Analysis of Factors Influencing the Development of Physical Exercise Habits Among Chinese University Students

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Abstract

This study aimed to 1) develop an initial theoretical model identifying factors that influence the development of physical activity habits among university students in Shenyang City using the Delphi method and Analytic Hierarchy Process (AHP); 2) validate and refine this model through Confirmatory Factor Analysis (CFA) to enhance its fit and applicability; and 3) examine the differential impact of gender and age on physical activity habits. A cross-sectional design was employed, targeting 426 university students aged 18–25 in Shenyang City, People's Republic of China. The sample size was calculated using Taro Yamane's formula. The study incorporated multiple research methods, including literature analysis, questionnaire surveys, expert interviews, and statistical analysis.

Key findings were as follows: 1. Status Investigation: The overall level of physical activity habits among university students was low. Male students demonstrated significantly higher levels of physical activity than female students ($p < 0.05$). 2. Factor Identification: Four key domains influencing physical activity habits were identified: environmental (e.g., school facilities), individual (e.g., self-efficacy), social (e.g., peer support), and family (e.g., economic status). 3. Model Validation: The theoretical model was confirmed through regression analysis and the analytic Hierarchy Process. Key influencing factors were validated, providing a structured foundation for targeted interventions.

This study contributes to the existing literature by introducing and validating a comprehensive theoretical model for understanding physical activity habits among university students. The findings underscore the importance of multi-dimensional support-including improvements in school infrastructure, enhanced physical education programs, self-efficacy training, and family involvement-in fostering long-term physical activity habits and overall student well-being.

Keywords: University students; Physical activity in habits; Affecting factors; Model construction; Intervention measures

Introduction

In recent years, concerns about declining physical activity among Chinese university students have become increasingly urgent. According to the National Student Physical Health Test (2023), over 60% of students in urban universities fail to meet the recommended standards for physical fitness, with rising obesity rates and declining cardiovascular endurance. This trend is particularly evident in northern cities like Shenyang, where long winters and academic stress often contribute to sedentary lifestyles. These patterns raise critical questions about how physical activity habits (PAH) are formed, sustained, or disrupted in today's university environment.

Physical activity habits-defined as consistent, often automatic engagement in physical exercise-are crucial for students' physical, mental, and emotional well-being. Extensive research confirms that regular physical activity reduces the risk of chronic diseases, improves cognitive performance, alleviates stress, and enhances overall life satisfaction (Smith et al., 2023; Zhang & Wang, 2022). Despite these well-known benefits, studies continue to report low levels of physical activity among university students in China. While prior research has identified individual, social, and environmental factors, few studies have applied systematic modeling approaches, such as the Analytic Hierarchy Process (AHP) and Confirmatory Factor Analysis (CFA), to explore PAH formation in Chinese student populations.

Moreover, existing studies often generalize findings across regions without accounting for local cultural, environmental, and institutional contexts. Focusing on Shenyang City, this research addresses that gap. As a rapidly developing urban center in northeast China, Shenyang presents a unique case for studying student physical activity: harsh winters, intense academic schedules, and evolving campus infrastructure all play significant roles in shaping student behavior. Yet, these localized influences remain underexplored in the literature.

This study investigates the physical activity habits of university students in Shenyang City by identifying key influencing factors and constructing a validated theoretical model using AHP and CFA, aiming to generate evidence-based recommendations that inform policy and interventions to improve student health and promote sustainable exercise habits.

Research Objectives

1. To develop an initial theoretical model identifying the factors that influence the development of physical activity habits among university students in Shenyang city using the Delphi method and Analytic Hierarchy Process (AHP).

2. To validate and refine the theoretical model through Confirmatory Factor Analysis (CFA) to improve its fit and applicability.

3. To examine the differential impact of gender and age on the development of physical activity habits among university students in Shenyang city.

Literature Review

This section reviews existing scholarship related to physical activity habits (PAH), focusing on habit formation theories, influencing factors, measurement and modeling approaches, and regional as well as international perspectives. It also highlights research gaps that this study aims to address.

1. Theoretical Foundations of Habit Formation

Habit is typically defined as repetitive, automatic behavior that develops through regular performance in stable contexts. Foundational behaviorist theories—Pavlov's classical conditioning and Skinner's operant conditioning-describe how environmental stimuli and reinforcement contribute to the formation of habitual actions. These principles have been extended in health behavior studies to explain how regular physical activity can become automatic when triggered by consistent cues and rewards (Feng, 2024).

