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SCIENTIFIC PRESS PTE.LTD.

Molecular & Cellular Biomechanics 2025, 22(2), 789.
https://doi.org/10.62617/mcb789

Article

The relationship between the quality of sports facilities and people's satisfaction with exercise—The chain mediating effect of active participation and self-efficacy in the context of biomechanics

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CITATION

Wang L, Wang P. Sun S, Fan Y. The relationship between the quality of sports facilities and people's satisfaction with exercise—The chain mediating effect of active participation and self-efficacy in the context of biomechanics. Molecular & Cellular Biomechanics. 2025; 22(2): 789. https://doi.org/10.62617/mcb789

ARTICLE INFO

Received: 13 November 2024
Accepted: 11 December 2024
Available online: 21 January 2025

Abstract: In order to explore the relationship between active participation and self-efficacy in the quality of sports facilities and exercise satisfaction, this study takes into account the perspective of biomechanics. A survey was conducted among 361 urban residents aged 16 and above in Yongzhou City. The "Sports Facilities Quality Scale", "Active Participation Scale", "Self-Efficacy Scale", and "Exercise Satisfaction Scale" were utilized, with an added consideration of biomechanical factors. Biomechanics, which examines the mechanical aspects of human movement during exercise, provides a crucial framework for understanding how sports facilities interact with the human body. High - quality sports facilities, designed in accordance with biomechanical principles, can significantly influence the physical experience of exercise. For example, the surface material and structure of a running track can affect the impact forces on joints during running, and the ergonomic design of fitness equipment can enhance the efficiency and comfort of movements. These biomechanical factors directly impact a person's active participation in exercise. When facilities are biomechanically optimized, individuals are more likely to engage actively in physical activities, as they experience less discomfort and reduced risk of injury. The results showed that: 1) The quality of sports facilities, active participation, self-efficacy and exercise satisfaction were significantly correlated with each other. 2) Active participation played a single intermediary role between the quality of sports facilities and exercise satisfaction, accounting for 26.81% of the total effect, and self-efficacy played a single intermediary role between the quality of sports facilities and exercise satisfaction; Active participation and self-efficacy play a chain intermediary role between the quality of sports facilities and exercise satisfaction, accounting for 26.34% of the total effect. Conclusion: Considering biomechanics, the quality of sports facilities indirectly affects the exercise satisfaction of urban residents in Yongzhou City through the chain mediation of active participation and self - efficacy. In the context of national fitness, high - quality sports facilities, designed with biomechanical principles in mind, play a positive and crucial role in promoting residents' physical exercise, as they can enhance the overall exercise experience from a biomechanical perspective.

Keywords: sports facility quality; active participation; self-efficacy; exercise satisfaction; chain mediation effect; biomechanics

1. Introduction

With the promulgation and implementation of policies such as the National Fitness Program (2021–2025), the Outline of Building a Strong Sports Country and the Opinions on Building a Higher Level of Public Service System for National Fitness, the social atmosphere of national fitness and scientific fitness has become more and more intense, and physical fitness has been regarded as a healthy lifestyle by more and

more people. Develop the habit of regular fitness and pursue more convenient and intelligent fitness facilities.

In 2014, the number of Chinese people who frequently participated in sports exercises was 360 million. After six years of promotion and development, this figure has increased to 435 million. The number of people who frequently participate in sports exercises has reached 530 million, which is the target of the Healthy China 2030 initiative.

Under the environment that the country attaches great importance to sports and national fitness, with the development of China's economy [1] and the improvement of people's living standards, people's demand for physical exercise is expanding, and more and more people are willing to take the initiative to participate in physical exercise. At this time, the quality of sports facilities is very important to people's satisfaction with physical exercise. The state's quality control standards for sports facilities are becoming more and more stringent. In physical exercise, the better the quality of sports facilities, the more obvious the effect of people's physical exercise, and the more satisfied the sense of self-efficacy.

2. Theoretical basis and research hypothesis

2.1. The relationship between the quality of sports facilities and exercise satisfaction

The quality of sports facilities refers to the degree to which people meet the requirements for the inherent characteristics of fixed facilities such as various venues, venues and buildings used for sports competitions, training, teaching and mass fitness activities. With the increasing demand for national exercise, the state pays more and more attention to the quality of sports facilities. It has issued a series of important policy documents, such as "Opinions on Promoting National Fitness and Sports Consumption to Promote the High-quality Development of Sports Industry", "Opinions on Strengthening the Construction of National Fitness Facilities and Developing Mass Sports", and "National Fitness Plan (2021–2025)".The guarantee of the quality of sports facilities is an important condition for the realization of citizens' sports rights; the guarantee of the quality of sports facilities is an important part of the construction of the public service system of national fitness; the guarantee of the quality of sports facilities is an important link to speed up the construction of a strong sports country. Exercise satisfaction refers to the degree of comparison between people's actual feelings of physical exercise and their expectations. With the improvement of the quality of sports facilities, people's actual satisfaction with physical exercise is rising. At present, there are many studies on the relationship between the quality of sports facilities and exercise satisfaction in China, but there are relatively few studies on the mechanism of action. In this paper, the relationship between the quality of sports facilities and the satisfaction of exercise is investigated by drawing on the empirical research results of the National Fitness Monitoring Center's "Survey Bulletin of National Fitness Activities in 2020" and Yongzhou Cultural Tourism Radio and Television Sports Bureau's "Yongzhou National Fitness Data Report", which mainly focus on the urban residents of Yongzhou City. Wei and

Deng [2], after research, discussed how various aspects of sports facilities (such as safety, accessibility, cleanliness) affect user satisfaction and participation in sports activities. Chen [3] compared the user experience and satisfaction of different types of sports facilities, providing an in-depth analysis of the quality of the facilities. Jin et al. [4] studied and analyzed the relationship between the quality of sports facilities and the level of physical activity and satisfaction among adults.

