

ปัจจัยที่มีผลต่อการพัฒนาสมรรถภาพทางกายของนักศึกษาในมหาวิทยาลัยมณฑลซานซี

Factors Affecting the Development of Physical Fitness among

University Students in Shanxi Province

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บทคัดย่อ

วัตถุประสงค์ของการศึกษานี้: (1) เพื่อสำรวจปัจจัยที่มีอิทธิพลต่อการออกกำลังกายของนักศึกษาระดับอุดมศึกษา (2) วิเคราะห์ปัจจัยใดที่มีผลกระทบทางตรงหรือทางอ้อมต่อการพัฒนาสมรรถภาพทางกายของนักศึกษาระดับอุดมศึกษา และ (3) เพื่อเป็นพื้นฐานในการกำหนดนโยบายส่งเสริมสมรรถภาพทางกายของนักศึกษาระดับอุดมศึกษา โดยการศึกษาความสัมพันธ์ระหว่างความเข้มข้นและความถี่ของกิจกรรมกีฬา การจัดองค์กรกิจกรรมกีฬาในสถาบันอุดมศึกษา ทรัพยากรและสภาพแวดล้อมด้านกีฬาในสถาบันอุดมศึกษา การสนับสนุนและการปฏิสัมพันธ์ทางสังคม ตลอดจนการรับรู้และแรงจูงใจด้านกีฬาต่อการพัฒนาสมรรถภาพทางกายของนักศึกษาระดับอุดมศึกษา ได้ทำการทดสอบความสอดคล้องของแบบจำลองสาเหตุที่สร้างขึ้นจากข้อมูลเชิงประจักษ์ และสำรวจผลกระทบทางตรงและทางอ้อมของตัวแปรสาเหตุต่อการพัฒนาสมรรถภาพทางกายของนักศึกษาระดับอุดมศึกษาในมณฑลซานซี การศึกษานี้ได้เลือกกลุ่มตัวอย่างนักศึกษาประมาณ 150,000 คน จาก 5 มหาวิทยาลัยในมณฑลซานซี รวมถึงมหาวิทยาลัยซานซี เครื่องมือที่ใช้ในการเก็บรวบรวมข้อมูลคือแบบสอบถาม โดยใช้วิธีการสุ่มตัวอย่างอย่างง่ายและการสุ่มตัวอย่างแบบแบ่งชั้น เลือกกลุ่มตัวอย่างจำนวน 538 คน วิเคราะห์ข้อมูลโดยใช้ซอฟต์แวร์ SPSS27 และ AMOS26 ความเที่ยงตรงของแบบสอบถามมีค่าดัชนี IOC อยู่ระหว่าง 0.6-1.0 และความเชื่อมั่นเท่ากับ 0.976 วิเคราะห์ข้อมูลโดยใช้วิธีการวิเคราะห์เส้นทาง ผลการวิจัยพบว่า ตัวแปรแต่ละตัวมีความสัมพันธ์ทางบวกอย่างมีนัยสำคัญกับการพัฒนาสมรรถภาพทางกายของนักศึกษาในระดับ 0.01 แบบจำลองปัจจัยสาเหตุที่ตั้งสมมติฐานซึ่งมีอิทธิพลต่อการพัฒนาสมรรถภาพทางกายมีความสอดคล้องกับข้อมูลเชิงประจักษ์ ($\chi^2/df=1.19$, GFI=0.844, AGFI=0.836, RMSEA=0.019, SRMR=0.07) ผลกระทบรวมของความเข้มข้นและความถี่ในการออกกำลังกายที่มีต่อการพัฒนาสมรรถภาพทางกายของนักศึกษามีค่ามากที่สุด (0.254) รองลงมาคือ สภาพแวดล้อมและทรัพยากรด้านกีฬาในสถาบันอุดมศึกษา (0.251) การสนับสนุนและการปฏิสัมพันธ์ทางสังคม (0.224) แรงจูงใจและการรับรู้ในการออกกำลังกาย (0.193) และสุดท้ายคือองค์กรกิจกรรมเชิงปฏิสัมพันธ์ในสถาบันอุดมศึกษา (0.134) ตัวแปรที่มีอิทธิพลทางตรงมากที่สุดคือการสนับสนุนและการปฏิสัมพันธ์ทางสังคม (0.224) รองลงมาคือแรงจูงใจและการรับรู้ในการออกกำลังกาย (0.193) สภาพแวดล้อมและทรัพยากรด้านกีฬาของสถาบันอุดมศึกษา (0.169) ความเข้มข้นและความถี่ในการออกกำลังกาย (0.155) และการจัดองค์กรกิจกรรมกีฬา (0.134) ตัวแปรที่มีอิทธิพลทางอ้อมมากที่สุด ได้แก่ การปฏิสัมพันธ์และการสนับสนุนทางสังคม (0.417) และแรงจูงใจและการรับรู้ในการออกกำลังกาย (0.379) ตามลำดับ

