BMC Public Health

RESEARCH

Open Access

Investigating the youth physical activity promotion model among Chinese middle school students

Chuantong Jiang[1], Norsilawati Abdul Razak[2], Nelfianty Mohd Rasyid[2] and Hui Cheng[3*]

Abstract

Background This study aims to investigate the applicability of the Youth Physical Activity Promotion (YPAP) model among Chinese middle school students, focusing on the roles of reinforcing, enabling, and predisposing factors in adolescents' physical activity participation. Specifically, the research analysed the direct and indirect effects of parental support, physical education, as well as adolescents' perceived "Am I able" and "Is it worth it" on their participation in physical activities.

Methods A quantitative research design was adopted, with data collection relying on cross-sectional questionnaires. The participants were middle school students from grades 7, 8, and 9 in Zhaoqing City, China. A total of 463 samples (223 boys; 240 girls; M_{age} = 13.08 years; SD = 0.820) were used for data analysis. Structural equation modeling (SEM) analyzed the interactive relationships among YPAP model variables.

Results The YPAP model showed good fit indices, explaining 61.7% of the variance in adolescents' physical activity participation. The findings revealed that reinforcing and enabling factors had significant direct effects on adolescents' physical activity participation. Moreover, both the concepts of "Am I able" and "Is it worth it" mediated the relationship between parental support and physical activity participation. Physical education also indirectly influenced adolescents' physical activity participation through the concept of "Am I able". Notably, the concepts of "Am I able" and "Is it worth it" serially mediated the relationships between both reinforcing factors and physical activity participation, as well as enabling factors and physical activity participation.

Conclusions The study validates the YPAP model in the context of Chinese middle school students, highlighting the importance of parental support and physical education in promoting physical activity. Parents and schools should focus on enhancing adolescents' self-concept of ability and value perception to foster long-term engagement in physical activities. These findings provide valuable insights for designing targeted interventions to address the global issue of insufficient physical activity among adolescents.

Keywords Parental support, Physical education, Middle school students, Physical activity, YPAP model

*Correspondence:
Hui Cheng
chenghui@zqu.edu.cn
[1]Faculty of Physical Education and Health, Zhaoqing University, Zhaoqing, China
[2]Faculty of Sports Science and Coaching, Sultan Idris Education University, Tanjong Malim, Malaysia
[3]School of Economics and Management, Zhaoqing University, Zhaoqing, China

Introduction

Regular physical activity plays a crucial role in promoting the physical and mental health of adolescents [1]. Adolescence is a critical period for cultivating good physical activity habits [2]. However, the Global Status Report on Physical Activity [3] shows that the majority (81%) of adolescents aged 11 to 17 engage in moderate to vigorous physical activity for less than one hour daily, failing to meet the global physical activity guidelines established by the World Health Organization [4]. Insufficient physical activity not only negatively impacts adolescents' physical health, such as increasing the risk of obesity, cardiovascular diseases, and other chronic conditions [5], but may also adversely affect their mental health and social skills, leading to issues like anxiety and depression [6]. Recent studies indicate that the rates of overweight and obesity among Chinese children and adolescents have reached nearly 20%, while the prevalence of myopia among middle school students has soared to 71.6%. Additionally, mental health issues such as academic stress are on the rise, all of which are closely linked to their low levels of physical activity [7]. In view of this, exploring the determinants of adolescents' participation in physical activities is of crucial practical significance.

The phenomenon of insufficient physical activity among adolescents has garnered widespread academic attention, prompting researchers to delve into the influencing factors and mechanisms underlying adolescents' physical activity behaviors. Following the neoclassical framework, researchers have proposed several theoretical models to explain children's physical activity behavior, such as Becker's [8] treatise on the family and the SLOTH model further adapted by Cawley [9]. Simultaneously, sociological and psychological theories also provide important perspectives for research in this field. These theories focus more on exploring the formation mechanisms of individual preferences, the influence of social values, and the interaction between individuals and social environments, such as Bandura's [10] social cognitive theory and the expectancy-value model proposed by Eccles et al. [11]. Clearly, the determinants of physical activity are multidimensional and complex, resulting from the interplay of multiple factors. In this research context, the Youth Physical Activity Promotion (YPAP) model proposed by Welk [12] provides a comprehensive theoretical framework for understanding and promoting youth physical activity.

Based on the social-ecological perspective, the YPAP model integrates the influences of individual, sociocultural and environmental factors, emphasizing the interactions among them. Specifically, the model categorizes the factors influencing adolescents' physical activity behaviors into three types: predisposing, enabling, and reinforcing factors. First, precipitating factors are related to personal psychological and cognitive characteristics, including two components: "Am I able?" and "Is it worth it?" [12]. For example, previous studies have shown that individuals' perception of physical ability and self-worth directly influences their participation in physical activities [13–17]. Second, enabling factors refer to environmental and biological factors, such as access to sports facilities, fitness, skills and physical education. As Welk [12] pointed out, physical education is regarded as one of the best ways to influence adolescents' physical activity habits, and its content and curriculum have a significant impact on students' physical activity behaviors [18, 19]. Finally, reinforcing factors involve social and cultural influences, such as parental, peer, and coach support, which can enhance motivation and continuity of participation, and are significant for youth participation in physical activity [12, 13, 15, 20].

Numerous studies have applied the YPAP model to explore adolescent physical activity behaviors across different countries and regions. For example, Rowe et al. [13] validated the measurement properties of the YPAP model's constructs and their relationships with physical activity, providing a foundation for further understanding the factors influencing adolescent physical activity. Subsequently, Seabra et al. [20] found that parental influence indirectly influenced Portuguese elementary school students' physical activity participation through perceived competence and enjoyment. A study on the physical activities of rural elementary school students in the United States [15], as well as a study on the physical activities of Chinese international college students [14], both reported similar findings. Later, Ahn et al. [21] utilized virtual pets to promote children's physical activity, further validating the effectiveness of this model. More recently, Pelletier et al. [16] used the YPAP model to study physical activity participation among adolescent hockey players, finding that all factors in the model significantly influenced physical activity. Druica et al. [17] also demonstrated that all theoretical dimensions of the YPAP model had positive and significant effects on physical activity. Overall, these studies confirm the effectiveness of the YPAP model in explaining adolescent physical activity behaviors.