According to the theory of emotional effect of physical exercise, the positive impact of sports facility quality on residents' satisfaction with exercise has been verified to a certain extent in the existing research. Many studies have shown that high-quality sports facilities can effectively improve the satisfaction of physical exercise. Based on the statistical analysis of the data of sports facilities, this paper holds that sports facilities are the guarantee of residents' physical exercise, and the types, service quality and intellectualization of facilities play a major role in teenagers' physical exercise. Under the environment of national fitness, the construction of sports facilities has gradually attracted the attention of the public. As the most basic building of the country, community sports facilities are directly related to the improvement of the quality of national sports [5]. Community sports facilities have made great contributions to make up for the shortage of urban gymnasiums, but there are many similarities in the existing community sports facilities, which are only matched to meet the basic needs [6]. During the 13th Five-Year Plan period, the basic pattern of sports facilities is in an unbalanced state between East and West. The development dilemma mainly lies in the shortage of land and the difficulty of venue construction. It is believed that sports facilities are the basic media of physical exercise. Improving the quality of facilities allocation can greatly enhance the satisfaction of residents' physical exercise. Based on the existing empirical research results, this paper puts forward the research hypothesis 1: the quality of sports facilities can positively affect exercise satisfaction.

2.2. Mediating role of active participation

Active participation refers to the attitude and behavior of active participation in sports activities. The theoretical basis for active participation as a mediating variable stems from the Self-Determination Theory (SDT) and the Social Identity Theory. Self-Determination Theory (SDT): This theory emphasizes the importance of intrinsic motivation and autonomy in behavior. The higher the quality of sports facilities, the more likely users are to increase their motivation for active participation, thereby enhancing their exercise experience and satisfaction. Positive participation behaviors can improve social interaction and psychological satisfaction, which in turn increases exercise satisfaction. Social Identity Theory: When people participate in sports, they enhance their social identity through interactions with others. When sports facilities provide a good environment and conditions that promote active participation, individuals' sense of belonging to the collective is strengthened. This emotional connection can further enhance satisfaction with exercise.

Studies have shown that regular participation in sports activities can cultivate and develop people's interest and hobbies in sports, develop the habit of physical exercise, and make sports activities an important part of life. Sports participation as a school

field requires students to have the attitude and behavior of actively participating in sports activities, master the knowledge and methods of scientific fitness, and develop the habit of insisting on physical exercise.

Active sports participation means that people accept the correct sports values, have a strong interest in sports and physical entertainment, and consciously and actively adhere to sports activities. Active sports population is the most active part of the sports population. The concept of active participation in this study is the concept of active sports participation in social sports.

6 December 2022 At present, there are relatively few studies on the relationship between active participation in sports facilities and exercise satisfaction and its mechanism. The empirical investigation and research on the participation of Shanghai residents in sports shows that there is a significant difference between the effect of active participation in physical exercise and passive participation in physical exercise. It is proposed that the initiative of residents should be mobilized so as to achieve the effect of fitness exercise. A better understanding of how community sport services should be delivered is needed if local authorities are to influence the level of sport participation of their population [7]. To study the relationship between urban residents' perceived leisure constraints and their active participation in leisure sports, a data sample of 2901 Chinese urban residents was collected, and a structural equation model was used to analyze their perceived constraints and the impact of perceived constraints on their active participation in leisure sports [8]. Based on this, hypothesis 2 is put forward: active participation plays a mediating role between the quality of sports facilities and exercise satisfaction.

2.3. Mediating effect of self-efficacy

Self-efficacy is the core concept of Bandura's social cognitive theory, which refers to the individual's speculation and judgment about whether he has the ability to complete a certain behavior, and plays an important role in coping with and controlling threats in life [9]. The theoretical basis for self-efficacy as a mediating variable comes from Self-Efficacy Theory and Expectancy-Value Theory. Self-Efficacy Theory: Bandura's self-efficacy theory emphasizes that individuals' confidence in their abilities affects their choices of behavior and persistence. High-quality sports facilities can enhance users' self-efficacy, making them more confident in their ability to successfully participate in exercise, and this confidence ultimately affects satisfaction with exercise. Expectancy-Value Theory: According to this theory, individuals evaluate activities based on expectations of success and the value of the activity when participating. High-quality facilities make exercise more valuable and anticipated, thereby enhancing self-efficacy and affecting individuals' satisfaction with exercise.

In the study of emotional benefits of physical exercise, individuals can improve their self-efficacy and mental health through positive feedback such as body plasticity and improvement of sports ability after exercise. However, some studies show that there is no correlation between self-efficacy and physical exercise. For example, in the study of exercise intensity and self-efficacy, scholars such as Katula found that only under high intensity, the level of self-efficacy will increase. Existing studies on physical exercise and self-efficacy mainly focus on the mutual promotion of physical

exercise on self-efficacy. De Brabandere et al. [10] that less state appearance comparison will increase physical satisfaction. More self-efficacy increases body satisfaction and exercise intention REF. The subjects of physical exercise and self-efficacy are also concentrated in college students. Considering the difference of physical fitness level among different groups, the relationship between physical exercise and self-efficacy level of the elderly needs further verification. Therefore, the research hypothesis 3 is put forward: self-efficacy plays a mediating role between the quality of sports facilities and exercise satisfaction.

2.4. Active participation and self-efficacy play a chain mediation role in the quality of sports facilities and exercise satisfaction

The theoretical basis of the chain mediation effect originates from the mediation model and the integrative model. Mediation Model: The mediating variable can explain how the independent variable (quality of sports facilities) affects the dependent variable (exercise satisfaction). In the study, active participation and self-efficacy can be considered as forming a chain-like mediating effect that connects the quality of sports facilities with exercise satisfaction by influencing each other. Integrative Model: Combining the aforementioned theories, an integrative model has been constructed that explains how the quality of sports facilities stimulates individual active participation, thereby enhancing their self-efficacy, and ultimately promoting the increase in exercise satisfaction. Such a model not only has logical consistency but can also be tested in empirical studies.