คำสำคัญ: นักศึกษามหาวิทยาลัย, สมรรถภาพทางกาย, การสนับสนุนทางสังคม, ทรัพยากรด้านกีฬา

Abstract

The objectives of this study were to: (1) explore factors influencing physical exercise among higher-education students; (2) analyze which factors have direct or indirect effects on the development of physical fitness among higher-education students; and (3) provide a basis for developing policies to promote physical fitness among higher-education students. The study examined the relationships between (a) exercise intensity and frequency, (b) the organization of sports activities in higher-education institutions, (c) sports resources and the sports environment in higher-education institutions, (d) social support and social interaction, and (e) sport-related cognition and motivation, and their effects on the development of physical fitness among higher-education students in Shanxi Province. A causal model developed from empirical data was tested for model fit, and the direct and indirect effects of the causal variables were examined. The population comprised approximately 150,000 students from five universities in Shanxi Province (including Shanxi University). Data were collected using a questionnaire. Simple random sampling and stratified sampling were used to select 538 participants. Data were analyzed using SPSS 27 and AMOS 26. The questionnaire content validity (IOC) ranged from 0.6 to 1.0, and reliability was 0.976. Path analysis showed that each variable was significantly and positively related to physical fitness development at the 0.01 level. The hypothesized causal model was consistent with the empirical data ($\chi^2/df = 1.19$, GFI = 0.844, AGFI = 0.836, RMSEA = 0.019, SRMR = 0.07). The largest total effect on physical fitness development was exercise intensity and frequency (0.254), followed by sports environment and resources in higher-education institutions (0.251), social support and interaction (0.224), exercise motivation and cognition (0.193), and the organization of sports activities in higher-education institutions (0.134). The largest direct effect was social support and interaction (0.224), followed by exercise motivation and cognition (0.193), sports environment and resources (0.169), exercise intensity and frequency (0.155), and the organization of sports activities (0.134). The largest indirect effects were social support and interaction (0.417) and exercise motivation and cognition (0.379).

Keywords: University students, Physical fitness, Social support, Sports resources.

1. Introduction

With the development of the socioeconomy and the continuous improvement of people's living standards, health has become a key focus of national attention. As the country's future, the physical fitness of university students is directly related to national development and long-term interests. In recent years, all sectors of society have paid increasing attention to the physical health of university students. The government, universities, families, and other stakeholders have participated in efforts to promote students' physical fitness. With the deepening of education reform, the role of sport and physical education in cultivating students' holistic development has become increasingly prominent. Many universities have included physical exercise as a compulsory course, increased physical education contact hours, and improved teaching quality. Improvements in campus sports facilities have also provided more opportunities

and conditions for students to engage in physical activity, promoting the formation of regular exercise habits (Xu Xiaohong, 2021). The 2014 National Physical Fitness Monitoring Bulletin reported that, among adult males aged 19–22 years, abilities such as speed, endurance, and explosive power showed a downward trend, indicating declines in these aspects of physical fitness (Wang Lin, 2015). Scholars have also noted that the future development of Chinese society depends on the overall quality of its people. In the classic article On Youth China, the importance of young people’s physical fitness is emphasized, stating that the strength of young people is related to the strength of the nation.