Contemporary models such as Social Cognitive Theory (Bandura) emphasize the role of self-efficacy, observational learning, and reciprocal determinism, while Self-Determination Theory (Deci & Ryan) highlights the importance of intrinsic motivation and autonomy in sustaining long-term behavior. These perspectives suggest that habit formation is not merely mechanical but influenced by cognitive and emotional processes-particularly in university settings where students navigate complex motivational landscapes.

2. Factors Influencing Physical Activity Habits (PAH)

The literature identifies a wide range of factors that influence the development and maintenance of PAH among university students:

Environmental: The availability of sports facilities, safe exercise spaces, and climate conditions (Kang et al., 2024). Psychological: Traits such as self–control, self–efficacy, and personality dimensions like extraversion and emotional stability (Li et al., 2024). Family and Social: Peer influence, parental modeling, and family attitudes toward exercise are especially impactful during early habit formation (Avraham et al., 2024). Institutional (School): The structure and emphasis of physical education programs, academic workload, and university policies on student well–being (Hu & Phucharoen, 2024a). Although these domains are well–documented in general, there is a lack of integrated, localized models that synthesize these variables specifically for Chinese university students.

3. Measurement and Modeling of PAH

Despite growing interest in PAH, researchers have yet to agree on standard measurement tools. Instruments such as the Self–Report Habit Index (SRHI) are widely used internationally (Feil et al., 2021), but have seen limited application in Chinese academic contexts, especially among university populations. To bridge this gap, this study adopts the Delphi method to gather expert consensus and structure key influencing factors. Then, Analytic Hierarchy Process (AHP) is employed to prioritize these factors based on expert judgment. Finally, Confirmatory Factor Analysis (CFA) is used to statistically validate the theoretical model's structure and fit.

These methods are selected for their ability to combine qualitative insights with quantitative rigor, offering a nuanced and validated framework that is both context–sensitive and generalizable.

4. International Comparisons of PAH Trends

International research shows marked differences between China and Western countries regarding PAH. For example, universities in Europe and North America often integrate mandatory physical education, campus wellness programs, and extensive recreational infrastructure into student life. By contrast, Chinese universities frequently prioritize academic achievement, with fewer structured opportunities for regular exercise (Zhao, 2023).

Cultural attitudes toward fitness also differ: individualism and health autonomy are more emphasized in the West, while in China, physical activity is often externally motivated—by

institutional mandates or family expectations. These cultural distinctions must be accounted for in the design of effective interventions.

5. Research Gaps

Despite the growing body of research on PAH, limited studies apply AHP or CFA to model PAH development among Chinese university students, particularly in Shenyang City. This city's unique environmental challenges (e.g., long winters), academic pressures, and evolving urban infrastructure present distinct obstacles and opportunities for habit formation that have not been thoroughly explored. (Liang & Tasnaina, 2024), there is a lack of similar research aimed at university students, particularly in China, where academic and social pressures may significantly impact their physical activity habits. Existing research has yet to fully integrate environmental, psychological, family, and institutional factors into a region-specific theoretical model. Nor has there been sufficient attention to how intrinsic and extrinsic motivations interact within this context to shape long-term physical activity behaviors.

This study seeks to address these gaps by developing a localized, validated model of physical activity habit formation among university students in Shenyang City. Through the integration of expert-driven (Delphi, AHP) and data-driven (CFA) methods, it aims to offer practical, evidence-based insights for improving student well-being through sustainable physical activity.

Conceptual Framework

This research is a study focusing on the factors influencing the physical activity levels of students. The researcher defines the research conceptual framework based on the concept of multiple factors affecting health behaviors together with theories of behavior change and motivation. The details are as follows:

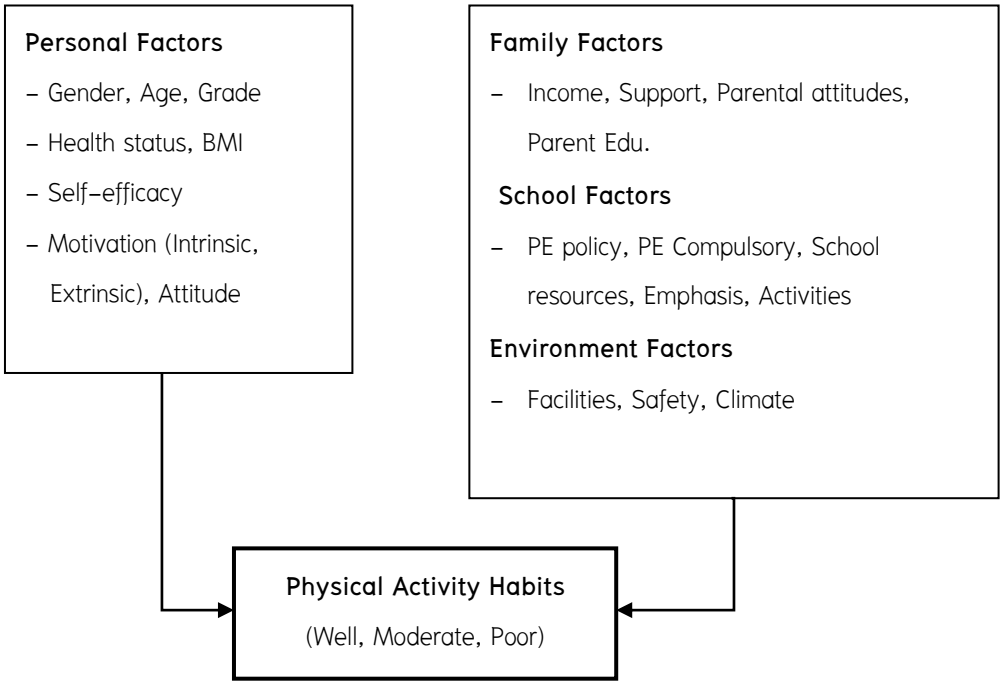

Figure 1 Conceptual Framework

Research Methodology

This study employed a mixed-methods approach integrating theoretical modeling, expert consultation, and empirical survey data to investigate the factors influencing the physical activity habits (PAH) of university students in Shenyang City, China. The methodology was designed to ensure validity, reliability, and representativeness of the findings.

1. Research Design and Theoretical Framework Development

The conceptual framework was first constructed based on a comprehensive literature review, including data mining using Cite Space III and analysis of publications retrieved from CNKI and Web of Science. These sources helped identify core themes in PAH research, including behavioral, psychological, and environmental factors.

To enhance the content validity of the theoretical model, a three-round Delphi method was conducted with 10 experts in physical education and behavioral science. This process generated 80 influencing factors across four domains: personal, family, school, and environment. Through iterative rounds of rating and refinement, the final model included 32 prioritized factors. The Analytic Hierarchy Process (AHP) was used to assign relative weights to these factors using Yaahp 10.4 software with consistency indices to verify logical alignment.

2. Sampling Design and Sample Justification

A stratified random sampling approach was employed across three universities in Shenyang:

- Shenyang Jianzhu University (Engineering) – 128 students
- Shenyang Normal University (Liberal Arts) – 128 students
- Liaoning University (Comprehensive) – 166 students

The sample size was calculated using Taro Yamane's formula:

$$n = \frac{N}{1 + N(e)2}$$

Where:

N = total population of students

$\mathbf{e}$ = margin of error (0.05)

Z = 1.96 (95% confidence level)

The initial required sample size was 384, which was then adjusted for finite population and inflated by 10% to compensate for potential non–response or invalid responses. This led to a target sample size of 422, ensuring statistical power and reliability. Ultimately, 543 valid responses were analyzed, exceeding the minimum requirement.

3. Inclusion and Exclusion Criteria

Inclusion criteria:

- Full–time undergraduate students aged 18–25
- Residing and studying in Shenyang City
- No medical contraindications for physical activity
- Engaged in at least one physical activity per week in the past six months
- Provided informed consent

Exclusion criteria:

- Part–time students or those without valid student ID
- Existing medical conditions restricting physical activity
- No physical activity in the past six months
- Incomplete or invalid questionnaire responses

4. Data Collection Process

A self–administered Physical Activity Behavior (PAB) questionnaire was distributed via the Wenjuanxing online platform, supplemented by paper–based informed consent. Out of 600

distributed questionnaires, 588 were returned. After excluding 30 incomplete, 17 logically inconsistent, and 10 ineligible responses, 543 valid questionnaires were retained (effective response rate = 90.5%).