In the study of residents' active participation and self-efficacy, it is found that the active participation driven by the exercisers themselves can effectively improve the level of residents' self-efficacy. Self-efficacy can directly reflect the self-emotional experience in the process of physical exercise, thus improving the level of exercise satisfaction. Exercise satisfaction is the affirmation of self-exercise and the mobilization of positive emotions. Self-efficacy is triggered as the exerciser's own coping emotional resources. At this time, self-efficacy mainly includes the determination and confidence to cope with the difficulties and challenges of physical exercise, as well as the ability to cope with the pain caused by exercise. Therefore, in the face of fatigue, tiredness, pain and other events encountered in the process of exercise, the exercisers themselves should enhance their confidence in coping with them, so that the exercisers themselves can cope with various events caused by exercise with a positive attitude, while the exercisers with low self-efficacy have a relatively low level of individual exercise satisfaction. Through relevant theories and literature review, Li et al. [11] have shown that perceived social support plays a partial mediating role between achievement motivation and general self-efficacy of college students, and sports participation plays a moderating role in general self-efficacy. The study suggests that active participation and self-efficacy may be important mediators between the quality of sports facilities and exercise satisfaction. To sum up, this study proposes Hypothesis 4: Active participation and self-efficacy play a chain mediation role in the quality of sports facilities and exercise satisfaction (**Figure 1**).

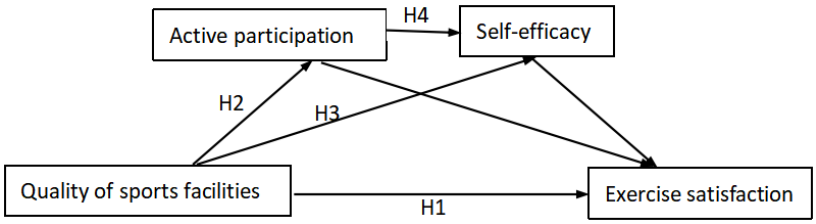

Figure 1. Study hypothesis model.

In summary, the theoretical support provided above has established a solid research foundation for the chain mediating effect of "active participation" and "self-efficacy," which helps to demonstrate how the quality of sports facilities indirectly affects sports satisfaction, adding depth and breadth to the study.

3. Research methods

3.1. Object of study

In this study, random sampling method was used to select residents over 16 years old in Yongzhou City, Hunan Province as the respondents. By using "General Demography Questionnaire", "Sports Facility Quality Scale", "Active Participation Scale", "Self-Efficacy Scale" and "Exercise Satisfaction Scale", the "Questionnaire on the Relationship between Sports Facility Quality and Perceived Satisfaction" was made. 395 questionnaires were collected in the form of star line distribution, and 34 questionnaires that did not meet the measurement requirements, such as not answering seriously or missing answers, were rejected. Finally, 361 valid questionnaires were obtained, with an effective rate of 91%.There were 114 males (31.58%) and 274 females (68.42%) in the valid samples; Age 16–25 144 (39.89%), 25–35 6 (1.66%), 35–45 97 (26.87%), 45–55 94 (26.04%), 55–65 17 (4.71%), 65 + 3 (0.83%)113 persons (31.3%) had junior middle school education or below, 62 persons (17.17%) had senior middle school or secondary vocational education, 25 persons (6.93%) had higher vocational or junior college education, and 161 persons (44.6%) had bachelor's degree or above; 189 people (52.35%) had less than 5 years of exercise, 85 people (23.55%) had 5–10 years of exercise, 42 people (11.63%) had 10–15 years of exercise, and 23 people (6.37%) had 15–20 years of exercise.22 (6.09%) were older than 20 years.

3.2. Research instrument (scale)

(1) Sports Facilities Quality Scale

Wang [12] and Jin [13] created the "Sports Facilities Design Quality Scale". This study adopted this scale. The combined scale contained five items and was scored on a five-point scale from 1 (completely unsatisfied) to 5 (completely satisfied). The higher the score of "Sports Facilities Quality Scale", the higher the level of exercise satisfaction of the subjects, and the Cronbach's Alpha coefficient in this study is 0.883.

(2) Active Participation Scale

Li et al. [14] developed the Proactive Personality Scale (PPS). This study employed this scale. The scale consists of 4 items. Score 5 points from 1 (not at all) to 5 (completely). The higher the score of Active Participation Scale, the higher the level

of active participation of the subjects, and the Cronbach's Alpha coefficient was 0.855 in this study.

(3) Self-efficacy Scale

The self-efficacy scale compiled by Schwarzer et al. Is widely used to assess the perception or belief of urban residents about whether they can adopt adaptive behavior in the face of physical exercise challenges. A total of five items were scored from 1 (very inconsistent) to 5 (very consistent). The higher the score, the better the self-efficacy. The Chinese version has good reliability and validity. The alpha coefficient of Cronbach's in this study was 0.909.

(4) Exercise Satisfaction Scale

Oliver [15] developed the "Customer Satisfaction Measurement Scale." This study adopted the scale. The scale after synthesis contained four items, and five points were scored from 1 (very inconsistent) to 5 (very consistent). The higher the score, the better the self-efficacy. The Chinese version had good reliability and validity. The alpha coefficient of Cronbach's in this study was 0.911.

(5) Validity Test of the Survey Instrument

The KMO and Bartlett test of the questionnaire on the relationship between the quality of sports facilities and perceived satisfaction found that the scores of all items were positively correlated with the total score of the scale, and the KMO coefficient of the questionnaire was 0.925, which indicated that the structural validity of the questionnaire was good, the design was reasonable, and the significance of the Bartlett spherical test was 0.000. In the exploratory factor principal component analysis, the factor loading values of each measurement item are far greater than 0.5. The rotation has converged after five iterations, and four principal components have been extracted, and the cumulative contribution rate of variance is 74.024%, which is more than 50%, indicating that the questionnaire has a good structure.