Although the YPAP model has been widely validated in different cultural backgrounds and contexts, there are still some research gaps and limitations. First, most previous studies have been conducted in Western cultural contexts [13, 15, 20], and there have been very few investigations targeting the Chinese adolescent population. Second, previous research has focused on primary school students [15, 20, 21] or college students [14, 17], paying little attention to middle school students in adolescence. Last, although the extensive characteristics of parents, teachers and the school environment as determinants of

adolescents' sports participation have received more and more attention [18, 22–25], little research has simultaneously investigated the combined influence of PE-related environmental characteristics and parents' sports-related support behaviors within the YPAP model. Overall, further validation of the YPAP model in the context of Chinese culture can not only provide practical guidance for addressing the issue of insufficient physical activity among Chinese adolescents but also offer new empirical support for research on the YPAP model.

Given its potential as an explanatory model for adolescents' participation in physical activities, this study aims to explore the applicability of the YPAP model among Chinese middle school students, identify the key factors influencing Chinese middle school students' physical activities, and analyze the interaction relationships among these factors (see Fig. 1). Specific objectives include: (1) to validate the applicability of the YPAP model among Chinese middle school students using structural equation modeling. (2) to test the relationships between predisposing factors (i.e., "Am I able" and "Is it worth it"), enabling factors (i.e., physical education), and reinforcing factors (i.e., parental support) and adolescents' physical activity participation. (3) to test the mediating roles of "Am I able" and "Is it worth it" in the relationships between reinforcing factors, enabling factors, and physical activity participation. These objectives can provide important theoretical support for a deep understanding of the physical activity behaviors of Chinese middle school students, and offer practical suggestions to physical education teachers and policymakers to promote the active participation of middle school students in physical activities.

Materials and methods

Sample and procedure

The participants in this study were middle school students (aged 12 to 15) in grades 7, 8, and 9 in Zhaoqing, China. Based on the *N: q* rule proposed by Jackson [26], that is, the ratio of the sample size (*N*) to the number of parameters to be estimated (*q*) is 10:1 [27], and since the parameters to be estimated in this study are 46, the minimum sample size is determined to be 460. Moreover, Hair et al. [28] indicate that when the sample size is greater than 500, the chi-square value will be severely inflated, resulting in poor model fitness. As a result, the determined sample size for this study ranges between 460 and 500. In order to ensure the representativeness of the sample, stratified random cluster sampling strategy was adopted. Firstly, 3 schools were selected by region, with 1 school in each region, and then 3 classes were selected by grade, with 1 class in each grade. Students from a total of 9 classes participated in the subsequent questionnaire survey. The research instruments were translated into Chinese through the back-translation method [29]. After obtaining approval from education administrative departments and schools, along with the informed consent of students and their parents, trained investigators guided students in selected classes to fill out questionnaires, and a total of 468 questionnaires were collected. This research protocol was approved by the Science and Technology Ethics Committee of Zhaoqing University.

Measures

A set of questionnaires consisting of 5 scales was used to measure each construct of the YPAP model, namely reinforcing factors, enabling factors, two predisposing factors, and physical activity participation. Prior to the formal data collection, a pilot study was carried out with 30 junior high school students, including item analysis and reliability analysis for each scale. The item analysis

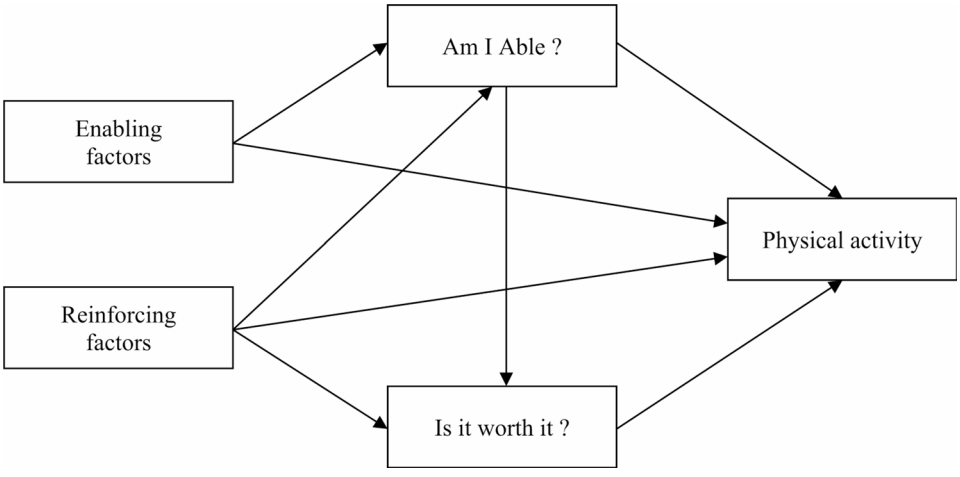

Fig. 1 Application of the youth physical activity promotion model to chinese middle school students

results indicated that the t-values of all items were significantly different, thus all the items were retained. The scales also all showed good internal consistency ($\alpha > 0.80$). Next, this study specifically detailed the measuring instruments for each variable in the YPAP model.

Reinforcing factors

Parental support behaviors were regarded as the main family reinforcing factors in this study. To assess students' perceived parental practices, this study adopted the Parent Support Scale developed by Sallis et al. [30]. The questionnaire included the following 5 items: "During a typical week, how often has your mother or father (1) encouraged you to do physical activity or play sport, (2) done physical activity or played sports with you, (3) provided transportation to a place where you can do physical activity or play sports, (4) watched you participate in physical activity or sport, and (5) told you that you are doing well in physical activity or sport?". Participants responded to these questions on a 5-point Likert scale (i.e., 1 = never, 2 = once, 3 = sometimes, 4 = almost every day, and 5 = every day). The higher score indicates greater perceived support from parents. A previous study showed that this scale had good reliability, with a Cronbach's alpha coefficient of 0.85 [31]. Moreover, in the current study, the scale showed a good level of internal consistency ($\alpha = 0.87$).

Enabling factors

The school PE environment variables were taken as enabling factors in this study. The PE-related environmental characteristics were measured by using the questionnaire on physical education content from the School Physical Activity Policy Assessment (S-PAPA) developed and validated by Lounsbery, McKenzie, Morrow, Holt, et al. [32]. The questionnaire consisted of 7 items, asking "In general, how frequently does physical education address each of the following categories?" and the specific categories include, for example, "Physical/motor skill development" and "Promoting active participation in physical activity". Respondents answered to these items on a 5-point Likert scale (i.e., 1 = never, 2 = rarely, 3 = sometimes, 4 = often, and 5 = always). A higher score shows school PE focuses more on motor skills, sports theory, participation, fitness, moral growth, and health awareness. In previous research, the scale had good or moderate test-retest reliability [19]. Furthermore, in this study, the questionnaire revealed a excellent level of internal consistency ($\alpha = 0.93$).

