced by the increasing prevalence of adolescent mental health concerns, which require a combined physical and psychological health approach^{18,19}.

A sedentary lifestyle has become increasingly prevalent, influenced by both personal and environmental factors^{20,21}. To support active living, it is vital to eliminate both individual and systemic barriers. *Barriers include socioeconomic inequality, lack of access to facilities, gender norms, and inadequate urban planning, all of which require targeted interventions to ensure equitable opportunities for participation²².

Despite recognition of these issues, there remains a research gap in identifying and integrating the determinants of sustainable sports behaviors into actionable frameworks²³. Students, as a large and influential population segment, are critical in fostering active lifestyles as a cultural norm. Moreover, in light of climate change and resource scarcity, the concept of sustainability in sports must now encompass both long-term behavioral engagement and environmental responsibility^{24–26}.

While sports participation yields health and well-being benefits, it can also have environmental impacts through the use of natural resources and pollution²⁴. Prior research has primarily centered on elite sports, with limited attention to grassroots-level organizations²⁵. This study focuses on grassroots sports clubs, primary providers of organized sports that depend on members' environmentally responsible behavior²⁶. Understanding what influences members' sustainable actions is critical. This dual focus—on sustaining participation and minimizing environmental impact—aligns with emerging international sports policy frameworks such as the Kazan Action Plan and the UNESCO Quality Physical Education Guidelines^{33–39}.

Societal stress, mobility poverty, and psychological strain further complicate participation²⁸. Planners increasingly recognize the importance of sports for national unity and societal progress, yet disparities in access to programs and infrastructure highlight persistent “sports poverty”²⁹. This inequity reflects a disconnect between the theoretical and practical aspects of physical education, alongside declining public engagement due to infrastructural and lifestyle shifts³⁰. Thus, holistic planning is needed to address physical activity deficits³¹. Policymakers should focus on scalable models for promoting participation³².

Despite institutional support, coordination gaps remain, impeding program effectiveness³³. Socioeconomic inequality exacerbates these challenges, demanding integration of physical education into broader welfare strategies³⁴. Although the benefits of physical activity are widely acknowledged, obstacles such as limited facilities and cultural norms persist³⁵. To address sports poverty, a comprehensive understanding of socioeconomic and motivational factors is crucial³². Strategic, sustainable investment is key to future development³⁶. Sports integration into national frameworks holds promise for cohesion and development³⁷.

Theoretical background

The present study applies the Theory of Planned Behavior (TPB) as its guiding theoretical framework. TPB, developed by Ajzen⁴⁰, posits that individual behavior is driven by three core components: (1) attitude toward the behavior, reflecting the degree to which a person has a favorable or unfavorable evaluation of the behavior; (2) subjective norms, which capture perceived social pressures to perform or not perform the behavior; and (3) perceived behavioral control, referring to the perceived ease or difficulty of performing the behavior, which is assumed to reflect past experiences and anticipated obstacles⁴⁰.

Within the context of sports participation, TPB has been widely used to predict both initiation and maintenance of physical activity behaviors, as well as pro-environmental actions within sports organizations^{41,42}. Attitude may be shaped by beliefs about the health, social, and environmental benefits of sustained participation; subjective norms may derive from peer, family, and institutional expectations; and perceived behavioral control may be influenced by access to facilities, financial resources, and scheduling flexibility.

Recent applications of TPB in sports research have also incorporated additional constructs, such as moral obligation and environmental concern, to capture sustainability-oriented behaviors better⁴³. This expansion is particularly relevant for grassroots sports clubs, where sustaining member engagement often depends on collective responsibility for facility upkeep, energy use, and resource conservation. By employing TPB, this study aims to integrate both participation-related and environmental dimensions into a single predictive framework. This approach not only strengthens the academic grounding of the proposed model but also facilitates a more robust comparative analysis with existing models of sustainable sports engagement, thereby addressing a key gap in prior research identified by the reviewers.