3.3. Data processing

SPSS24.0 and Amos24.0 were used to conduct exploratory factor analysis, confirmatory factor analysis and Pearson correlation analysis, and Bootstrap method was used to conduct mediation effect analysis.

4. Research results

4.1. Exploratory factor analysis

In the exploratory factor principal component analysis, the factor loading values of each measurement item are far greater than 0.5, and the rotation has converged to extract four principal components after five iterations, and the cumulative contribution rate of variance is 74.024%, far greater than 50%, which indicates that the questionnaire has a good structure.

4.2. Confirmatory factor analysis

In order to verify the fitness of the model design, the Amos 24.0 software was used to test the construct validity. See **Figure 2** and **Table 1** for the specific overall fitting coefficient.

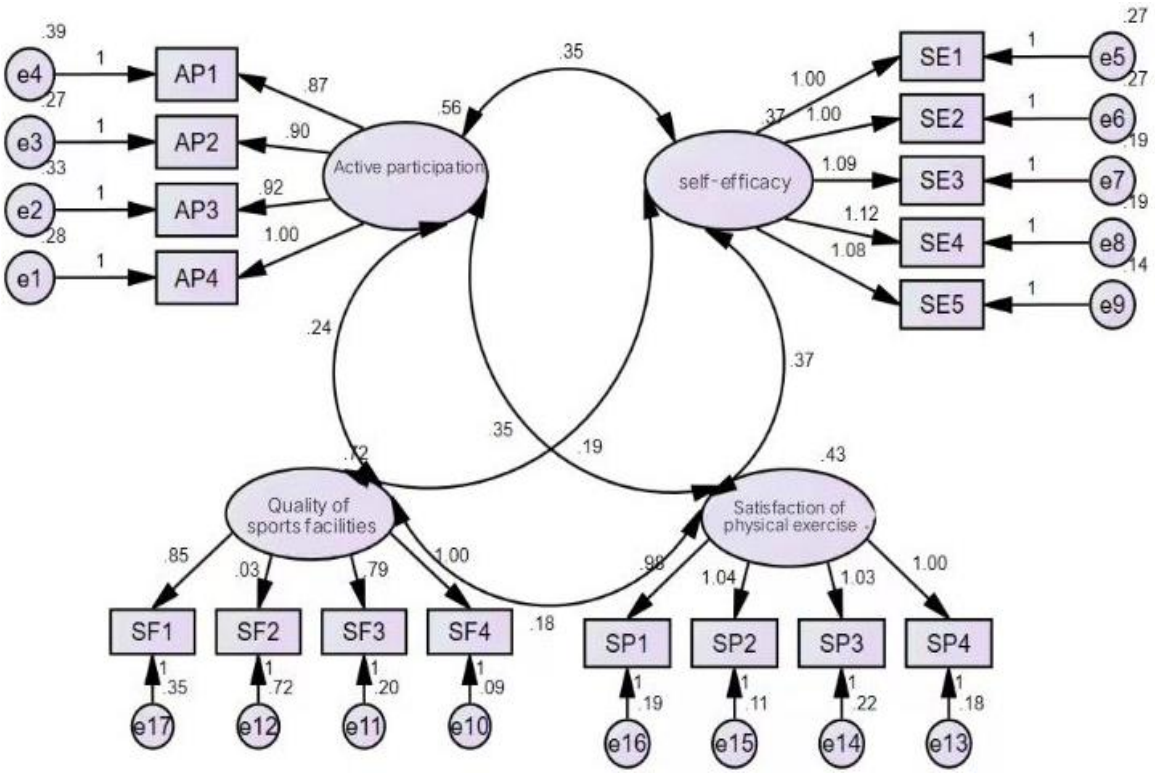

Figure 2. Confirmatory factor analysis model.

Table 1. Global fit coefficients (construct validity).

X^2/df	RMSEA	GFI	AGFI	CFI	IFI	TLI	PGFI	PNFI	RMR
3.100	0.076	0.896	0.859	0.945	0.945	0.933	0.662	0.765	0.049

According to **Figure 2** and **Table 1**, X^2/DF is 3.100, greater than 3; RMSEA is 0.076, greater than 0.05; GFI is 0.896, less than 0.9; AGFI is 0.859, less than 0.9; CFI is 0.945, greater than 0.9; IFI is 0.945, greater than 0.9; The TLI was 0.933, greater than 0.9; the PGFI was 0.662, greater than 0.5; the PNFI was 0.765, greater than 0.5; and the RMI was 0.049, less than 0.05. Based on the above data, X^2/DF is close to the judgment standard 3, RMSEA meets the judgment standard of good fit, GFI and AGFI are close to the judgment standard, and CFI, IFI, TLI, PGFI, PNFI and RMR meet the judgment standard of good fit. Therefore, the model fitting is relatively good.

Table 2. Discriminant validity test.

Discriminant validity				
	Quality of sports facilities	**Active participation**	**Self-efficacy**	**Exercise satisfaction**
Quality of sports facilities	0.586	0.377	0.368	0.315
Active participation		0.578	0.769	
Self-efficacy			0.591	
Exercise satisfaction		0.712	0.913	0.593
AVE square root	0.766	0.760	0.769	0.770

From **Table 2**, we can see that there is a significant correlation between the quality of sports facilities, active participation, self-efficacy and exercise satisfaction

($P < 0.01$). The correlation coefficient is less than the square root of the corresponding AVE, indicating that there is a certain correlation between the latent variables, and there is a certain degree of discrimination between them. The validity of the scale is ideal.

4.3. Correlation analysis among variables

Using SPSS 24. The Pearson correlation analysis between the independent variable of sports facility quality, the dependent variable of physical exercise satisfaction, the intermediary variable of active participation and self-efficacy shows that the quality of sports facility is positively correlated with active participation and self-efficacy, and with exercise satisfaction. Active participation was positively correlated with self-efficacy and exercise satisfaction. There was a significant positive correlation between self-efficacy and exercise satisfaction. This result provides a basis for the subsequent mediation effect test, indicating that active participation and self-efficacy may mediate the relationship between the quality of sports facilities and exercise satisfaction. The detailed analysis results are shown in **Table 3**.