5. Validity and Reliability Assessment

To ensure content and construct validity, the questionnaire was developed based on literature and expert interviews. It underwent three rounds of revision with nine domain experts. The following metrics were used:

– Item–Objective Congruence (IOC) Index = 0.80

– Cronbach's Alpha (internal consistency reliability) = 0.84, indicating good reliability

– Factor Loadings from CFA all exceeded 0.50, meeting standard thresholds for convergent validity

6. Data Analysis Techniques

Data analysis was conducted using SPSS and AMOS software with the following methods:

– Descriptive Statistics: Frequencies, means, and standard deviations to describe participant characteristics and PAH status

– Exploratory Factor Analysis (EFA): To identify the underlying factor structure

– Confirmatory Factor Analysis (CFA): To test and validate the proposed model

– Structural Equation Modeling (SEM): To examine the relationships among latent variables and overall model fit using indices such as:

– Chi–square (χ^2)

– Root Mean Square Error of Approximation (RMSEA)

– Comparative Fit Index (CFI)

7. Bias and Missing Data Considerations

Given the use of self–reported questionnaires, the study acknowledges the potential for social desirability bias, where respondents may over report positive behaviors (e.g., exercise frequency). To mitigate this, anonymity was assured and neutral language was used in all items.

For missing responses, the following protocol was applied:

– Responses missing more than 20% of items were excluded (n = 30)

– For questionnaires with minor missing data (<10%), mean imputation was used

– Logical inconsistencies (e.g., conflicting answers) were flagged and removed (n = 17)

This methodology ensures a rigorous, evidence–based approach to modeling physical activity habits. The use of expert consultation, validated instruments, and advanced statistical

analysis strengthens both the internal validity and external applicability of the study findings—particularly in the context of Chinese university students in Shenyang.

Research Results

Objective 1: Factor Weighting Using AHP

Based on expert ratings using the Analytic Hierarchy Process (AHP), the individual dimension received the highest total weighting (0.46), followed by society (0.28), school (0.14), and family (0.12) in Table 1.

Table 1 Delphi Method Selected Indicators and Revised Indicators

	Weight	Code	Corrected Code	Metric Layer	Weight
Individual	0.46	a1	e1	Initiative in participating in physical activities	0.0831
		a2	e2	Enjoyment, stress relief	0.0777
		a3	e3	Making friends and expanding social networks	0.312
		a4	e4	Personal fitness awareness	0.0541
		a5	e5	Satisfaction in achieving goals	0.0382
		a6		Avoidance of sports injuries	0.0617
		a7		Positive self-assessment	0.1575
		a8	e6	Enjoyment of physical activities	0.2157
Family	0.12	b1	e7	Parental involvement in physical activities	0.2321
		b2	e8	Parental knowledge of physical education and exercise habits	0.2262
		b3	e9	Family atmosphere for physical activity	0.2212
		b4	e10	Family economic conditions	0.0474
		b5		Grandparents' role in caregiving	0.0593
		b6		Communication and support from relatives	0.0402
		b7	e11	Parental education level	0.0623
		b8	e12	Parental management of children's time	0.1113
School	0.14	c1		Availability of school activity facilities	0.3056
		c2	e13	Participation in school sports clubs	0.2151
		c3	e14	Peer participation in physical activities	0.1232
		c4	e15	Academic pressure	0.0426
		c5	e16	Quality of sports instruction	0.1247
		c6	e17	School health records	0.0331
		c7		School health education programs	0.0561

	Weight	Code	Corrected Code	Metric Layer	Weight
		c8	e18	Physical education teachers' pedagogical philosophy	0.0996
Society	0.28	d1	e19	Participation in community sports organizations	0.0786
		d2		Daily walking and cycling distance	0.1037
		d3	e20	Access to sports and fitness information	0.0441
		d4	e21	Commercial fitness centers	0.0633
		d5	e22	Government–sponsored large–scale sports events	0.0852
		d6	e23	Fitness instructor qualifications	0.0563
		d7	e24	Accessibility of urban sports facilities	0.2526
		d8	e25	Government support for sports promotion	0.3162

Factors such as enjoyment of physical activity (e6) and initiative in participation (e1) received the highest weights within the individual domain, indicating the crucial role of internal motivation. In contrast, family economic condition (e10) and academic pressure (e15) received lower weights, suggesting limited direct influence on long–term habit formation.