Predisposing factors

The original study divided predisposing factors into two constructs, namely "Am I able?" and "Is it worth it?" [12]. In this study, the two constructs were measured by a set of questionnaires previously used by Yan et al. [14]. Specifically, the "Am I able?" construct was measured by 8 items. Four of these items evaluated perceived physical competence, and the other four measured self-efficacy. As for the "Is it worth it?" construct, this study adopted 7 items to measure it. Two of these items assessed attitude, and another five measured enjoyment. Participants provided responses to these items on a 5-point Likert scale, ranging from 1 (strongly disagree) to 5 (strongly agree). This set of questionnaires has been applied to the adolescent population by Druicá et al. [17] to assess the perceptions of their physical activity competence and values ($\alpha > 0.80$). In addition, each of the four subscales showed a good level of confidence ($\alpha = 0.85 – 0.89$).

Physical activity participation

The Physical Activity Questionnaire for Older Children (PAQ-C), developed by Crocker et al. [33], was used to assess physical activity participation in adolescents. The PAQ-C, an autonomous 7-day recall assessment tool, is specifically developed for students aged 8 to 14 to measure their daily physical activity levels. This questionnaire contained 9 items, each of which was rated on a 5-point Likert scale, ranging from 1 (none) to 5 (5 times last week). Similar to Chen et al. [15], this study used three of these items to measure the physical activity of middle school students during recess (item 2), after school (item 4), and during the weekend (item 6). A score of 1 indicates low physical activity, whereas a score of 5 indicates high physical activity. Chen et al. [15] has shown that the reliability coefficient of these items was within an acceptable range ($\alpha = 0.73 – 0.81$). In addition, the preliminary analysis indicated a good level of internal consistency ($\alpha = 0.87$).

Data analysis

This study utilized SPSS 25 and AMOS 24 software for data analysis, which was divided into two main parts: descriptive statistics and inferential statistics. On the one hand, the data obtained are first screened in the descriptive statistics section, including missing value interpolation, outlier detection, and normality assessment. Next, descriptive statistical analyses were performed on demographic variables and related constructs, calculating key indicators such as means and standard deviations to clearly present the central tendencies and dispersion of the variables. Subsequently, correlation analysis was conducted to compute correlation coefficients among variables, clarifying the degree and direction of linear relationships, thereby laying the foundation for further in-depth analysis. On the other hand, Inferential statistics employed structural equation modeling (SEM) to examine the direct and mediating effects among variables in the research model.

The SEM analysis followed the two-step approach proposed by Anderson and Gerbing [34], including (1) estimating the parameters of the measurement and structural models using the maximum likelihood (ML) method; and (2) evaluating the model's fit validity using multiple indicators (Hair et al., 2018; Jackson et al., 2009; Kline, 2015), namely normed chi-square (χ^2/df) less than 3, comparative fit index (CFI) and Tucker-Lewis index (TLI) greater than or equal to 0.95, root mean square error of approximation (RMSEA) less than or equal to 0.08, and standardized root mean residual (SRMR) less than or equal to 0.05. For the reliability and validity of the measurement model, the internal consistency of the observed items was assessed by calculating Cronbach's α coefficient and composite reliability (CR). In terms of validity, when factor loadings exceeded the criterion of 0.7 and the model's fit indices met the standards, it indicated that the measurement model had good construct validity.

Finally, this study assessed the fit validity between the theoretical model and the sample data, further analyzed the path relationships among latent variables, and assessed the explanatory power of the model for adolescents' participation in physical activities. Considering that the unstandardized path coefficient product for the mediating effect does not conform to the normal distribution assumption, the Bootstrap method was used to test the mediating effect [35, 36]. The significance of the mediating effect was evaluated by calculating the 95% confidence interval (CI), and if the CI does not contain zero, it indicates that the mediating effect is significant. Overall, this study tested the direct effects of reinforcing, enabling, and predisposing factors on adolescent physical activity, and whether predisposing factors mediated the relationship between reinforcing, enabling, and adolescent physical activity.

Results

Prior to conducting descriptive statistics and bivariate correlation analysis, this study screened the collected data, including missing value evaluation, outlier detection, and normality assessment, to ensure compliance with the requirements of SEM analysis. For the missing data with a missing rate of less than 1% in 19 observed variables and a random distribution, we employed the Bayesian method [37] built into Amos for imputation processing. By analyzing histograms, box plots, and standardized z-scores, 5 cases with potential univariate outliers were removed. Additionally, based on the Mahalanobis d-squared results, no multivariate outliers were found in the sample data. As shown in Table 1, the skewness values of all variables are between – 1.187 and 0.187, and the kurtosis values are between – 1.088 and 4.066, which were lower than the normality deviation threshold, indicating that the data conform to the statistical univariate normal distribution [27, 38]. Overall, a total of 463 cases were retained for the next stage of data analytics, including 223 boys and 240 girls, with a mean age of 13.08 years ($SD = 0.820$). Power analysis indicated that the data used for analysis meet the minimum sample size requirements [27, 39], and also conform to the rules of thumb for SEM analysis [27, 28]. The results of the chi-square test and independent samples t-test showed that there were no significant differences between boys and girls in terms of grade, age, reinforcing factors, enabling factors, attitude, enjoyment, and physical activity participation, while significant differences were found in perceived competence ($t = 2.62$, $p < .01$) and self-efficacy ($t = 3.99$, $p < .01$).

As shown in Table 1, the data distribution characteristics of each construct indicated that school physical education classes paid slightly less attention to aspects such as motor skills, sports theory, participation, fitness, moral cultivation, and health awareness. In contrast, adolescents perceived a high level of parental support, held strong beliefs in their own abilities and the value of participating in physical activities, and had a high level of physical activity participation. Moreover, all bivariate correlation estimates were statistically significant ($p < .01$), with physical activity showing a strong correlation with both reinforcing factors and "Am I able", enabling factors demonstrating a weak correlation with reinforcing factors and "Is it worth it" respectively, and a moderate correlation existing among other pairs of variables. Overall, the bivariate correlation coefficients for all latent variables ranged from 0.174 to 0.633, less than 0.7, and the variance inflation factor (VIF) values for independent variables ranged from 1.118 to 1.310 ($0 < VIF < 5$).