Table 3. Correlation analysis among the variables.

Correlation					
		SF1	**AP1**	**SE1**	**SP1**
SF 1: Quality of Sports Facilities	Pearson correlation	1			
	Significance (2-sided)				
AP 1: Active Participation	Pearson correlation	0.255**	1		
	Significance (2-sided)	0.000			
SE 1: Self-efficacy	Pearson correlation	0.234**	0.469**	1	
	Significance (2-sided)	0.000	0.000		
SP 1: Exercise Satisfaction	Pearson correlation	0.214**	0.454**	0.579**	1
	Significance (2-sided)	0.000	0.000	0.000	

Note: ***, ** and * represent the significance levels of $p < 0.01$, $p < 0.05$ and $p < 0.1$, respectively.

4.4. Analysis of mediating effects of active participation and self-efficacy

Hayes [16] compiled the Process plugin. This study utilized this plugin. The study took the quality of sports facilities as the independent variable, positive engagement and self-efficacy as mediating variables, and exercise satisfaction as the dependent variable, and conducted a Bootstrap mediation effect test analysis on positive engagement and self-efficacy. Bootstap Samples was set as 5000, “Bias Corected” “was selected as the Bootstrap CI method, and the significance level of the confidence interval was set as 95%, which was significant when the confidence interval did not include 0. The chain mediation effect model is shown in **Figure 3**. The results of successive tests show that the quality of sports facilities has a positive impact on exercise satisfaction ($\beta = -0.18$, $P < 0.05$), positive influence on active participation ($\beta = 0.24$, $P < 0.01$); In the influence of sports facility quality and active participation on self-efficacy, the influence of active participation is significant ($\beta = 0.35$, $P < 0.01$); When the quality of sports facilities, active participation and self-efficacy are substituted into the regression equation at the same time, active participation ($\beta = 0.35$,

$P < 0.01$) and self-efficacy ($\beta = 0.37$, $P < 0.01$) have a significant impact on exercise satisfaction, while the impact of sports facilities quality on exercise satisfaction is no longer significant, indicating that active participation and self-efficacy play a chain intermediary role between sports facilities quality and exercise satisfaction.

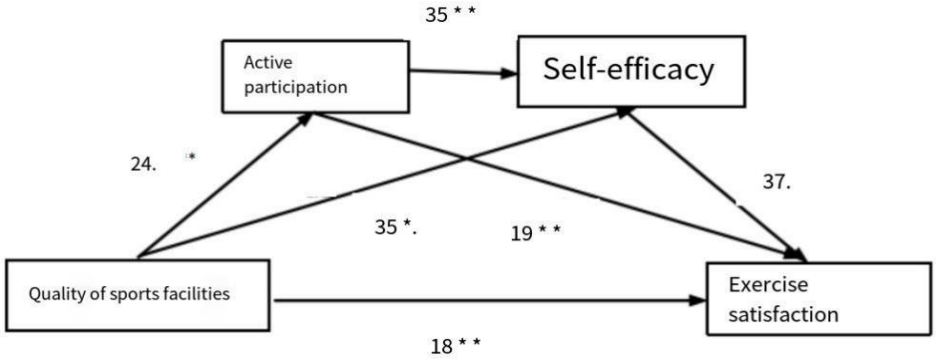

Figure 3. Bootstrap model diagram.

Note: ***, ** and * represent the significance levels of $p < 0.01$, $p < 0.05$ and $p < 0.1$, respectively.

The results of the mediating effect test are shown in **Table 4**. According to the suggestions of Li et al. [11], the Bootstrap confidence interval method was used to test the mediating effect. The results show that the 95% confidence interval of the indirect effect of active participation between the quality of sports facilities and the satisfaction of exercise is [0.0357, 0.0705], the 95% confidence interval of the indirect effect of self-efficacy between the quality of sports facilities and exercise satisfaction is [0.0285, 0.0759], and the 95% confidence interval of the indirect effect of active participation and self-efficacy between the quality of sports facilities and exercise satisfaction is [0.0068, 0.0607] do not contain 0, indicating that the chain mediation effect of active participation and self-efficacy between the quality of sports facilities and exercise satisfaction is established. The indirect effect was 77.33%, of which three significant mediating effect paths were: sports facility quality → active participation → exercise satisfaction, accounting for 26.81%; sports facility quality → self-efficacy → exercise satisfaction, accounting for 26.34%; Sports facility quality → active participation → self-efficacy → exercise satisfaction, accounting for 24.22%. In particular, the mediating effect of self-efficacy between the quality of sports facilities and satisfaction with exercise shows that the quality of sports facilities → self-efficacy → satisfaction with exercise accounts for 26.81% > 26.34% > 26.81% > 24.22%. The mediating effect of self-efficacy between the quality of sports facilities and exercise satisfaction is the largest, indicating that self-efficacy plays a significant mediating role between the quality of sports facilities and exercise satisfaction. This means that good sports facilities enhance the self-efficacy of exercisers, which in turn promotes their satisfaction with exercise. Self-efficacy acts as a bridge in this process, allowing improvements in facility quality to be translated into higher exercise satisfaction for users. This phenomenon can be analyzed from two theoretical perspectives: Social Cognitive Theory and Expectation Confirmation Theory. Social Cognitive Theory emphasizes the predictive role of self-efficacy on behavior, indicating that an individual's confidence in their abilities can significantly improve their performance and satisfaction with the behavior. Expectation Confirmation Theory suggests that

satisfaction comes from the realization of expectations. When the quality of facilities exceeds user expectations, enhanced self-efficacy can increase overall satisfaction.