Objective 2: Model Validation Using CFA and SEM

Initial CFA using 32 items showed poor model fit, requiring refinement. After eliminating 7 low–loading indicators and adjusting covariance's, the revised model with 25 items achieved acceptable fit:

Table 2 The results after fitted by SEM

Model	χ^2/df	RMSEA	CFI	GFI	PGFI
Initial	7.62	0.062	0.779	0.752	0.696
Adjusted	4.63	0.052	0.933	0.903	0.743

All factor loadings were ≥ 0.50, and composite reliability values exceeded 0.70. R^2 values ranged from 0.41 to 0.72, indicating strong explanatory power of the model. These results confirm a statistically valid and reliable structure.

Objective 3: Group Differences by Gender and Age

Gender Differences

A bar chart comparison (see Figure 2) reveals that male students reported higher PAH in the "Well" category, while female students showed higher frequencies in the "Moderate" and "Poor" levels. These differences were statistically significant ($p < 0.05$).

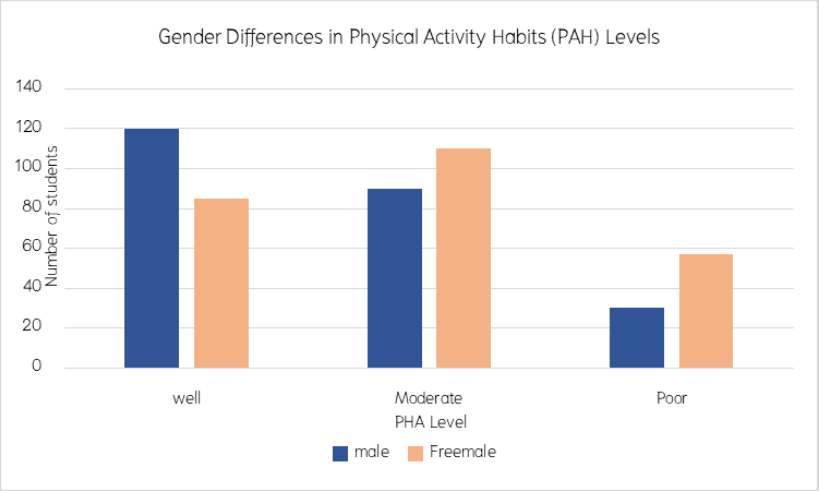

Figure 2 Bar chart comparing gender differences in PAH levels.

Notable findings from SEM analysis:

Male students scored significantly higher on indicators such as e1 (initiative), e6 (enjoyment), and e3 (social connections through exercise).

However, some female students also reported high levels of PAH, particularly in domains associated with stress relief and structured PE programs – indicating a possible anomaly contradicting traditional gender trends.

Effect sizes for gender differences (Cohen's d) ranged from 0.25 to 0.58, indicating small to moderate effects.

Family Income – Unexpected Outcome

Contrary to expectations, family economic status (e10) showed low weighting in AHP (0.0474) and non-significant factor loading in CFA (loading = 0.39, $p > 0.05$). This suggests that economic barriers may not be a major obstacle to PAH formation among students in Shenyang, possibly due to low-cost public exercise options or government initiatives.

Age Differences

Younger students (18–20) demonstrated higher motivation, greater peer influence, and more positive attitudes toward fitness. Older students (21–25) exhibited declines in initiative (e1) and enjoyment (e2) –likely due to academic workload.

Significant age differences were observed in:

– e14 (Peer participation) and e15 (Academic pressure) ($p < 0.05$)

– e22 (Government events) and e24 (Facility access)

Summary of Key Results

– Individual factors (e.g., self–efficacy, enjoyment) had the highest weight in PAH formation.

– Model refinement using CFA and SEM improved fit and revealed robust latent constructs.

– Gender and age differences were statistically significant across multiple dimensions.

– Some unexpected findings, such as low impact of family income and female students with high PAH levels, highlight the complexity of behavior formation.

Discussions

This study explored the multifaceted factors influencing physical activity habits (PAH) among university students in Shenyang City through expert–informed factor weighting (AHP), empirical validation (CFA and SEM), and analysis of demographic differences. Three key findings emerged, which are discussed below in the context of existing literature, theoretical implications, practical applications, and future research directions.