Research objectives

This study aims to develop and validate a model that identifies the determinants of sustainable sports behavior among undergraduates. Findings may inform interventions that promote participation and environmental responsibility in educational and club settings. Moreover, this research supports SDG 3, which advocates for global well-being through physical activity. By promoting sustainable sports behaviors, this study contributes to the holistic development of students and the advancement of public health. Accordingly, this study poses the following research questions:

1. What factors influence the sustainable behaviors of undergraduate students' sports participation?
2. Does the developed model exhibit acceptable psychometric properties (reliability and validity)?

Research methodology

This study employed a pragmatist philosophical paradigm, which assumes that research questions should determine the methodological choices and that both objective (positivist) and subjective (interpretivist) perspectives can contribute to the generation of valid knowledge. Within this stance, Ajzen's⁴⁰ Theory of Planned Behavior (TPB) is adopted instrumentally—as a problem-solving framework linking modifiable beliefs to intention and behavior—so the theory provides the “what” (which beliefs and pathways to examine) while pragmatism provides the “how” (the most useful methods to answer the questions). Under this paradigm⁴⁴, the study employed a sequential exploratory mixed-methods design, integrating qualitative and quantitative approaches to explore and analyze the factors influencing sustainable participation in student sports. This sequencing mirrors TPB's recommended practice: qualitatively elicit salient behavioral, normative, and control beliefs in the target population, then quantitatively test the attitude/subjective norm/perceived behavioral control → intention → behavior pathways; thus, the philosophical orientation (pragmatism) and the theorist's perspective (TPB) are methodologically aligned. This design was chosen because it allows in-depth exploration of contextual factors in the qualitative phase, followed by quantitative validation of the emergent model, thereby enhancing both theoretical grounding and empirical generalizability. Potential tensions are handled a priori and transparently: if qualitative results indicate under-represented drivers in core TPB (e.g., habit/past behavior, anticipated affect, moral norm, or activity identity), we specify and compare core versus extended TPB models; where belief domains are formative composites (e.g., barriers), we model them formatively rather than forcing reflective specifications; and we use joint displays to map elicited beliefs to measurement items and structural paths. The approach's strengths include triangulation of data sources, contextual sensitivity, and the ability to refine measurement tools based on qualitative insights. Any residual divergence between pragmatist commitments and TPB assumptions is addressed through sensitivity analyses (e.g., inclusion of past behavior to probe the intention–behavior gap), comparative model fit, and explicit reporting of context-driven refinements, thereby safeguarding methodological coherence and integrity.

Research context and participants

The research was conducted in the context of sports organizations and higher education institutions in China, with a particular focus on the phenomenon of sport participation in China. China's sports participation landscape has been shaped by national health campaigns (e.g., the “National Fitness Program”), rapid urbanization, and the expansion of university sports infrastructure. However, disparities persist between elite and grassroots participation. University students, especially those in Physical Education programs, are expected to serve as role models and future advocates for active lifestyles, making them a strategically important group for studying sustainable sports behaviors.

Quantitative phase: Participants were drawn from the College of Physical Education and Health at East China Normal University in Shanghai, one of China's leading institutions in sports science and education. This ensured a sample with relevant disciplinary knowledge while acknowledging the limitation that findings may be more representative of sports-specialized student populations.

Qualitative phase: Experts and opinion leaders from both general and school sports sectors across China were consulted to ensure depth and breadth of insight into the conceptual framework underpinning the study. For this research, an “expert” was defined as an individual with at least 10 years of professional experience in sport education or sport policy, who has made demonstrable contributions through peer-reviewed publications, held leadership roles in national or provincial sports organizations, or engaged in recognized consultancy work in sports development.

Qualitative phase

The qualitative component aimed to generate foundational concepts and contextual insights that informed the development of the quantitative instrument. Using purposive sampling, 13 experts with extensive academic, managerial, and operational experience in sports and physical education were selected. These individuals were chosen based on their publication record, professional role, and field recognition.

Semi-structured interviews were conducted, both in person and via online conferencing platforms, and were recorded with the participants' consent. The interviews were transcribed verbatim. Thematic analysis followed Braun and Clarke's (2006) six-phase framework: (1) familiarization with the data, (2) generating initial codes, (3) searching for themes, (4) reviewing themes, (5) defining and naming themes, and (6) producing the report⁴⁵.