Research objectives. This study aimed to: (1) investigate factors influencing physical exercise among university students in Shanxi Province; (2) analyze the direct and indirect effects of these factors on students’ physical fitness improvement; and (3) provide a basis for formulating region-specific policies to promote university students’ physical fitness.

Research hypotheses. The hypotheses were as follows: H1: Exercise intensity and frequency directly improve university students’ physical fitness. H2: Exercise intensity and frequency indirectly improve physical fitness through social support and interaction. H3: Social support and interaction directly improve physical fitness. H4: University sports organization directly improves students’ physical fitness. H5: University sports resources and environment directly improve students’ physical fitness. H6: University sports resources and environment indirectly improve physical fitness through exercise motivation and cognition. H7: Exercise motivation and cognition directly improve students’ physical fitness.

Conceptual framework. This study examined factors influencing physical fitness improvement among university students in Shanxi Province. The model included three predictor variables (exercise intensity and frequency; university sports organization; and university sports resources and environment), two mediating variables (social support and interaction; and exercise motivation and cognition), and one criterion variable (physical fitness improvement among university students). The hypothesized relationships among variables are shown in Figure 1.

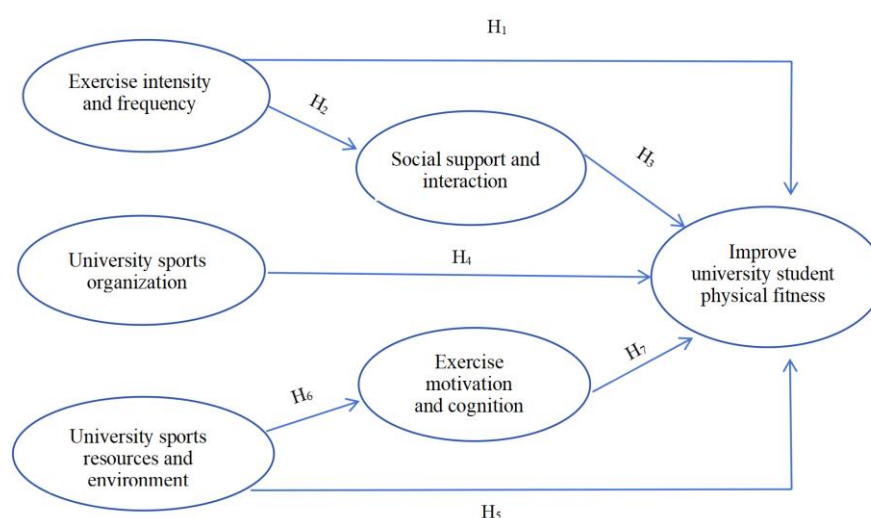


Figure 1. Research conceptual framework.

2. Materials and methods

2.1 Population and Sample

The target population comprised undergraduate and postgraduate students from five major universities in Taiyuan, Shanxi Province: Shanxi University, Taiyuan University of Technology, Shanxi Medical University, North University of China, and Shanxi Normal University, with a combined enrollment of approximately 153,000 students.

Stratified random sampling was used. First, universities were stratified by student population size. Then, within each stratum, students were randomly selected from undergraduate, master's, and doctoral programs in proportion to their numbers at each university. This procedure yielded a final sample of 538 students. The sample distribution is shown in Table 1.

Table 1. University Student Population and Sample Size

University	Student Population	Sample Size	Undergraduate	Master's	Doctoral
1	22,084	78	63	12	3
2	23,000	81	66	12	3
3	30,000	105	86	14	5
4	36,000	127	103	18	6
5	42,000	147	121	19	7
Total	153,084	538	439	75	24

Data were collected using a six-part questionnaire developed through a synthesis of established literature in sports science and health behavior. Specifically, perceived stress-related components were adapted from the Perceived Stress Scale (Cohen et al., 1983), while exercise motivation and cognition were operationalized in accordance with the self-determination theory framework (Teixeira et al., 2012). Other domains, including university sports resources and environment, social support and interaction, and physical fitness improvement, were formulated based on prior research in sport participation and health behavior. All items were rated on a 5-point Likert scale. Internal consistency reliability was assessed for each domain, with Cronbach's alpha coefficients indicating acceptable levels.