Table 1 Descriptive analysis, normality, correlation, reliability, and discriminant validity ($N = 463$)

Variable	Mean	SD	Skewness	Kurtosis	1	2	3	4	5
1. Enabling factors	2.990	1.126	0.187	-1.088	**0.813**				
2. Reinforcing factors	4.125	0.759	-1.870	3.349	0.235**	**0.757**			
3. Am I able?	4.222	0.820	-1.783	4.066	0.336**	0.469**	**0.819**		
4. Is it worth it?	4.021	0.915	-1.612	2.472	0.174**	0.447**	0.449**	**0.807**	
5. Physical activity	4.153	0.765	-1.630	3.137	0.421**	0.633**	0.618**	0.568**	**0.840**

Note: A diagonal element in bold represents the square root of AVE; The elements below the diagonal in the matrix are the Pearson correlation coefficients between the latent constructs; ** $p < .01$

The results revealed that there were no multicollinearity problems between the variables in this study [40].

Based on Anderson and Gerbing [34], the CFA for the measurement models was performed prior to the structural model analysis. As shown in Table 2, the standardized factor loadings for all measurement models exceeded the threshold of 0.7 (p <.001), supporting the retention of all items based on the criteria recommended by Hair et al. [28]. Moreover, the overall measurement model yielded good fit indices: χ^2 = 284.055, p <.001, χ^2/df = 2, CFI = 0.973, TLI = 0.967, RMSEA = 0.047, and SRMR = 0.038. The statistically significant p-value is likely attributable to the large sample size employed in this study, as previously noted by Marsh et al. [41]. Additionally, both the AVE and SMC values exceeded the 0.5 threshold, while the CR values exceeded the 0.7 standard. These results collectively confirm the convergent validity of all measurement models. As presented in Table 1, the arithmetic square root of the AVE for each construct was greater than its correlation coefficients with other constructs, demonstrating discriminant validity among the variables, in line with the guidelines provided by Fornell and Larcker [42].

As illustrated in Fig. 2, the structural model exhibited acceptable fit indices: χ^2 = 287.298, p <.001, χ^2/df = 2.009, CFI = 0.972, TLI = 0.967, RMSEA = 0.047, and SRMR = 0.041. Meanwhile, four key predictors were significantly and positively associated with physical activity participation, validating the effectiveness of the YPAP model in explaining the relationship between these factors and physical activity participation among Chinese middle school students (Research Objective 1). The results of the structural model analysis also revealed the path coefficients among the variables, as well as the proportion of variance explained by the exogenous variables (Research Objective 2). Specifically, reinforcing factors (β = 0.342, p <.001), enabling factors (β = 0.204, p <.001), "Am I able" (β = 0.274, p <.001), and "Is it worth it" (β = 0.256, p <.001) had positive direct effects on adolescents' physical activities participation respectively. Reinforcing factors had positive direct effects on "Am I able" (β = 0.413, p <.001) and "Is it worth it" (β = 0.303, p <.001). Enabling factors had a positive direct effect on "Am I able" (β = 0.239, p <.001), while "Am I able" had a positive direct effect on "Is it worth it" (β = 0.307, p <.001). Additionally, the squared multiple correlation coefficient (R^2) for adolescents' physical activity participation was calculated as 0.617, indicating that reinforcing, enabling, and predisposing factors collectively explain 61.7% of the variance in their participation in physical activities.

To achieve the third research objective, this study investigated the direct and indirect effects of reinforcing and enabling factors on adolescents' participation in physical activities. The findings revealed that both reinforcing and enabling factors had significant direct and indirect effects on adolescents' physical activity participation (see Table 3). Specifically, the reinforcing factors positively influence physical activity participation through the mediating effects of "Am I able" (β = 0.115, Z = 2.949, p =.002) and "Is it worth it" (β = 0.079, Z = 2.257,

Table 2 CFA results for the measurement model

Construct	Item	Parameter Significance Estimation				Convergent Validity			
		Unstd.	SE	t-value	P	Std.	SMC	CR	AVE
Enabling factors	EN1	1.000				0.854	0.729	0.931	0.661
	EN2	0.791	0.040	19.701	***	0.762	0.581		
	EN3	0.920	0.038	24.442	***	0.868	0.753		
	EN4	0.886	0.038	23.219	***	0.843	0.711		
	EN5	0.754	0.037	20.585	***	0.784	0.615		
	EN6	0.904	0.039	23.216	***	0.843	0.711		
	EN7	0.682	0.037	18.225	***	0.724	0.524		
Reinforcing factors	RF1	1.000				0.771	0.594	0.870	0.573
	RF2	1.159	0.066	17.476	***	0.807	0.651		
	RF3	0.977	0.061	15.946	***	0.741	0.549		
	RF4	0.963	0.059	16.197	***	0.752	0.566		
	RF5	0.917	0.060	15.253	***	0.712	0.507		
Am I able?	PC	1.000				0.834	0.696	0.802	0.670
	SE	0.934	0.071	13.204	***	0.803	0.645		
Is it worth it?	AT	1.000				0.755	0.570	0.788	0.651
	ENJ	1.013	0.087	11.658	***	0.856	0.733		
Physical activity	PA1	1.000				0.854	0.729	0.878	0.706
	PA2	0.924	0.045	20.694	***	0.821	0.674		
	PA3	1.052	0.049	21.500	***	0.845	0.714		

Note: N = 463. Unstd, unstandardized factor loading; SE, standard error; Std, standardized factor loading; SMC, item reliability; CR, composite reliability; AVE, average variance extracted; *** p <.001