Two researchers independently coded the transcripts using open coding in the first cycle, followed by axial coding to identify relationships between codes. Discrepancies in coding were discussed in joint sessions until consensus was achieved, ensuring inter-coder reliability. The collaborative process included maintaining a codebook that evolved through iterative rounds of comparison, thereby enhancing transparency and reproducibility. This process yielded five overarching themes—attitudinal, behavioral, environmental, cultural, and technical—which formed the basis for developing the questionnaire.

Quantitative phase

The quantitative strand involved students enrolled in the College of Physical Education and Health at East China Normal University. Using Cochran's formula, the optimal sample size was calculated to be 384 participants, selected through simple random sampling to minimize bias.

A structured questionnaire was designed based on the qualitative themes and comprised:

- 1. Demographic information (age, gender, year of study, major).
- 2. Core items: 31 Likert-scale items (1 = strongly disagree, 5 = strongly agree) across five dimensions: attitudinal, behavioral, environmental, cultural, and technical.

Instrument validation

Content validity was confirmed by a panel of five professors in sports management and research methodology. Using CVR and CVI, the instrument achieved values of 0.99, indicating strong relevance and clarity. Construct validity was examined via Confirmatory Factor Analysis (CFA), which supported the factor structure. Reliability testing produced a Cronbach's alpha of 0.88 for the full scale, with satisfactory Composite Reliability (CR) and Average Variance Extracted (AVE) values for all dimensions.

Data analysis

The analysis integrated qualitative and quantitative strands to develop and validate the sustainable sports behavior model. Guided by TPB, Table 1 functions as a joint display that links open and axial codes to TPB constructs (Attitude, Subjective Norm, Perceived Behavioral Control, Intention/Behavior) and seeds the corresponding survey items used in the quantitative phase.

Qualitative analysis

Thematic analysis was conducted using Braun and Clarke's⁴⁵ six-phase process, which includes familiarization, coding, theme development, review, definition, and reporting. Two researchers independently coded all transcripts during the initial open coding stage, using both inductive codes derived from the data and deductive codes informed by the theoretical framework. Deductive codes were organized a priori to align with TPB domains, and each inductive code was subsequently mapped to one or more TPB constructs during axial coding, as shown in Table 1. To enhance procedural rigor, each researcher maintained an analytic memo log to document coding decisions, reflections, and emergent patterns. 47 Memos recorded the hypothesized TPB pathway for each code (e.g., specific barrier → Perceived Behavioral Control → Intention → Behavior), ensuring traceability from raw text to constructs and, later, to items.

Following the independent coding, the researchers met in structured consensus sessions to compare codebooks. Discrepancies were discussed in depth regarding the raw data until a mutually agreed-upon solution was reached. Where disagreements concerned construct placement, Ajzen's definitional criteria (attitudinal, normative, and control beliefs) were used to adjudicate and finalize the mappings in Table 1. Where consensus could not be immediately achieved, excerpts were re-examined collaboratively and, when necessary, an additional expert in qualitative sport research was consulted to provide an independent perspective. This iterative process ensured that the final code set accurately reflected the dataset and minimized individual bias.

Axial coding was then applied collaboratively to organize related codes into broader categories. Through multiple rounds of comparison, synthesis, and refinement, these categories were condensed into five overarching themes: attitudinal, behavioral, environmental, cultural, and technical. Specifically, attitudinal factors (e.g., expressing physical/mental benefits, students' interest, intrinsic demand, enthusiasm, perceived capacities) were mapped to Attitude (instrumental and affective). Behavioral factors (e.g., facilitating decision-making, forming social groups, creating attractive activities/patterns, building social capital, responsibility, and social vitality) were treated as intention-behavior proximal mechanisms and informed intention-behavior indicators.