The questionnaire comprised six domains:

- 1) Exercise intensity and frequency (15 items)
- 2) Organization of university sports activities (15 items)
- 3) University sports resources and environment (17 items)
- 4) Social support and interaction (15 items)
- 5) Exercise motivation and cognition (15 items)
- 6) Physical fitness improvement among university students (15 items)

2.2 Tryout and quality of the research instruments

1) To develop the conceptual framework, formulate hypotheses, and design the sampling plan, the researchers reviewed relevant literature, concepts, theories, and prior studies on factors influencing university students' physical fitness improvement, and then defined the population and sample.

2) Based on the literature review, the researchers developed and refined the questionnaire items and overall instrument structure for data collection.

3) The draft questionnaire was submitted to the thesis supervisor to review language accuracy, clarity, and coverage consistent with the study scope and operational definitions.

4) After revision based on the supervisor's feedback, the questionnaire was sent to five experts to assess content validity. The index of item-objective congruence (IOC) was calculated, and items with IOC values of 0.60–1.00 were retained.

5) The questionnaire was revised in line with expert suggestions and resubmitted to the thesis supervisor for final review.

6) Reliability was examined using Cronbach's alpha. In general, an alpha coefficient above 0.75 indicates acceptable internal consistency.

2.3 Data collection

After the questionnaire was finalized, it was digitized and distributed via the online survey platform "Questionnaire Star." The survey link was shared through WeChat groups and by direct distribution, and paper-based questionnaires were also administered in parallel. After data collection, incomplete or invalid questionnaires were removed, and the remaining valid responses were used for descriptive statistics and subsequent analyses.

In collecting data, the researcher followed these steps:

1) Contacted the five universities in Shanxi Province to obtain permission to collect data from the participating institutions.

2) Submitted official request letters to university administrators and coordinated with relevant staff to schedule data collection.

3) Administered the questionnaire covering exercise intensity and frequency, organization of sports activities, sports resources and environment, social support and interaction, exercise motivation and cognition, and physical fitness improvement (January–February 2025). The researchers collected the data themselves.

4) Before administering the questionnaire, established rapport with participants by creating a friendly environment and encouraging them to provide accurate responses.

5) Explained the purpose of the study and the response instructions to ensure participants understood how to complete the questionnaire.

2.4 Data analysis

This article presents the data analysis results in five parts, as follows:

Part 1: Results of the examination of data distribution characteristics.

Part 2: Effects of exercise intensity and frequency, university sports organization, university sports resources and environment, social support and interaction, and exercise motivation and cognition on physical fitness improvement among university students.

Part 3: Results of the analysis of relationships among the variables (exercise intensity and frequency, university sports organization, university sports resources and environment, social support and interaction, and exercise motivation and cognition).

Part 4: Results of the examination of model fit between the empirically constructed causal model and the observed data.

Part 5: Results of the analysis of the direct and indirect effects of causal factors on physical fitness improvement among university students.

3. Results

Part 1. Descriptive statistics (mean, standard deviation, and coefficient of variation) were used to summarize each observed variable. The distribution of the data was examined using skewness and kurtosis, and the p-values of the χ^2 statistics for normality testing are reported in Table 2.

Table 2. Mean, standard deviation, distribution coefficient, skewness, kurtosis, and chisquare statistic values for testing the normal distribution of each observed variable

observable Table	min	max	$\bar{x}$	S.D.	SK	KU	C.V.	p of χ^2
EF	1.00	5.00	3.63	0.78	-1.60	-0.11	0.35	0.96
USO	1.00	5.00	3.70	0.70	-1.47	0.08	0.34	0.97
USE	1.00	5.00	3.73	0.69	-1.54	0.06	0.31	0.97
SSI	1.00	5.00	3.55	0.79	-1.38	0.03	0.30	0.98
EMC	1.00	5.00	3.65	0.78	-1.53	-0.05	0.29	0.95
IUSF	1.00	5.00	3.61	0.80	-1.43	0.07	0.32	0.98