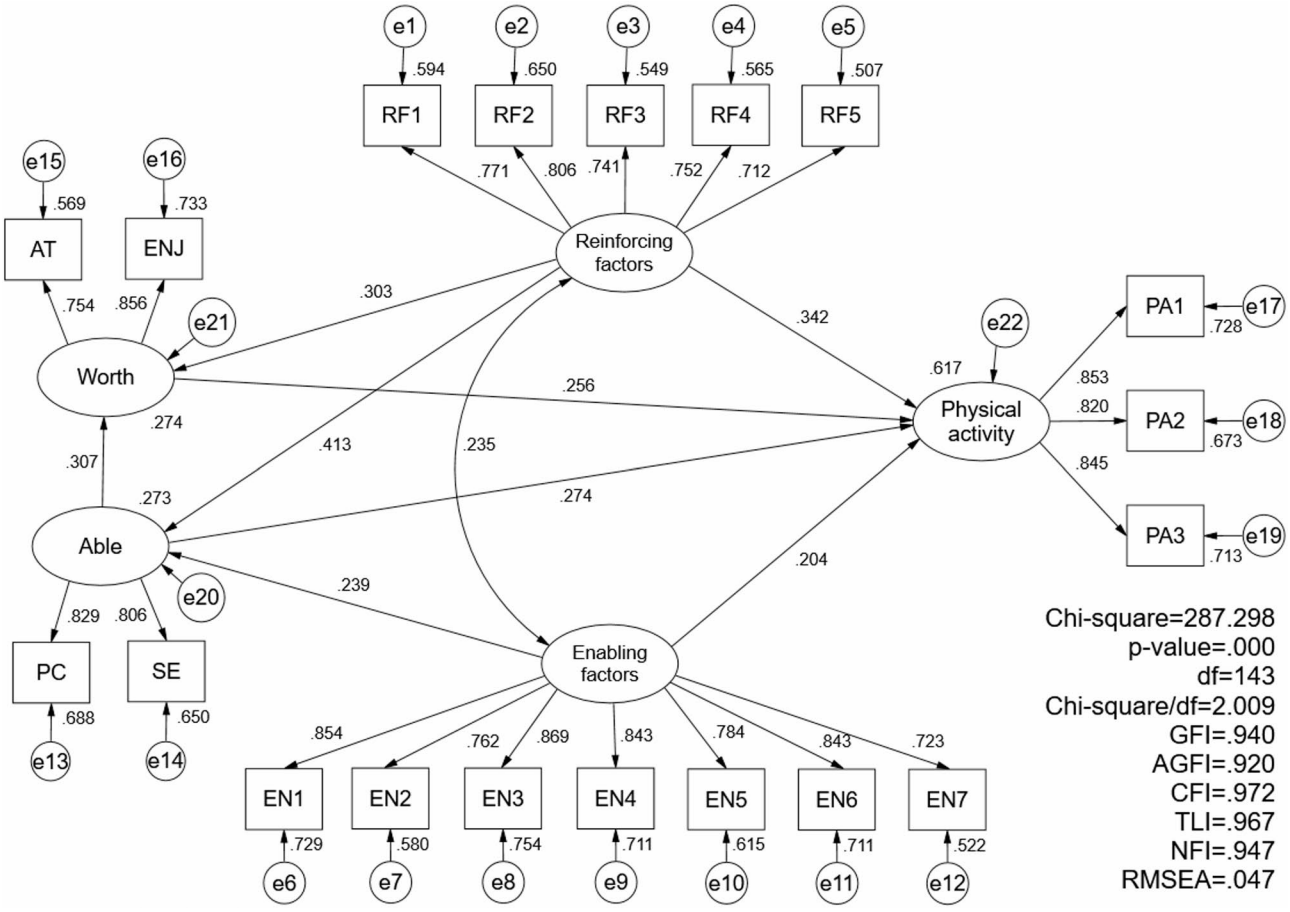

Fig. 2 Results of structural model analysis with standardized coefficients and R^2

Table 3 Direct, indirect, and total effects of the statistical model

Relationships	Point Estimation	Product of Coefficients			Bootstrapping			
					BC 95% CI		Percentile 95% CI	
		SE	Z	*P*	Lower	Upper	Lower	Upper
Specific indirect effects								
RF→Able→Worth→PA	0.033	0.016	2.063	0.020	0.011	0.078	0.008	0.068
RF→Able→PA	0.115	0.039	2.949	0.002	0.050	0.205	0.046	0.198
RF→Worth→PA	0.079	0.035	2.257	0.012	0.025	0.170	0.019	0.158
EN→Able→Worth→PA	0.011	0.005	2.200	0.014	0.003	0.023	0.002	0.021
EN→Able→PA	0.037	0.014	2.643	0.004	0.015	0.070	0.013	0.067
Total indirect effect								
RF→PA	0.228	0.054	4.222	0.000	0.137	0.351	0.131	0.343
EN→PA	0.047	0.015	3.133	0.001	0.021	0.081	0.020	0.080
Direct effect								
RF→PA	0.349	0.083	4.205	0.000	0.181	0.510	0.181	0.509
EN→PA	0.115	0.025	4.600	0.000	0.068	0.165	0.066	0.163
Total effect								
RF→PA	0.576	0.069	8.348	0.000	0.437	0.708	0.436	0.707
EN→PA	0.162	0.024	6.750	0.000	0.116	0.211	0.115	0.210

Note: $N = 463$. 5,000 bootstrap sample; SE, standard error; BC, bias corrected; CI, confidence interval; Worth, Is it worth it?; Able, Am I able?; RF, Reinforcing Factors; EF, Enabling Factors; PA, Physical Activity

p =.012) respectively. Meanwhile, "Am I able" and "Is it worth it" serially mediated the relationship between reinforcing factors and physical activity participation (β = 0.033, Z = 2.063, p =.020). Similarly, "Am I able" (β = 0.037, Z = 2.643, p =.004) mediated the relationship between enabling factors and adolescents' participation in physical activities. Moreover, "Am I able" and "Is it worth it" (β = 0.011, Z = 2.200, p =.014) serially mediated the relationship between them. As shown in Table 3, the bootstrap analysis with 5,000 samples, showing the confidence intervals for all indirect effects did not contain zero, further confirmed the significance of these mediating effects.

Discussion

This study investigated the factors influencing Chinese middle school students' participation in physical activity and their underlying mechanisms based on Welk's [12] YPAP model. The findings reveal complex relationships among these factors, providing theoretical insights and practical implications for understanding adolescent physical activity behaviors. Regarding the first research objective, this study validated the applicability of the YPAP model among Chinese middle school students using structural equation modeling. The results showed that the model's fit indices met acceptable standards, indicating that the YPAP model effectively explains adolescents' physical activity behaviors (see Fig. 2). This finding was consistent with previous studies conducted in Western cultural contexts [15–17]. However, it is noteworthy that in several previous studies, the enabling factors mainly focused on sports competence, fitness and skills, and environmental factors [15, 17], as well as access to infrastructure and opportunities for participating in physical activities [16]. In this study, we regard physical education as an enabling factor determining the participation of Chinese middle school students in physical activities, because physical education is considered to be one of the best ways to influence the formation of adolescents' physical activity habits [12]. Overall, this finding further supports the potential applicability of the YPAP model across different cultural contexts.