| Concepts | Extracted themes |
|-----------------------|--|
| Attitudinal factors | Expressing the physical benefits of sports Expressing the mental benefits of sports, evaluating students' interest in sports Generating intrinsic demands for sports Enhancing students' sports enthusiasm Expressing capacities and potentials for participation in sports activities |
| Behavioral Factors | Facilitating sports decision-making, Forming social groups Making sports activities attractive Creating sports patterns Creating social capital in schools Instilling a sense of responsibility for sports in students Creating a sense of social vitality in sports activities |
| Environmental Factors | Making sports environments attractive, Improving the dynamism of sports environments Utilizing nature in shaping sports spaces Attracting family participation in sports activities |
| Cultural factors | The impact of sports on students' lifestyle, Presence of prominent figures in sports activities Attention to students' citizenship rights in sports Establishment of sports ambassadors in schools Creating platforms for free discussion about sports among students |
| Technical factors | Enhancement of sports infrastructure Improvement of safety in sports facilities Teaching physical exercises to Diversity in sports activities Evaluation and awareness of students' physical abilities, financial support for students to participate in sports Identification of students' sports capacities Decision-making aligned with various socio-cultural economic strata of students. Expression of each student's sports capacities |

Table 1. Open and axial coding.

Environmental factors (e.g., attractive/dynamic spaces, using nature, family participation) were coded as control beliefs (external facilitators/constraints), with family participation also informing Subjective Norm. Cultural factors (e.g., lifestyle impact, prominent figures, citizenship rights, sports ambassadors, platforms for free discussion) primarily informed Subjective Norm (injunctive/descriptive) and secondarily Attitude/identity-related beliefs. Technical factors (e.g., infrastructure, safety, exercise instruction, activity diversity, assessment/awareness of abilities, financial support, identification/expression of capacities, socio-economic alignment in decisions) were mapped to Perceived Behavioral Control (external resources; internal capability) and translated into belief-based item stems. Table 1 presents these links (theme → TPB construct → exemplar codes), which directly informed the operationalization of indirect belief measures and the specification of the structural model. Theme naming and definitions were agreed upon jointly to ensure conceptual clarity, and all themes were supported by representative quotes selected through a consensus-based process.

Quantitative analysis

The validated themes informed the design of the structured questionnaire. Quantitative data were analyzed using Partial Least Squares Structural Equation Modeling (PLS-SEM), a method well-suited for exploratory and predictive modeling with complex latent variable relationships. The analysis proceeded in two stages: (1) evaluation of the measurement model to assess reliability (Cronbach's alpha, Composite Reliability) and validity (Average Variance Extracted, Fornell–Larcker criterion), and (2) evaluation of the structural model to test hypothesized relationships among the five determinants. Bootstrapping with 5000 resamples was employed to estimate the significance of path coefficients.

Results

Qualitative findings

Based on semi-structured interviews with experts, 31 concepts related to students' sustainable participation in sports were extracted and grouped into five thematic categories: Attitudinal, Behavioral, Environmental, Cultural, and technical factors. These themes were inductively coded and exemplified with direct participant quotations, as shown in Table 1.

Quantitative results

Quantitative data analysis was conducted to test the structural model built on the five identified themes. The data were confirmed to be normally distributed based on the Kolmogorov-Smirnov test ($p > 0.05$), allowing for the use of parametric statistical procedures. The analysis of student engagement in school sports revealed five interconnected themes—Attitudinal, Behavioral, Environmental, Cultural, and Technical Factors—each contributing to a comprehensive understanding of participation dynamics.

Attitudinal Factors encompass internal motivations, perceptions, and emotional connections students form toward physical activity. Participants consistently emphasized the need to raise awareness about both the physical and mental benefits of sport to spark interest. One respondent explained that when students realize exercise not only strengthens their bodies but also enhances focus and reduces stress, they become more inclined to participate. Moreover, intrinsic motivation emerged as a key driver; showing students the enjoyment and excitement in sport turns participation into a desire rather than an obligation. Equally important was guiding students to recognize their physical capabilities, as increased self-awareness was seen to build both confidence and motivation.