As shown in Table 2, the minimum and maximum values for all dimensions (exercise intensity and frequency; university sports resources and environment; organization of university sports activities; social support and interaction; exercise motivation and cognition; and physical fitness improvement) were 1.00 and 5.00, respectively. Mean values ranged from 3.61 to 3.73, with standard deviations ranging from 0.69 to 0.80. The absolute values of the skewness coefficients were all below 3, with a standard error of 0.105, and the absolute values of the kurtosis coefficients were all below 10, with a standard error of 0.210. These values fall within acceptable ranges, indicating that the data were suitable for further analysis.

Part 2. The descriptive results indicate that the five hypothesized causal factors (exercise intensity and frequency; university sports organization; university sports resources and environment; social support and interaction; and exercise motivation and cognition) were all positively associated with physical fitness improvement among university students.

Table 3. The mean and standard deviation of the six variables

NO.	variables	$\bar{x}$	S.D.	level
1	Exercise intensity and frequency	3.63	0.78	agree
2	university sports organization	3.71	0.70	agree
3	university sports resources and environment	3.73	0.69	agree
4	social support and interaction	3.55	0.79	agree
5	exercise motivation and cognition	3.65	0.78	agree
6	the improvement of college students' physical fitness	3.61	0.80	agree

As shown in Table 3, the mean score for exercise intensity and frequency was 3.63 (S.D. = 0.78). The mean score for university sports organization was 3.71 (S.D. = 0.70). The mean score for university sports resources and environment was 3.73 (S.D. = 0.69). The mean score for social support and interaction was 3.55 (S.D. = 0.79). The mean score for exercise motivation and cognition was 3.65 (S.D. = 0.78). Finally, the mean score for physical fitness improvement among university students was 3.61 (S.D. = 0.80). Overall, all variables were at the “agree” level.

Part 3. This part presents the results of the relationship analysis among exercise intensity and frequency, university sports organization, university sports resources and environment, social support and interaction, and exercise motivation and cognition.

Pearson’s correlation coefficients were calculated to examine the relationships between the causal variables and physical fitness improvement among university students.

Table 4. Matrix of the correlation coefficient between the causal variables and improvement of university students' physical fitness

Variables	EF	USO	USE	SSI	EMC	IUSF
EF	1.00					
USO	.46**	1.00				
USE	.42**	.31**	1.00			
SSI	.44**	.47**	.42**	1.00		
EMC	.32**	.34**	.40**	.37**	1.00	
IUSF	.43**	.41**	.42**	.45**	.40**	1.00