The practical analysis is conducted from three aspects: Firstly, regarding the implications for sports facility managers, managers should focus on improving the quality of facilities, such as through equipment updates, venue maintenance, and environmental improvements to create a high-quality exercise environment. In addition, strengthening user training and guidance can enhance their self-efficacy and further increase the satisfaction of exercise participants. For example, organizing professional coaches to guide beginners and enhancing their confidence through courses and activities. Secondly, regarding strategies to enhance self-efficacy, managers and policymakers can design a series of programs to enhance self-efficacy, such as hosting sports skill training, establishing social support systems, and conducting team-building activities. In these activities, users can gain feedback and a sense of achievement, thereby increasing their confidence and satisfaction with exercise. Thirdly, regarding the promotion and application of research results, researchers in the fields of exercise psychology and sports management can conduct follow-up studies based on the results of this research to explore the differences in how various types of sports facilities affect self-efficacy and exercise satisfaction. Furthermore, in practice, the management of sports facilities in different regions and cultural contexts should also consider the impact of self-efficacy to develop region-specific sports promotion strategies.

Therefore, by focusing on enhancing self-efficacy, managers can effectively improve residents' exercise satisfaction, thereby promoting the popularization and development of sports activities.

Table 4. Analysis of mediating effect.

Path	Indirect effect value	Boot SE	Boot CI lower limit	Boot CI upper limit	Relative effect/%
Indirect effects	0.1494	0.0191	0.1141	0.1878	77.33
Sports facilities quality →Active participation →Exercise satisfaction	0.0518	0.0089	0.0357	0.0705	26.81
Sports facility quality →Self-efficacy →Exercise satisfaction	0.0509	0.0285	0.0759	0.0119	26.34
Sports facility quality →Active participation →Self-efficacy →Exercise satisfaction	0.0468	0.0343	0.0607	0.0068	24.22

5. Analysis and discussion

The demographic survey sample shows an imbalance in gender ratio (31.58% male vs. 68.42% female) and a skewed age distribution (39.89% aged 16–25), which may have a certain impact on the research results. Therefore, the study employs a common method bias test to examine the effect of such phenomena on the outcomes. Common method bias is an artificial covariation due to the same data source or respondent, measurement environment, item characteristics and context between variables, which is a systematic error. With the continuous improvement of research methods, domestic scholars have gradually begun to pay attention to the common method bias. In this study, according to the recommendations of Podsakoff et al.

Harman's one-way test was applied, and no significant common method bias was found, which verified the reliability of the results of this study.

5.1. The direct effect of the quality of sports facilities on exercise satisfaction

The results show that there is a significant positive correlation between the quality of sports facilities and exercise satisfaction. The quality of sports facilities can directly affect exercise satisfaction and is an effective predictor of exercise satisfaction. Sports facilities, as the fastest growing physical exercise project with Chinese characteristics in recent years, have become an effective means to promote the mental health of the elderly in the context of aging. The direct effect of sports facility quality on exercise satisfaction can be discussed from two dimensions of physiology and psychology. On the one hand, the quality of sports facilities as the physical basis of physical exercise media, residents in the process of exercise can make neurotransmitters change. For example, in terms of neural mechanisms, exercise has been shown to be associated with structural changes in limbic brain regions related to emotion and cognition. Neurological changes produced by serotonin and norepinephrine are considered to be the drug basis of satisfaction, and the quality of sports facilities will produce similar neurological responses. Based on time out Hypothesis, good quality of sports facilities can help exercisers "get out" from the downturn, help to improve the excitement of exercise, and form a virtuous circle to achieve the effect of improving exercise satisfaction. Especially the quality of sports facilities with the interactive use of modern intelligent equipment, so that residents can experience the convenience brought by the new era of intellectualization, so as to better improve the level of exercise satisfaction.

5.2. Mediating role of active participation

The study shows that the quality of sports facilities has a positive impact on exercise satisfaction. After adding the variable of active participation, the direct effect of the quality of sports facilities on exercise satisfaction is no longer significant, but indirectly affects exercise satisfaction through active participation.

In recent years, more and more attention has been paid to physical health. It is better to prevent diseases in advance than to treat them after illness. Physical exercise is a good medicine to prevent diseases and improve their resistance. Community sports can improve public health [9]. Therefore, the number of people who actively participate in physical exercise is increasing, and the effect of active participation and passive participation in exercise is obviously different. Active participation in physical exercise is more likely to have the perseverance to adhere to regular exercise, not only to enjoy the body and mind, enhance physical fitness, but also to enhance the creativity and innovation ability of the exercisers. Active participation in physical exercise can effectively affect residents' satisfaction with exercise, which verifies the hypothesis that active participation mediates the relationship between the quality of sports facilities and satisfaction with exercise. Therefore, the quality of sports facilities is of great significance to exercise satisfaction. It can not only enhance the initiative of exercise, but also improve physical fitness. It can also enhance residents' exercise

satisfaction, and ultimately play a positive role in enhancing residents' happiness and satisfaction.

5.3. Chain mediating effect of active participation and self-efficacy

The findings suggest that the quality of sports facilities can influence exercise satisfaction either directly or indirectly through active participation. Although the quality of sports facilities was significantly related to self-efficacy, the effect of self-efficacy on the relationship between the quality of sports facilities and exercise satisfaction was not significant. After taking into account the two factors of active participation and self-efficacy, the path of "sports facilities quality → active participation → self-efficacy → exercise satisfaction" is significant. Active participation and self-efficacy play a chain intermediary role between sports facilities quality and exercise satisfaction. The results of this study are consistent with previous studies. The level of active participation and self-efficacy of residents are significantly correlated, that is, the higher the level of active participation, the higher the level of self-efficacy of residents. The quality of sports facilities brings more opportunities for residents to exercise and successfully stimulates their active participation. When residents face negative emotions such as fatigue, hardship and difficulties during exercise, a good active participation emotional system brings positive emotional drive to residents and promotes positive changes in their sports cognition. Residents' sense of control and self-confidence increase, and then enhance their intuition or belief in the control of physical exercise behavior, promote residents to complete the process of physical exercise experience, obtain more positive emotions, and form a virtuous circle. Physical exercise not only directly affects the individual's perception of the meaning of life, but also affects the individual's perception of the meaning of life through self-efficacy. It further confirms that self-exercise ultimately affects the meaning of life through self-efficacy and life satisfaction [12]. Active participation benefits residents in different aspects, enhances residents' self-efficacy of active anti-aging, and reduces residents' fear of weak and sick tips. Residents who actively participate in physical exercise can not only meet their own social needs in physical exercise and improve their interpersonal communication level, but also give care and help to other residents who participate in physical exercise in the process of exercise, and extend this relationship beyond physical exercise to form a friendship network. Although there is a significant positive correlation between the quality of sports facilities and self-efficacy, the impact of the quality of sports facilities on the level of self-efficacy is not significant. Unlike previous studies, this may be due to the fact that the subjects of this study are located in Yongzhou City, which is at the southernmost tip of Hunan Province. Yongzhou City features undulating terrain and a landscape of interlocking mountains and rivers, and these specific characteristics of the mountainous environment have had a significant impact on the research outcomes.