1. Theoretical Integration and Alignment with Previous Research

Findings from this study align with prior research emphasizing the critical role of individual–level psychological factors–particularly self–efficacy, intrinsic motivation, and enjoyment–in sustaining physical activity. These results support Social Cognitive Theory (Bandura), which posits that self–belief, outcome expectations, and environmental influences interact to shape behavior. Additionally, the identification of goal satisfaction and social connection as significant individual factors is consistent with Self–Determination Theory (Deci & Ryan), which highlights autonomy, competence, and relatedness as core drivers of motivation.

The AHP–derived weightings further reinforce behavioral theories: factors with the highest influence (e.g., initiative in physical activity, enjoyment, urban sports accessibility) reflect

components of operant conditioning—where rewards (enjoyment, social approval) reinforce behavior repetition. Conversely, lower-weighted factors such as academic pressure and economic constraints echo findings from Western and Eastern studies showing that structural and economic barriers are less predictive of habitual behavior than psychological engagement (Martina et al., 2020; Zhang et al., 2017).

2. Practical Applications and Policy Implications

The validated 25-item model provides strong empirical support for the following university-level strategies:

2.1 Promote Self-Efficacy through Campus Programs

Offer goal-based fitness challenges, personalized activity tracking, and positive reinforcement to enhance students' confidence in their abilities.

Integrate peer mentoring and fitness clubs that foster social connection and intrinsic motivation.

2.2 Restructure Physical Education (PE) Curricula

Move beyond mandatory PE for first-year students and implement ongoing physical activity options throughout the academic journey.

Include gender-sensitive activities such as yoga, dance, and non-competitive fitness programs to engage female students more effectively.

2.3 Improve Facility Access and Environment

Increase availability and accessibility of urban sports facilities, especially for off-campus students.

Partner with local governments and communities to offer subsidized gym access and host joint sports events.

2.4 Family and Community Engagement

Universities should collaborate with families and communities by offering health education workshops that promote active lifestyles across generations.

3. Unexpected Findings

3.1 Low Impact of Family Economic Status

While prior research (Dumith et al., 2011) often emphasizes economic background, this study found family income to be one of the least influential factors in PAH. This may reflect the accessibility of public and low-cost exercise resources in urban China, and growing normalization of activity among economically diverse groups.

3.2 Gender–Based Anomalies

Although male students overall reported higher PAH levels, some female students demonstrated unexpectedly high scores in motivation and peer–based engagement. These findings suggest that female students may be underrepresented in structured sports but actively engaged in informal or non–competitive exercise formats, pointing to a need for more inclusive program design.

4. Limitations and Future Research

Regional Constraints

The study was conducted solely in urban universities in Shenyang City, limiting generalizability. PAH dynamics may differ considerably in rural areas, where access to facilities, family influence, and cultural attitudes may vary. Rural youth may rely more on physical labor but lack structured sports opportunities.

Cross–Sectional Design

As this study is cross–sectional, it cannot establish causality or track behavioral change over time. A longitudinal study would allow researchers to:

- Monitor how habits evolve across academic years
- Evaluate the long–term effects of interventions
- Detect seasonal or environmental influences (e.g., winter inactivity)

Self–Report Bias

The reliance on self–reported PAH data may be subject to social desirability bias, potentially inflating activity levels. Future studies should incorporate objective measures (e.g., pedometers, fitness tracking apps) alongside questionnaires.