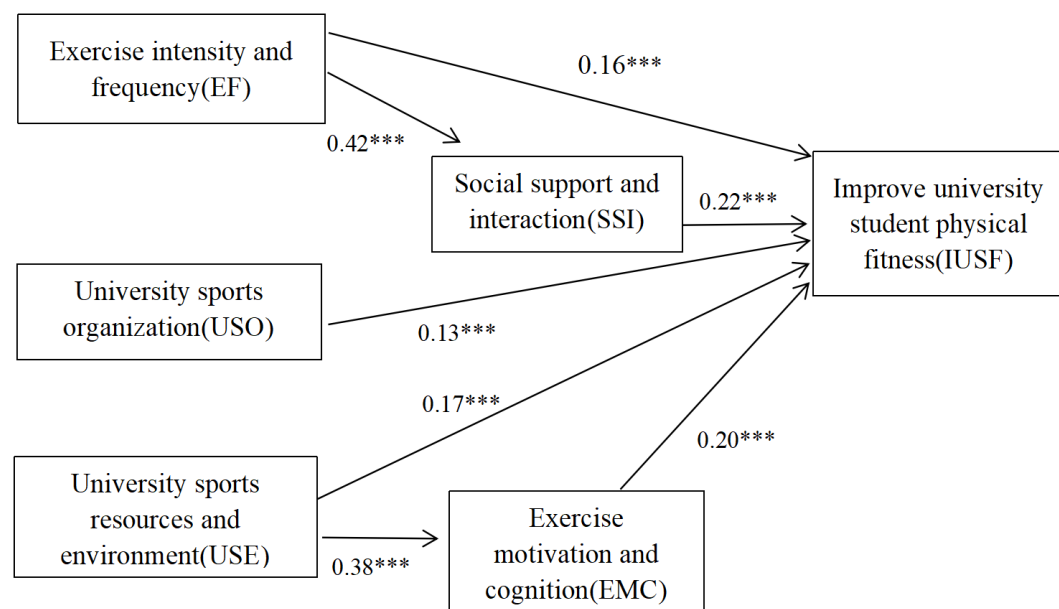
** $p < 0.01$

Pearson correlation was used to analyze the correlations among exercise intensity and frequency, school sports resources and environment, school sports activity organization, social support and interaction, exercise motivation, cognition, and physical fitness improvement. It can be seen from the table 4.

As shown in Table 4, exercise intensity and frequency were significantly and positively correlated with university sports resources and environment, university sports organization, social support and interaction, exercise motivation and cognition, and physical fitness improvement (correlation coefficients = 0.423, 0.462, 0.439, 0.324, and 0.431, respectively; all $p < 0.01$). University sports resources and environment were also significantly and positively correlated with university sports organization, social support and interaction, exercise motivation and cognition, and physical fitness improvement (correlation coefficients = 0.313, 0.415, 0.400, and 0.422, respectively; all $p < 0.01$). University sports organization was significantly and positively correlated with social support and interaction, exercise motivation and cognition, and physical fitness improvement (correlation coefficients = 0.470, 0.341, and 0.413, respectively; all $p < 0.01$). In addition, social support and interaction were significantly and positively correlated with exercise motivation and cognition and with physical fitness improvement (correlation coefficients = 0.367 and 0.452, respectively; both $p < 0.01$).

Part 4. This part reports the results of examining the fit of the empirically constructed causal model to the observed data.

Because the model fit the empirical data, the direct and indirect effects of the causal variables on physical fitness improvement were analyzed, as illustrated in Figure 2.



Note: *** indicates $p < 0.001$

Figure 2 A causal factor model affecting the improvement of university students' physical fitness

Path analysis was used to test the hypothesized relationships. As shown in Figure 2, all paths were statistically significant ($p < 0.05$), indicating that the hypothesized relationships were supported; therefore, all hypotheses were accepted.

Part 5. This part presents the results of the direct and indirect effects of the causal factors on physical fitness improvement among university students.

Table 5. Direct effects (DE), indirect effects (IE), and total effects (TE) on physical fitness improvement among university students

Effect Variable	R ²	Influence Variable	Causal Variable Effects (Standardized)				
			EF	USO	USE	SSI	EMC
SSI	0.048	DE	0.417	-	-	-	-
		IE	-	-	-	-	-
		TE	0.417	-	-	-	-
EMC	0.045	DE	-	-	0.379	-	-
		IE	-	-	-	-	-
		TE	-	-	0.379	-	-
IUSF	0.051	DE	0.155	0.134	0.169	0.224	0.193
		IE	0.099	-	0.082	-	-
		TE	0.254	0.134	0.251	0.224	0.193

As shown in Table 5, among the factors influencing physical fitness improvement among university students, exercise intensity and frequency had the largest total effect (0.254), followed by university sports resources and environment (0.251), social support and interaction (0.224), exercise motivation and cognition (0.193), and university sports organization (0.134).

The results of the data analysis to answer the research hypothesis are as follows: (1) The correlation analysis showed significant positive relationships between the causal variables and physical fitness improvement, with correlation coefficients ranging from 0.399 to 0.452 ($p < 0.01$). The strongest correlation with physical fitness improvement was social support and interaction (0.452), followed by exercise intensity and frequency (0.431), university sports resources and environment (0.422), university sports organization (0.413), and exercise motivation and cognition (0.399). (2) The path analysis results showed that exercise intensity and frequency had the greatest total effect on physical fitness improvement (0.254), followed by university sports resources and environment (0.251), social support and interaction (0.224), exercise motivation and cognition (0.193), and university sports organization (0.134). The analysis also indicated that exercise intensity and frequency affected physical fitness improvement indirectly through social support and interaction, and that university sports resources and environment affected physical fitness improvement indirectly through exercise motivation and cognition.