Firstly, the mountainous terrain brings significant geographical diversity. Yongzhou's mountainous areas possess complex topography and diverse ecosystems, including hills, mountains, and valleys. These topographical features result in relatively backward transportation and infrastructure conditions in the mountainous regions, which may limit the acquisition of research samples and the breadth of

surveys. For example, certain areas may be difficult to reach due to inconvenient transportation, thereby affecting the selection and representativeness of research subjects. Additionally, the lower population density in mountainous areas may lead to a reduction in the number of participants, thus impacting the reliability of statistical results.

Secondly, the lifestyle and economic activities of mountainous residents significantly differ from those in urban areas, typically relying on traditional agriculture and small-scale flexible economies. This economic background affects residents' behavior patterns and attitudes, exerting a certain influence on related research (such as participation enthusiasm, psychological qualities, self-perception, etc.). Therefore, researchers must fully consider this background factor when analyzing data to ensure the validity and applicability of conclusions.

Furthermore, the topography of mountainous areas and the distribution of natural resources directly affect people's sports habits and sports culture. Mountainous residents may rely more on natural resources and participate in traditional production and lifestyles. The layout and management of sports facilities and equipment have not yet formed a system, making it difficult to maintain their effective use. The quality of sports facilities is poor, with many damaged and unusable, becoming idle items. This will affect their views on the protection of sports facilities, the utilization of sports resources, and consequently impact the outcomes of related social science research.

In summary, the mountainous terrain of Yongzhou not only provides a unique research background but also shapes and influences research outcomes in various ways. When analyzing and interpreting results, it is necessary to pay full attention to this environmental characteristic to enhance the credibility and practical value of the research.

Therefore, sports facilities have lost the satisfaction and sense of achievement residents feel when using them for physical activities, and thus they do not have a direct impact on self-efficacy.

6. Conclusions and recommendations

6.1. Conclusion

The quality of sports facilities, active participation and self-efficacy are significantly related to exercise satisfaction. Active participation plays a partial mediating role between the quality of sports facilities and satisfaction with exercise. Active participation and self-efficacy play a chain mediation role between square dance exercise and death anxiety of the elderly. The results show that residents who use excellent sports facilities have higher levels of satisfaction with physical exercise, active participation and self-efficacy. The "integration of physical education and medicine" in the Outline of the "Healthy China 2030" Plan emphasizes the treatment of diseases through physical exercise, and the "integration of physical education and health" in the 14th Five-Year Plan for National Economic and Social Development of the People's Republic of China and the Outline of the Vision Goals for 2035 emphasizes active health. Especially under the social background of facing the inverted pyramid of population and serious aging in our country, we should explore the development of physical exercise to promote health. Promoting the coverage and

extension of sports and health integration to the grass-roots level and increasing the popularity of physical exercise among the people bear greater strategic significance.

However, due to the geographical environment of this study being set in the mountainous terrain of Yongzhou City, Hunan Province, this specific environmental characteristic has had a significant impact on the research outcomes.

Firstly, the mountainous terrain brings about significant geographical diversity. Yongzhou's mountainous areas possess complex topography and diverse ecosystems, including hills, mountains, and valleys. This topographical feature leads to relatively backward transportation and infrastructure conditions in the mountainous areas, which may limit the acquisition of research samples and the breadth of surveys. For example, certain areas may be difficult to reach due to inconvenient transportation, thereby affecting the selection and representativeness of the research subjects. Additionally, the lower population density in mountainous areas may lead to a reduction in the number of participants, thus affecting the reliability of statistical results.

Secondly, the lifestyle and economic activities of mountainous residents differ significantly from those in urban areas, typically relying on traditional agriculture and small-scale flexible economies. This economic background affects the behavior patterns and attitudes of residents, causing certain impacts on related research (such as participation enthusiasm, psychological qualities, self-perception, etc.). Therefore, researchers must fully consider this background factor when analyzing data to ensure the validity and applicability of the conclusions.

Furthermore, the distribution of terrain and natural resources in mountainous areas directly affects people's sports habits and sports culture. Mountain residents may rely more on natural resources and participate in traditional production and lifestyles, which will affect their views on the protection of sports facilities and the utilization of sports resources, thereby influencing the outcomes of related social science research.

In summary, the mountainous terrain of Yongzhou City not only provides a unique research background but also shapes and influences research outcomes in various ways. When analyzing and interpreting results, it is necessary to pay full attention to this environmental characteristic to enhance the credibility and practical value of the research.

6.2. Recommendations

1) On the basis of residents' active use of public sports facilities to participate in physical exercise, the population of physical exercise should be supervised and managed to promote the sound development and standardization of the use of sports facilities. To meet the exercise needs of residents, guide residents to use sports facilities correctly, and enhance residents' awareness of active participation in exercise. Popularize the knowledge of physical exercise to promote the physical and mental health of residents, organize a series of fitness activities, and improve the public awareness of the allocation of sports facilities.