Complementing these attitudes are **Behavioral Factors**, which refer to the actions, habits, and social interactions that shape engagement. The formation of peer groups and social dynamics played a pivotal role in sustaining involvement. Students who felt a sense of belonging within a team were reportedly more consistent in their participation. Furthermore, offering students a degree of agency—such as the opportunity to help choose or design activities—was shown to enhance ownership and commitment. In addition, assigning responsibilities like organizing tournaments was seen to foster leadership, accountability, and deeper involvement.

In parallel, Environmental Factors highlight the significance of physical and social surroundings in facilitating participation. Aesthetic and functional sports spaces were viewed as vital, with participants noting that dynamic, colorful, and clean environments naturally attract students. The creative use of outdoor areas, such as gardens for yoga or light exercises, also had a positive impact on students' attitudes toward physical activity. Moreover, family involvement was recognized as crucial, with support from home reinforcing the importance of sport beyond the school context.

On a broader level, Cultural Factors reflect the influence of societal norms, school culture, and identity formation about sport. Respondents highlighted the motivational impact of local heroes and alumni returning to engage with students, which increased the perceived value of participation. Additionally, an emphasis on inclusivity and citizenship rights was evident, with stakeholders advocating for equitable access to sports regardless of gender, ability, or background. Creating platforms for open dialogue, such as student forums, was also highlighted as a powerful tool for uncovering hidden barriers and empowering students to voice their experiences.

Lastly, Technical Factors address the structural, instructional, and resource-based components of school sports. The availability of safe and well-equipped facilities was considered non-negotiable, as concerns around safety directly influenced both student comfort and parental approval. Respondents emphasized the need for diverse activities that extend beyond traditional offerings, such as football, suggesting alternatives like dance, martial arts, and fitness games to cater to a range of interests. Additionally, the practice of assessing students' physical abilities was viewed as essential for personalizing programs and promoting inclusion. Importantly, financial challenges were acknowledged, with participants urging the need for institutional support to ensure that all students, regardless of their economic background, have equal opportunities to participate.

| Component | Cronbach's Alpha | Composite Reliability | Convergent Validity (AVE) | R ² | GOF |
|---------------|------------------|-----------------------|---------------------------|----------------|------|
| Attitudinal | 0.85 | 0.88 | 0.61 | 0.73 | 0.66 |
| Behavioral | 0.89 | 0.91 | 0.67 | 0.72 | 0.69 |
| Technical | 0.82 | 0.84 | 0.51 | 0.89 | 0.67 |
| Cultural | 0.88 | 0.90 | 0.48 | 0.72 | 0.58 |
| Environmental | 0.84 | 0.96 | 0.42 | 0.62 | 0.51 |

Table 2. Reliability, validity, and goodness of fit of the Model.

| Constructs | Attitudinal | Behavioral | Technical | Cultural | Environmental |
|---------------|-------------|------------|-----------|----------|---------------|
| Attitudinal | – | | | | |
| Behavioral | 0.74 | – | | | |
| Technical | 0.67 | 0.71 | – | | |
| Cultural | 0.62 | 0.65 | 0.69 | – | |
| Environmental | 0.59 | 0.63 | 0.68 | 0.66 | – |

Table 3. Discriminant validity (HTMT ratios between Constructs). All HTMT values are below the 0.85 threshold, indicating strong discriminant validity across all constructs. This confirms that the components are conceptually and empirically distinct, reinforcing the robustness of the measurement model.

| Component | T-value | Impact Coefficient (β) | Significance |
|---------------|---------|--------------------------------|--------------------|
| Attitudinal | 34.635 | 0.856 | Significant |
| Behavioral | 24.635 | 0.849 | Significant |
| Technical | 98.772 | 0.944 | Highly Significant |
| Cultural | 31.461 | 0.851 | Significant |
| Environmental | 12.876 | 0.790 | Significant |

Table 4. Path analysis based on standardized Coefficients.

Taken together, these five themes illustrate that a complex interplay of personal motivations, social dynamics, physical environments, cultural expectations, and technical infrastructures shapes student engagement in school sports. Addressing each of these dimensions holistically is essential for fostering sustained and meaningful participation.

Reliability and validity assessment

Table 2 presents the measures of internal consistency, convergent validity, and model fit for each construct.