4. Discussion

This study developed and tested an integrated model to explain physical fitness improvement among university students in Shanxi Province, China. The findings support the multifaceted nature of physical fitness determinants, suggesting that individual exercise behaviors, institutional conditions, and social-psychological processes jointly influence fitness outcomes.

Exercise intensity and frequency showed the largest total effect, which is consistent with evidence that an adequate exercise dose is essential for improving physical fitness (World Health Organization, 2020). The significant indirect effect through social support and interaction suggests that, in this context, social dynamics may help students sustain higher-intensity or more frequent exercise. This is in line with Wang et al. (2023), who reported a mediating role of social support in the relationship between exercise intensity and cardiorespiratory fitness.

University sports resources and environment also demonstrated a strong total effect, underscoring the importance of material and spatial conditions for physical activity. The significant indirect path through exercise motivation and cognition suggests that well-designed, accessible facilities may not only enable activity but also strengthen positive exercise beliefs and motivation, as noted by Giles-Corti et al. (2005) in related environmental research.

Social support and interaction exhibited the strongest direct effect on physical fitness improvement. This highlights the potential importance of peer encouragement, guidance from instructors or coaches, and shared participation experiences in promoting fitness-related outcomes. The finding is broadly consistent with evidence that social support is associated with higher physical activity participation (Beets et al., 2010).

4.1 Theoretical and practical implications

Theoretically, the proposed model helps clarify the pathways through which behavioral, environmental, and social factors relate to students' physical fitness improvement and may complement perspectives such as Social Cognitive Theory. Practically, for university administrators and policymakers in Shanxi Province and similar settings, the results suggest that single-component interventions may be insufficient. More effective strategies are likely to combine investments in facilities with program design and social supports, for example:

- 1) Infrastructure investment: Maintain and expand high-quality, accessible sports facilities.
- 2) Social scaffolding: Establish mentorship programs, "sports buddy" systems, and inclusive club cultures to strengthen supportive networks.
- 3) Motivational design: Design sports programs and communications that emphasize mastery, enjoyment, and personal growth (intrinsic motivation), rather than focusing only on competition.

4.2 Limitations and future research

This study has several limitations. First, the cross-sectional design limits causal interpretation. Second, although the sample size was adequate, participants were drawn from a single province, which may limit generalizability. Third, physical fitness improvement was assessed via self-report and may be

subject to response bias. Future research should consider longitudinal or experimental designs, incorporate objective fitness measures, and examine additional moderators and mediators (e.g., sport type and gender differences). Replicating the model in other regional contexts would also be valuable.

5. Conclusion and suggestions

5.1 Conclusion

This study identified and quantified interrelated factors associated with physical fitness improvement among university students in Shanxi Province. The findings suggest that fitness outcomes are shaped not only by individual exercise behaviors, but also by the availability of university sports resources and the social environment that supports participation. Overall, the results provide empirical evidence that may inform integrated, multi-level policies and programs aimed at promoting university students' physical fitness.

5.2 Suggestions for future research

5.2.1 Refine exercise “dose” classifications (intensity and frequency). Future studies could classify exercise intensity (e.g., low, moderate, high) and frequency (e.g., daily, several times per week) more precisely to examine whether different combinations have distinct effects on physical fitness improvement and to support more tailored recommendations.

5.2.2 Examine specific forms of social support and interaction. Future research may analyze how different sources of support (e.g., friends, family, instructors, and sports clubs) relate to exercise persistence and effectiveness, and whether these pathways differ across student subgroups.

5.2.3 Model the combined effects of multiple factors. Building on the current findings, researchers could develop and test a more comprehensive model that incorporates exercise behavior, social support, university sports resources and environment, sports activity organization, and exercise motivation and cognition to better understand their interactions and overall effects on physical fitness improvement.

6. References

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