Moreover, this study examined the relationships among reinforcing, enabling, and predisposing factors and adolescent physical activity participation in response to the second objective of this study. The results showed that reinforcing factor, enabling factor, and predisposing factors all had significant positive direct effects on adolescents' physical activity participation. These findings align with the theoretical framework of the YPAP model, suggesting that adolescent physical activity behaviors are influenced by multiple levels of factors [12]. Based on these findings, we can infer that parental support directly enhances adolescents' willingness to participate in physical activity by providing emotional and material resources, which is consistent with previous research [13, 20]. Similarly, this study found that school physical education can directly predict adolescents' extracurricular physical activity behavior. It is clear that this is consistent with previous findings that the quality and content of physical education courses have a significant impact on students' participation in physical activity [18, 19]. Furthermore, consistent with the literature [16, 43], this study found that adolescents' participation in physical activities was related to their perceptions of "Am I able" and "Is it worth it". This combination of findings provides some support for the conceptual premise that promoting adolescents' participation in physical activities can be achieved by designing targeted interventions, such as improving parental behaviors and enhancing the quality of physical education.

Another objective of this study was to investigate the mediating effects of "Am I able" and "Is it worth it" between parental support and adolescent physical activity participation, respectively. The results indicated that parental support not only directly influenced adolescents' physical activity participation but also indirectly affected their physical activity behaviors through "Is it worth it" and "Am I able". This finding supports the theoretical assumptions of the YPAP model. Several studies have reported similar findings that parental support can indirectly promote adolescent physical activity participation by shaping adolescent self-concept of ability, and task value perception [23, 43–45]. A possible explanation is that parental encouragement and support boost adolescents' confidence when engaging in physical activities. This confidence makes them more likely to believe in their ability to participate in physical activities. Meanwhile, parents' involvement in their children's physical activities helps adolescents perceive the importance of physical activity, thereby assigning it higher value [25, 43, 46]. Moreover, the results also showed the serial mediating effect of "Am I able" and "Is it worth it", which is consistent with the findings of Chen et al. [15] and Seabra et al. [20]. This result may be explained by the fact that when adolescents consider themselves to be performing well in physical activity, they tend to assign a higher value to that activity [20]. As a result, these findings further reveal the important role of parental support in adolescents' physical activity behavior and provide a theoretical basis for future interventions.

Finally, this study also investigated the mediating effect of "Am I able" between enabling factors and adolescent physical activity participation. The findings suggested that physical education indirectly influence adolescent physical activity participation through the "Am I able" component. In other words, school physical education can shape adolescents' perceptions of sports competance

and self-efficacy, which in turn promotes their participation in physical activity. This finding is consistent with research by García & Suárez [24], suggesting that school physical education plays a key role in shaping adolescent physical activity behavior, and also provides new empirical support for the YPAP model. In China, driven by the "Double Reduction" policy, schools are paying increasingly close attention to physical education courses, with the status of physical education and the importance of students' performance in this subject rising significantly [47]. Previous studies have found that students who perform well in sports tend to have higher self-efficacy, which further predicts their physical activity participation [48]. Overall, the results of this study not only support the theoretical framework of the YPAP model, but also provide an important theoretical basis and practical guidance for promoting the participation of Chinese middle school students in sports activities.

Practical implications

The findings of this study have significant practical implications for promoting physical activity participation among Chinese middle school students. Firstly, parents should actively participate in and support their children's physical activities, such as by engaging in co-activity, providing necessary material support (e.g., sports equipment and transportation), and offering emotional encouragement [30]. Moreover, schools can implement home-school collaboration programs to educate parents about the importance of physical activity, helping them better support their children's participation. Secondly, physical education content and curriculum should be further optimized, emphasizing various aspects, including motor skills, movement theories and patterns, participation in physical activities, physical health, moral growth, and health awareness [32]. Finally, policymakers can integrate the theoretical framework of the YPAP model into adolescent physical activity promotion programs, designing multi-level interventions. For example, the government can introduce policies requiring schools to increase physical education hours and ensure the quality and diversity of physical education programs. Meanwhile, communities can organize more physical activity events to provide adolescents with additional participation opportunities. In addition, public health departments can conduct awareness campaigns to educate adolescents and their parents about the health benefits of physical activity, fostering a societal environment that supports adolescent physical activity.

Limitations

This research has some limitations despite providing crucial theoretical and practical insights into the physical activity participation of Chinese middle school students. First, this study evaluated the path relationship between factors of the YPAP model based on cross-sectional data. Future studies can adopt longitudinal or experimental designs to further confirm the causal relationship between variables. Second, the sample of this study only came from middle school students in one city in China, and the geographical scope of the sample is relatively limited, which may affect the generality of the study results. Future studies can expand the sample range to cover adolescents from different regions and age groups. Third, this study mainly relies on self-reported data. Although this method is easier to capture the subjective feelings of adolescents, there may be social expectation bias and recall bias [49]. Future studies can use a variety of data collection methods (e.g., reports from parents, teachers, and students) to improve the accuracy and reliability of the data. Finally, there are still some potential variables that were not included in this study. For example, factors such as peer support and community environment may also have an important impact on adolescents' physical activity behavior [50]. Future research can further expand the YPAP model to include more relevant variables to fully understand the influencing factors of adolescents' physical activity behavior.

Conclusion

This study validated the applicability of the YPAP model among Chinese middle school students and revealed the interactive relationships among various factors. The results showed that parental support, physical education, and adolescents' perceptions of "Am I able" and "Is it worth it" significantly and positively influenced their physical activity participation. It is worth noting that "Am I able" and "Is it worth it" not only mediated the relationship between parental support and adolescent physical activity participation, respectively, but also had a serial mediating effect between them. Moreover, the results also found the mediating role of "Am I able" between physical education and adolescent physical activity participation. These findings provide theoretical support for understanding adolescent physical activity behaviors and offer practical guidance for designing effective interventions. Future research could adopt longitudinal designs, expand sample diversity, and employ multiple data collection methods to further validate causal relationships and enhance the generalizability of the findings, thereby contributing more empirical evidence to address the global issue of insufficient physical activity among adolescents.

Abbreviations

YPAP	Youth physical activity promotion
SEM	Structural equation modeling
CFI	Comparative fit index
TLI	Tucker-lewis index
RMSEA	Root mean square error of approximatio
SRMR	Standardized root mean residual

CR	Composite reliability
CI	Confidence interval
ANOVA	Analysis of variance
AVE	Average variance extracted
CFA	Confirmatory factor analysis
SMC	Squared multiple correlations
RF	Reinforcing factors
EF	Enabling factors
PA	Physical activity

Acknowledgements
The authors would like to thank all the participants who spent time and made efforts to complete the questionnaires, providing valuable data for this study.