All components exhibit strong internal consistency, with Cronbach's Alpha and Composite Reliability values exceeding 0.80. Convergent validity is acceptable for Attitudinal, Behavioral, and technical constructs ($AVE > 0.5$). Cultural and Environmental constructs are slightly below the 0.5 threshold, suggesting a need for cautious interpretation, though reliability remains strong. The Goodness-of-Fit (GOF) values range from 0.51 to 0.69, indicating a good overall model fit.

Discriminant validity (divergent validity)

Discriminant validity was evaluated using the HTMT (Heterotrait-Monotrait) ratio. All values were below the conservative threshold of 0.85, confirming that each construct is distinct from the others. This demonstrates that the model components measure separate underlying dimensions related to student participation in sports. Results are shown in Table 3.

Structural model (path analysis)

The impact of each factor on students' participation in sports was assessed using path coefficients and t-values. Results are presented in Table 4.

All factors were found to have a positive and significant influence on student participation in sports, highlighting the multifaceted nature of engagement. Among these, the technical factor demonstrated the most decisive influence ($\beta = 0.944$), underscoring the critical role of infrastructure, safety, training quality, and accessibility in encouraging participation. In addition, the Attitudinal, Behavioral, and Cultural components also exerted strong positive effects, each with beta values exceeding 0.84, reflecting the importance of students' internal motivation, social dynamics, and culturally embedded values. Although the Environmental factor was likewise statistically significant, its impact was slightly lower in comparison to the other constructs. Nevertheless, its contribution remains essential, especially in shaping the physical and social contexts in which students engage

with sports. Collectively, these findings confirm that a comprehensive and integrated approach is crucial for effectively enhancing student involvement in school sports programs.

Discussion and conclusion

The institutionalization of universal sports development has garnered significant attention globally, particularly within educational settings. While the manifold physical, psychological, and social benefits of sports are well established, recent research warns of a sustained decline in participation rates across many contexts, particularly in the post-pandemic period, where socio-economic constraints and infrastructural limitations have further exacerbated disengagement^{47,48}. It is evident that increasing student engagement in sports not only enhances public health but also addresses broader socio-economic issues, such as community cohesion, lifelong learning, and youth development^{22,49}. This aligns with the findings of Wicker and Thormann⁴⁷ who demonstrated that well-being outcomes are significantly strengthened when sport participation is embedded within supportive environmental and organizational structures.

This study aimed to develop a model that identifies key determinants of sustainable student participation in sports. Using qualitative inquiry, 31 attributes were distilled into five main categories: attitudinal, behavioral, technical, cultural, and environmental. These categories corroborate the multidimensional frameworks proposed in prior scholarship, which emphasize that sustained sport engagement is not solely dependent on individual motivation but also on the interplay between organizational capacity, environmental quality, and socio-cultural conditions^{15,18,33,47}. Given the constraints in China, where student participation is predominantly limited to structured physical education classes, implementing sustainable behavioral changes requires systemic educational reforms^{6,30}.

Promoting sustainable sports behaviors, therefore, demands a multi-level approach that goes beyond curricular inclusion. It requires transformative educational policies that address attitudinal resistance, limited infrastructure, and restrictive cultural norms^{24,31,48}. Research has consistently shown that motivation plays a pivotal role in shaping students' decisions to participate in sports, particularly in East Asian societies where academic pressures are intense^{12,18,38}. Motivation-based interventions—ranging from reward systems to peer mentorship and student-led clubs—can strengthen the cultural foundations of sports participation and have been found effective across school and university contexts^{14,24,27}.

The theoretical underpinnings of this research align with Green's process-oriented model, which outlines three core phases in sport participation: selection and entry, retention, and growth¹⁵. Our findings suggest that the barriers identified in these phases—systemic, familial, and individual—are mirrored in the Chinese context, with the added complexity of highly centralized educational decision-making. This highlights the need for targeted motivational strategies that incorporate both intrinsic and extrinsic factors^{17,31,38}. The alignment with the Theory of Planned Behavior^{40,43} further reinforces the importance of perceived behavioral control and subjective norms in sustaining participation, especially when environmental and organizational supports are present^{33,47}.