Knowledge from Research

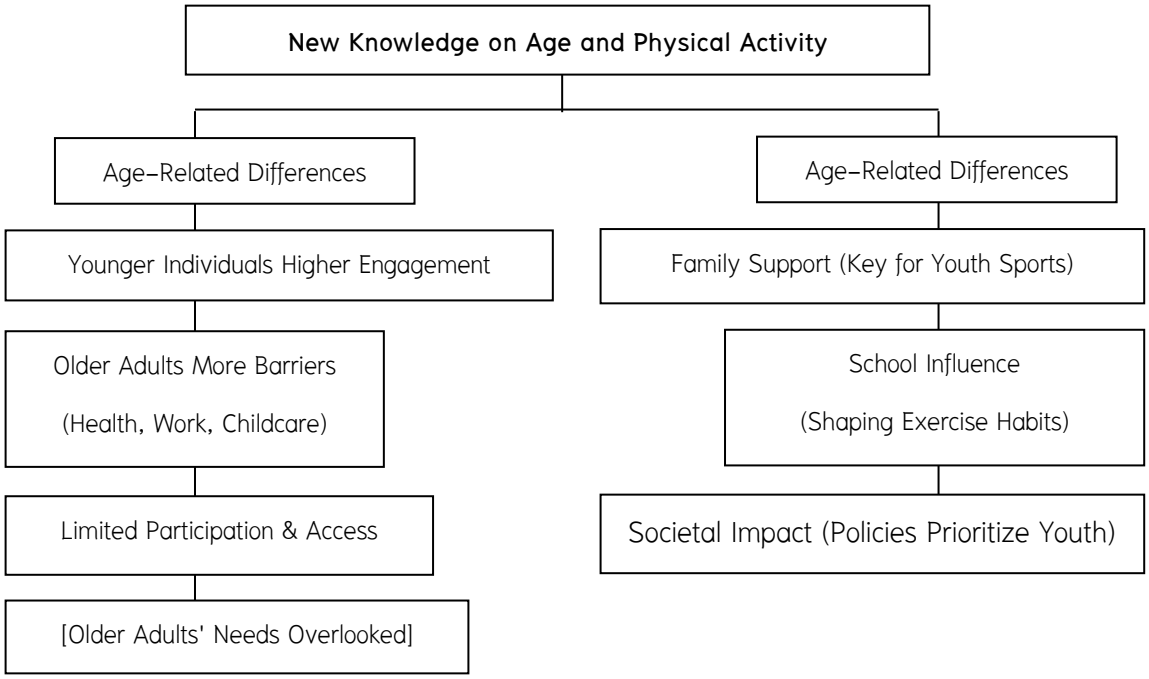

Figure 3 Knowledge from Research

Age significantly influences physical activity participation across personal, family, school, and societal levels. Younger individuals show greater engagement, while older adults face barriers such as health issues and responsibilities. Family support is crucial for youth sports involvement, whereas adult participation is often limited by work and childcare duties. Schools play a key role in shaping exercise habits, but sports emphasis decreases with age. At the societal level, policies and resource allocation prioritize youth, while older adults' sports needs are often overlooked.

Conclusion

This study developed and validated a multi–dimensional model to explain the formation of physical activity habits (PAH) among university students, using a hybrid Delphi–AHP–CFA methodology. By combining expert insight with statistical rigor, the model enables researchers and practitioners to prioritize influencing factors based on both theoretical relevance and empirical evidence.

One of the key contributions of this study lies in its practical application for intervention planning. The model allows universities and health educators to strategically allocate resources–focusing on high–impact areas such as self–efficacy enhancement, peer engagement, and

accessible fitness environments. Rather than applying one-size-fits-all solutions, institutions can now tailor interventions to students' psychological profiles and contextual barriers.

Moreover, the methodology employed in this research offers a flexible and transferable framework. The Delphi–AHP–CFA approach can be applied to other health behavior studies, such as nutrition, sleep hygiene, or screen time reduction–especially in cases where both expert opinion and behavioral theory must be integrated with field data.

Looking ahead, future research should consider incorporating digital tools to improve PAH tracking and engagement. Fitness apps, wearables, and mobile behavioral feedback systems could provide real-time insights and reinforce habit formation. Additionally, the potential for AI-driven recommendation engines–which adapt to users' behavior patterns, motivations, and preferences–represents a promising frontier in personalized health promotion.

Finally, expanding this model across different cultural, institutional, and regional contexts–especially in rural or resource-limited settings–can offer a more comprehensive understanding of PAH dynamics. Longitudinal research and integration with real-world data platforms will be essential for scaling and sustaining physical activity interventions in university populations and beyond.

Suggestions

Institutions should implement gender-sensitive fitness programs that address barriers faced by different student groups, and develop peer mentorship initiatives to enhance motivation and accountability in physical activity engagement.

The Ministry of Education should consider mandating PAH tracking as part of routine student health assessments. In addition, financial or academic incentives could be introduced to encourage sustained participation in physical activity programs.

Universities are encouraged to adopt mobile health applications to support habit tracking and personalized goal-setting. Incorporating gamification elements–such as badges, leaderboards, or point systems—can further enhance student engagement.

Future studies should: Include diverse samples across cultures and regions for broader generalizability. Investigate how digital tools and online communities influence long-term motivation and behavior change. Explore how PAH evolves from adolescence to adulthood, using longitudinal designs and possibly AI-based personalization for deeper insights.

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