Author contributions
C.J. conceptualized the study, contributed to methodology, data curation, software selection, funding acquisition, project administration, writing of the original draft, and also contributed to writing– review & editing. H.C. contributed to the conceptualization of the study, contributed to methodology, formal analysis, and writing– review & editing. N.A.R. and N.M.R. contributed to methodology, supervision and writing– review & editing. All authors reviewed the manuscript.

Funding
This research was funded by the Zhaoqing University Research Foundation Project (No. ZD202403), the Education Research Project of the Zhaoqing Education Development Research Institute (No. ZQJYY2022023), and the Quality Engineering and Reform Project of Zhaoqing University (No. ZLGC2024087).

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

Declarations

Ethics approval and consent to participate
This research was conducted in accordance with the guidelines of the Declaration of Helsinki, and the survey protocol was approved by the Zhaoqing Science and Technology Ethics Committee (No. 2024029). Prior to the data collection, informed consent was obtained from both the participants themselves and their parents or guardians.

Consent for publication
Not applicable.

Competing interests
The authors declare no competing interests.

Received: 18 February 2025 / Accepted: 5 May 2025
Published online: 19 May 2025

References

1. Hosker DK, Elkins RM, Potter MP. Promoting mental health and wellness in youth through physical activity, nutrition, and sleep. Child Adolesc Psychiatr Clin N Am. 2019;28:171–93. https://doi.org/10.1016/j.chc.2018.11.010.
2. Logan K, Lloyd RS, Schafer-Kalkhoff T, Khoury JC, Ehrlich S, Dolan LM, et al. Youth sports participation and health status in early adulthood: A 12-year follow-up. Prev Med Rep. 2020;19:101107. https://doi.org/10.1016/j.pmedr.2020.101107.
3. Global Status Report on Physical Activity. Geneva: World Health Organization; 2022.
4. World Health Organization. Global action plan on physical activity 2018–2030: more active people for a healthier world. Geneva: 2018.
5. Elagizi A, Kachur S, Carbone S, Lavie CJ, Blair SN. A review of obesity, physical activity, and cardiovascular disease. Curr Obes Rep. 2020;9:571–81. https://doi.org/10.1007/s13679-020-00403-z.
6. Panza MJ, Graupensperger S, Agans JP, Doré I, Vella SA, Evans MB. Adolescent sport participation and symptoms of anxiety and depression: A systematic review and Meta-Analysis. J Sport Exerc Psychol. 2020;42:201–18. https://doi.org/10.1123/jsep.2019-0235.
7. Ma Y, Xiang X. The necessity and urgency of physical exercise for teenagers. China Sports Daily; 2023.
8. Becker GS. A treatise on the family. Cambridge, MA: Harvard University Press; 1981.
9. Cawley J. An economic framework for Understanding physical activity and eating behaviors. Am J Prev Med. 2004;27:117–25. https://doi.org/10.1016/j.amepre.2004.06.012.
10. Bandura A. Social foundations of thought and action: a social cognitive theory. Englewood Cliffs (N.J.): Prentice-Hall; 1986.
11. Eccles JS, Adler TF, Futterman R, Goff SB, Kaczala CM, Meece JL, et al. Expectancies, values, and academic behaviors. In: Spence JT, editor. Achievement and achievement motivation. San Francisco: W. H. Freeman; 1983. pp. 75–146.
12. Welk GJ. The youth physical activity promotion model: A conceptual Bridge between theory and practice. Quest. 1999;51:5–23. https://doi.org/10.1080/00336297.1999.10484297.
13. Rowe DA, Raedeke TD, Wiersma LD, Mahar MT. Investigating the youth physical activity promotion model: internal structure and external validity evidence for a potential measurement model. Pediatr Exerc Sci. 2007;19:420–35. https://doi.org/10.1123/pes.19.4.420.
14. Yan Z, Cardinal BJ, Acock AC. Understanding Chinese international college and university students' physical activity behavior. J Sport Health Sci. 2015;4:203–10. https://doi.org/10.1016/j.jshs.2013.07.002.
15. Chen S, Welk GJ, Joens-Matre RR. Testing the youth physical activity promotion model: fatness and fitness as enabling factors. Meas Phys Educ Exerc Sci. 2014;18:227–41. https://doi.org/10.1080/1091367X.2014.936017.
16. Pelletier V, Girard S, Lemoyne J. Adolescent hockey players' predispositions to adopt sport and exercise behaviours: an ecological perspective. PLoS ONE. 2020;15. https://doi.org/10.1371/journal.pone.0228352.
17. Druică E, Ianole-Călin R, Sakizlian M, Aducovschi D, Dumitrescu R, Sakizlian R. Testing the youth physical activity promotion model during the COVID-19 pandemic, with partial least squares Second-Order latent constructs. IJERPH. 2021;18:6398. https://doi.org/10.3390/ijerph18126398.
18. Solmon MA. Optimizing the role of physical education in promoting physical activity: A Social-Ecological approach. Res Q Exerc Sport. 2015;86:329–37. https://doi.org/10.1080/02701367.2015.1091712.
19. Lounsbery MAF, McKenzie TL, Morrow JR, Monnat SM, Holt KA. District and school physical education policies: implications for physical education and recess time. Ann Behav Med. 2013;45:131–41. https://doi.org/10.1007/s12160-012-9427-9.
20. Seabra AC, Maia J, Seabra AF, Welk G, Brustad R, Fonseca AM. Evaluating the youth physical activity promotion model among Portuguese elementary schoolchildren. J Phys Activity Health. 2013;10:1159–65. https://doi.org/10.1123/jpah.10.8.1159.
21. Ahn SJ (Grace), Johnsen K, Robertson T, Moore J, Brown S, Marable A Using Virtual Pets to Promote Physical Activity in Children, et al. editors. An Application of the Youth Physical Activity Promotion Model. Journal of Health Communication 2015;20:807–15. https://doi.org/10.1080/10810730.2015.1018597
22. Kovács K, Földi R, Gyömbér N. The effects of parents' and their children's characteristics on parental involvement in sport. J Fam Issues. 2023;44:2589–612. https://doi.org/10.1177/0192513X221106739.
23. Jaf D, Wagnsson S, Skoog T, Glatz T, Özdemir M. The interplay between parental behaviors and adolescents' sports-related values in Understanding adolescents' dropout of organized sports activities. Psychology of sport and exercise. 2023;68. https://doi.org/10.1016/j.psychsport.2023.102448
24. García J, Suárez M. Organised and non-organised after-school physical activity among children in Spain: the role of school-related variables. Eur SPORT Manage Q. 2020;20:171–88. https://doi.org/10.1080/16184742.2019.1594329.
25. Eccles JS, Wigfield A. From expectancy-value theory to situated expectancy-value theory: A developmental, social cognitive, and Sociocultural perspective on motivation. Contemp Educ Psychol 2020;61. https://doi.org/10.1016/j.cedpsych.2020.101859
26. Jackson DL. Revisiting sample size and number of parameter estimates: some support for the N:q hypothesis. Struct Equation Modeling: Multidisciplinary J. 2003;10:128–41. https://doi.org/10.1207/S15328007SEM1001_6.
27. Kline RB. Principles and practice of structural equation modeling. 4th ed. New York: Guilford; 2015.
28. Hair J, Black WC, Babin BJ, Anderson RE. Multivariate data analysis. Eighth edition. United Kingdom: Annabel Ainscow; 2018.
29. Brislin RW. Back-Translation for Cross-Cultural research. J Cross-Cult Psychol. 1970;1:185–216. https://doi.org/10.1177/135910457000100301.