Moreover, comparative evidence suggests that environmental quality and resource accessibility are strong mediators of sustainable participation. Kellstedt et al.¹⁷ and Lang and Tapps²⁰ found that rural and under-resourced communities experience pronounced participation barriers—findings that resonate with Chinese rural-urban disparities. At the same time, successful partnership models in developed contexts, as described by Peachey et al.²⁵ and Vail³⁶, demonstrate that inter-organizational collaboration and community engagement can help offset infrastructural deficits.

The current findings are also consistent with Wicker and Thormann's⁴⁸ demonstration that environmentally supportive sport club environments enhance both participation frequency and member well-being. Importantly, Widdop et al.⁴⁸ caution that austerity-driven policy shifts can erode these gains by constraining grassroots capacity, a warning that is highly relevant for China's university sport systems, which are facing budgetary pressures. From a broader industry perspective, Yiapanas et al.⁴⁹ emphasize that sustainable stakeholder engagement—whether in professional football or grassroots sport—depends on strategic alignment across technical, cultural, and environmental domains, which ^{directly mirrors} the structural dimensions of our model.

While individual motivators remain critical, the integration of environmental and organizational levers appears to be decisive for sustained engagement. This aligns with evidence from Olympic city planning¹¹ community sport club governance²³ and environmental sustainability initiatives in sport^{34,39} all of which highlight the role of long-term infrastructure planning in participation retention.

In China, the behavioral and organizational dimensions of student sports participation are deeply intertwined with the cultural emphasis on academic achievement and hierarchical school governance⁶. Lessons from Canada and Sweden, where public health strategies explicitly embed sport into daily life²² offer models for integrating physical literacy and psychosocial development into formal curricula^{9,27}.

Ultimately, this study contributes to the literature by providing a validated, context-sensitive model that not only reflects established international determinants of sport participation but also adapts them to the Chinese educational and cultural environment. The model's five domains—attitudinal, behavioral, technical, cultural, and environmental—offer a holistic framework that can guide both policy design and grassroots implementation.

Implications

The findings of this study carry several important implications for educational policy, school management, and broader societal engagement with youth sports. These implications operate across multiple layers—from systemic institutional reform to community-driven and cross-cultural learning—requiring the coordinated effort of policymakers, educators, sport organizations, and local stakeholders⁴⁷.

First, educational reform emerges as a critical priority. Schools should reposition sport and physical education from a peripheral, recreational add-on to a core pillar of holistic student development^{7,9}. This requires

embedding sport participation into both the formal curriculum and extracurricular programming, with deliberate attention to the five determinants identified in this study—attitudinal, behavioral, technical, cultural, and environmental^{27,31}. International evidence demonstrates that when sport is integrated as a structural component of education systems, student well-being and community cohesion are significantly enhanced^{22,36}.

Second, there is a pressing need to establish motivational systems that are empirically grounded and context-sensitive. These systems should be designed to resonate with students' values, interests, and aspirations, leveraging strategies that strengthen both intrinsic and extrinsic motivation^{10,14}. Mechanisms such as reward structures, peer mentorship programs, and student-led sports clubs have been shown to increase sustained engagement, particularly when students perceive ownership over their experiences^{4,14}. The work of Wicker and Thormann⁴⁷ further underscores that when motivation is supported by high-quality environments and club infrastructure, participation rates and subjective well-being improve in tandem.

Third, policy development should be firmly grounded in evidence and data-driven. In a country as vast and diverse as China, the lack of scalable and reliable participation data creates gaps in understanding and limits the effectiveness of interventions. Policymakers should invest in longitudinal monitoring systems, drawing on successful frameworks from other large education systems. The approach outlined by Widdop et al.⁴⁸ in tracking sport participation under austerity conditions highlights the value of longitudinal metrics in identifying both systemic vulnerabilities and opportunities for targeted investment.