2) The results show that active participation and self-efficacy are two important mediating variables in the relationship between the quality of sports facilities and exercise satisfaction. It is suggested that in the process of using sports facilities for physical exercise, residents should pay attention to the role of sports facilities in

improving the level of active participation, actively innovate the use of sports facilities in the process of exercise, enhance active participation, enhance exercise drive, expand self-efficacy, enhance the desire for exercise, strengthen the role of sports tangible media, and improve the quality of their exercise. On the basis of continuing the correct use of sports facilities, the construction and operation of community sports will affect the physical and mental health and cultural environment of citizens, and the further development of spiritual and material civilization [13]. Communities and instructors should strengthen reasonable guidance on the use of intelligent sports facilities, so that residents can more easily join and complete the use of intelligent equipment, thereby improving residents' confidence in the use and control of modern facilities, so as to achieve the purpose of physical exercise to promote physical and mental health.

3) At present, the number and types of sports facilities are relatively small, and most of them are simple walking machines, rotating wheels, sitting pedals and other simple equipment. Facilities in communities and stadiums should try to allocate more kinds of sports facilities, especially the allocation of digital and intelligent facilities and equipment that can follow the times should be increased to attract residents' enthusiasm for physical exercise and provide more choices for residents to participate in physical exercise.

4) The following are some specific recommendations for sports facility managers and policy makers to improve the quality of sports facilities and promote active participation in order to increase sports satisfaction. There are four specific suggestions for facility managers: The first suggestion is to enhance the functionality and comfort of sports facilities. Regular assessment of facility condition: carry out regular inspection to ensure the safety and comfort of equipment and environment, timely maintenance and update of old facilities. Diversified sports equipment: Provide a variety of sports equipment to meet the needs of different participants, including strength training, aerobics, group classes, etc., to encourage more people to try different forms of exercise. The second suggestion is to create a friendly social environment. Establish community events: Organize regular community events, fitness classes, and social events to encourage residents to communicate and cooperate with each other, thereby enhancing social interaction. Set up convenient communication Spaces: set up rest areas and communication Spaces in sports facilities to encourage users to socialize before and after sports and increase their sense of belonging. The third suggestion is to optimize user experience. Simplify the use process: reduce complex procedures for using the facility, such as simplifying registration and reservation systems, providing clear and easy to understand guidelines, and making it easier for users to participate. Provide professional guidance: Provide users with guidance and advice from professional coaches to help them master the correct exercise methods, improve their self-confidence and willingness to participate. The fourth suggestion is to focus on information dissemination and feedback. Use social media and applications: promote the functions and activities of the facility through social media, set up user feedback channels, understand user needs and adjust the facility services in a timely manner. Conduct satisfaction surveys: Conduct regular user satisfaction surveys to collect feedback on facility quality and services and make improvements based on this information.

There are three specific recommendations for policy makers. The first suggestion is policy support and financial investment. Increase investment in public facilities: Increase financial investment in the construction and maintenance of sports facilities, especially in areas with weak infrastructure such as communities and schools, to improve the accessibility and utilization of facilities [14]. Set up a special fund: Set up a special fund to support the implementation of innovative projects and community activities to stimulate citizens' sense of participation. The second suggestion is to promote the concept of nationwide fitness. Carry out awareness campaigns: through public information, education and advocacy campaigns, emphasize the importance of exercise for health and motivate people to take active part in exercise. Add corresponding policies: Formulate policies conducive to national fitness, such as reducing the cost of participating in activities, providing subsidies, etc., and lower the threshold of participation. The third suggestion is to collaborate with the community and schools. Establish a cooperation mechanism: encourage the government to cooperate with local communities, schools and other institutions to jointly build facilities and organize activities to enhance the efficiency of the use of facilities. Develop youth sports activities: Pay special attention to youth sports participation, and set up special programs and courses to cultivate their sports interests and habits.

Through the above measures, facility managers and policy makers can effectively improve the quality of sports facilities and promote people's active participation. This will not only increase satisfaction with sports, but also contribute to better public health.

7. Insufficient research

This study enriches the research content of sports facilities quality and exercise satisfaction, but it should be pointed out that there are still some shortcomings in this study: First, cross-sectional studies cannot prove the causal relationship between variables, and longitudinal intervention experiments are needed to further study the causal relationship between variables in the future. Secondly, the study only considers the mediating effects of active participation and self-efficacy on the quality of sports facilities and exercise satisfaction, but in reality, there are other mediating variables, such as exercise motivation and personality characteristics, which need further study. Finally, the residents of Yongzhou are the subjects of this study, but China has a vast land area and obvious cultural differences among regions. In the future, more research on sports facilities and physical exercise in other regions of China is needed, and the influence mechanism of physical exercise satisfaction in different regions is explored.

Author contributions: Conceptualization, LW and SS; methodology, PW; software, SS; validation, SS, YF and LW; formal analysis, YF; investigation, LW; resources, YF; data curation, PW; writing—original draft preparation, YF; writing—review and editing, LW; visualization, LW; supervision, SS; project administration, YF; funding acquisition, LW. All authors have read and agreed to the published version of the manuscript.

Funding: This research was supported by The Planning Fund for Humanities and Social Sciences Research of the Ministry of Education of China (Nos.24YJA890034),

Hunan Provincial Department of Education Scientific Research Fund (Nos.23A0583), Hunan Provincial Social Sciences Fund (Nos.23YBA229), Hunan Provincial Social Sciences Evaluation Committee Fund (Nos.XSP24BC126), Hunan Provincial Education Reform Fund (Nos.HNJG-20231114).

Ethical approval: This study was conducted in accordance with the Declaration of Helsinki from 1964 and was approved by the Institutional Review Board of Hunan University of Science and Technology. Institutional name: Institutional Review Board of Hunan University of Science and Technology, Protocol code xky240817, Approval date, January 10, 2024.
Written informed consent has been obtained from the patient for the publication of this article.

Conflict of interest: The authors declare no conflict of interest.

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