30. Sallis JF, Taylor WC, Dowda M, Freedson PS, Pate RR. Correlates of vigorous physical activity for children in grades 1 through 12: comparing Parent-Reported and objectively measured physical activity. Pediatr Exerc Sci. 2002;14:30–44. https://doi.org/10.1123/pes.14.1.30.
31. Kwon S, Janz K, Letuchy E, Burns T, Levy S. Parental characteristic patterns associated with maintaining healthy physical activity behavior during childhood and adolescence. Int J Behav Nutr Phys ACTIVITY. 2016;13. https://doi.org/10.1186/s12966-016-0383-9.
32. Lounsbery MAF, McKenzie TL, Morrow JR, Holt KA, Budnar RG. School physical activity policy assessment. J Phys Activity Health. 2013;10:496–503. https://doi.org/10.1123/jpah.10.4.496.
33. Crocker PRE, Bailey DA, Faulkner RA, Kowalski KC, McGRATH R. Measuring general levels of physical activity: preliminary evidence for the Physical Activity Questionnaire for Older Children. Medicine & Science in Sports & Exercise 1997;29:1344–9. https://doi.org/10.1097/00005768-199710000-00011.
34. Anderson JC, Gerbing DW. Structural equation modeling in practice. A review and recommended Two-Step approach. Psychol Bull. 1988;103:411–23. https://doi.org/10.1037/0033-2909.103.3.411.
35. MacKinnon DP. Introduction to statistical mediation analysis. 1st ed. New York: Routledge; 2008.
36. Preacher KJ, Hayes AF. Asymptotic and resampling strategies for assessing and comparing indirect effects in multiple mediator models. Behav Res Methods. 2008;40:879–91. https://doi.org/10.3758/brm.40.3.879.
37. Buhi E, Goodson P, Neilands T. Out of sight, not out of Mind: strategies for handling missing data. Am J Health Behav. 2008;32:83–92. https://doi.org/10.5993/AJHB.32.1.8.
38. Byrne BM. Structural equation modeling with AMOS: basic concepts, applications, and programming. 2nd ed. New York: Taylor & Francis/Routledge; 2010.
39. MacCallum RC, Browne MW, Sugawara HM. Power analysis and determination of sample size for covariance structure modeling. Psychol Methods. 1996;1:130–49. https://doi.org/10.1037/1082-989X.1.2.130.
40. Grewal R, Cote JA, Baumgartner H. Multicollinearity and measurement error in structural equation models: implications for theory testing. Mark Sci. 2004;23:519–29. https://doi.org/10.1287/mksc.1040.0070.
41. Marsh HW, Dowson M, Pietsch J, Walker R. Why multicollinearity matters: A reexamination of relations between Self-Efficacy, Self-Concept, and achievement. J Educ Psychol. 2004;96:518–22. https://doi.org/10.1037/0022-0663.96.3.518.
42. Fornell C, Larcker DF. Evaluating structural equation models with unobservable variables and measurement error. J Mark Res (JMR). 1981;18:39–50. https://doi.org/10.2307/3151312.
43. Simpkins SD, Fredricks JA, Eccles JS. Charting the eccles' expectancy-value model from mothers' beliefs in childhood to youths' activities in adolescence. Dev Psychol. 2012;48:1019–32. https://doi.org/10.1037/a0027468.
44. Timperio A, van Stralen M, Brug J, Bere E, Chinapaw M, De Bourdeaudhuij I, et al. Direct and indirect associations between the family physical activity environment and sports participation among 10–12 year-old European children: testing the EnRG framework in the ENERGY project. Int J Behav Nutr Phys ACTIVITY. 2013;10. https://doi.org/10.1186/1479-5868-10-15.
45. Laird Y, Fawkner S, Niven A. A grounded theory of how social support influences physical activity in adolescent girls. Int J Qualitative Stud Health Well-Being. 2018;13. https://doi.org/10.1080/17482631.2018.1435099.
46. Eccles JS, Wigfield A. The development, testing, and refinement of Eccles, Wigfield, and colleagues' situated Expectancy-Value model of achievement performance and choice. Educ Psychol Rev. 2024;36:51. https://doi.org/10.1007/s10648-024-09888-9.
47. Yu S. Value and innovation of P.E. From double reduction policy. J Wuhan Sports Univ. 2022;56:83–91. https://doi.org/10.15930/j.cnki.wtxb.2022.01.006.
48. Viljaranta J, Tolvanen A, Aunola K, Nurmi J-E. The developmental dynamics between interest, Self-concept of ability, and academic performance. Scandinavian J Educational Res. 2014;58:734–56. https://doi.org/10.1080/00313831.2014.904419.
49. Rosenman R, Tennekoon V, Hill LG. Measuring bias in self-reported data. IJBHR. 2011;2:320. https://doi.org/10.1504/IJBHR.2011.043414.
50. Li L, Moosbrugger M. Correlations between physical activity participation and the environment in children and adolescents: A systematic review and Meta-Analysis using ecological frameworks. Int J Environ Res Public Health. 2021;18. https://doi.org/10.3390/ijerph18179080.

Publisher's note