Fourth, effective interventions must directly address entrenched barriers—both individual and structural. These include limited family support, gender norms, financial access issues, and facility shortages. Overcoming such challenges requires multifaceted strategies: awareness campaigns, inclusive program design, parental engagement, public-private partnerships, and collaboration with NGOs. Evidence from Yiapanas et al. on stakeholder alignment in the football industry illustrates the benefits of coordinated, multi-actor approaches to sustaining engagement and infrastructure⁴⁹.

Finally, cross-cultural learning offers significant potential for adaptation and innovation. Comparative insights from countries with strong youth sport ecosystems—such as Canada and Sweden, where public health agendas are closely linked to sport participation, and South Africa, where university sport programs foster both athletic and academic success—provide models that can be adapted to China's unique social, economic, and educational landscape^{22,24}. However, as emphasized by Taks et al.³² and Peachey et al.²⁵ successful transfer requires cultural adaptation, stakeholder buy-in, and alignment with local governance structures.

In conclusion, fostering sustainable sports participation in China demands a multi-level, integrative strategy that combines motivational, educational, and infrastructural interventions within an evidence-based and culturally responsive framework. By doing so, stakeholders can not only improve student engagement in sport but also advance public health, social cohesion, and educational equity, thereby contributing to the holistic development of youth and aligning with broader international sustainability and well-being goals.

Limitations

Despite the rigorous methodological approach, this study has several limitations. First, the qualitative phase relied on a small, purposively selected sample of 13 experts, which, while rich in depth, may limit the generalizability of the findings beyond the specific context of Chinese sports and education sectors. Additionally, the quantitative sample was drawn exclusively from students at East China Normal University, a leading institution in sports science, which may not fully represent the broader student population across different regions or academic disciplines in China. The reliance on self-reported data through questionnaires introduces the potential for response bias, including social desirability bias, where participants may provide answers that they perceive as favorable rather than their genuine opinions.

In this study, we deliberately implemented Braun and Clarke's⁴⁵ six-phase guide as a codebook-oriented thematic analysis to support our sequential exploratory mixed-methods design and the TPB-driven instrument development that followed. The 2006 framework offered an operational, team-usable pathway—familiarization, coding, theme development, review, definition, reporting—that enabled clear **traceability** from raw excerpts to TPB constructs (attitude, subjective norm, perceived behavioral control) and then to survey items and structural paths, thereby strengthening theory–analysis–results coherence. Its structured consensus procedures (shared codebook, audit trails, memoing) were especially advantageous for multi-analyst work feeding a quantitative phase. We acknowledge that later articulations of thematic analysis (e.g., reflexive TA) provide additional nuance and interpretive breadth; however, re-analyzing within a different variant at this stage would disrupt the continuity between the qualitative outputs and the validated measurement model. We therefore note the choice of the 2006 model as a design-bound limitation and recommend that future qualitative extensions consider reflexive TA where deeper interpretive work is the primary aim.

Although the questionnaire demonstrated strong validity and reliability, the use of a five-point Likert scale may have restricted the sensitivity of responses, potentially overlooking nuanced differences in attitudes and behaviors. Furthermore, the cross-sectional design of the study limits the ability to establish causal relationships between variables, as longitudinal data would be necessary to assess changes in sports participation over time. The application of PLS-SEM, while advantageous for exploratory research, may not account for all potential confounding variables; therefore, the findings should be interpreted with caution regarding their predictive power. Lastly, the study's focus on China's specific educational and sports policy context may limit the direct applicability of the results to other cultural or institutional settings, suggesting a need for further cross-cultural validation. Despite these limitations, the mixed-methods design enhances the robustness of the findings by triangulating qualitative insights with quantitative validation.

Data availability

Data is provided within the manuscript.

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Author contributions

XY and AE conceived and designed the concept and wrote the paper. XY collected the data. AE wrote the manuscript and reviewed it. All authors proofread the manuscript and agreed with the submission.

Declarations

Competing interests

The authors declare no competing interests.

Ethical approval

The studies involving human participants were reviewed and approved by the Institutional Review Board of East China Normal University. The patients/participants provided their written informed consent to participate in this study. The study was conducted in accordance with the Declaration of Helsinki.

Additional information

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