

LIU, Yongsen, ZHANG, Mufan and JI, Bin. Analysis of the Mechanism of Smart Sports Services in School Physical Education and Student Physical Health. *Quality in Sport*. 2025;40:59422. eISSN 2450-3118.

<https://doi.org/10.12775/QS.2025.40.59422>

<https://apcz.umk.pl/QS/article/view/59442>

The journal has been 20 points in the Ministry of Higher Education and Science of Poland parametric evaluation. Annex to the announcement of the Minister of Higher Education and Science of 05.01.2024. No. 32553.

Has a Journal's Unique Identifier: 201398. Scientific disciplines assigned: Economics and finance (Field of social sciences); Management and Quality Sciences (Field of social sciences).

Punkty Ministerialne z 2019 - aktualny rok 20 punktów. Załącznik do komunikatu Ministra Szkolnictwa Wyższego i Nauki z dnia 05.01.2024 r. Lp. 32553. Posiada Unikatowy Identyfikator Czasopisma: 201398.

Przypisane dyscypliny naukowe: Ekonomia i finanse (Dziedzina nauk społecznych); Nauki o zarządzaniu i jakości (Dziedzina nauk społecznych).

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The authors declare that there is no conflict of interests regarding the publication of this paper.

Received: 13.03.2025. Revised: 21.03.2025. Accepted: 04.04.2025 Published: 10.04.2025.

Analysis of the Mechanism of Smart Sports Services in School Physical Education and Student Physical Health

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Abstract: With the rapid development of information technology, smart sports have emerged as a new form of support and service for school physical education and student physical health. This study adopts literature review and logical analysis methods to explore the connotations, categories, basic elements, and mechanisms of smart sports services for school physical education and student physical health.

The study points out that: (1) Smart sports services refer to efforts aimed at improving the quality and effectiveness of school physical education through the application of information technology, achieving the organic integration of student physical health and school physical education, and providing personalized and precise sports services. (2) Smart sports services in school physical education include four categories: data collection and analysis, teaching assistance and management, sports resource sharing and exchange, and health management and services. (3) The basic elements of smart sports services for school physical education and student physical health include policies, technology, and the practical needs of school physical education development, where policies provide support and guidance for smart sports services, technology serves as the foundation of these services, and the practical needs of school physical education development act as the motivation for the services. (4) The process of smart sports services for school physical education and student physical health involves data collection and analysis, personalized diagnosis and customized plans, service tracking and monitoring, personalized feedback and incentives, and effect evaluation and improvement. (5) The inherent mechanism of the service is to facilitate convenient and intelligent school physical education management, promote accurate and enjoyable sports teaching, ensure fairness and efficiency in school physical education exams, and empower students' physical exercise to be personalized and proactive.

Keywords: Smart sports services, school physical education, mechanism, student physical health

Introduction

School physical education is an important component of student physical health and has a significant impact on student's physical and mental development. The issue of student physical health has become increasingly prominent in recent years. In 2020, the General Office of the CPC Central Committee and the General Office of the State Council issued the "Opinions on Comprehensively Strengthening and Improving School Physical Education Work in the New Era," which set the goal of significantly improving students' physical fitness and overall quality. The 2022 "New Curriculum Standards" stated that physical education and health courses should focus on cultivating three core competencies: students' sports abilities, healthy behaviors, and sports ethics. In 2023, the Ministry of Education's General Office issued a notice requiring the provision of one hour of physical activity at school and one hour of physical activity outside of school every day. These policies respond to the current issues of student physical health and place new demands on school physical education and physical education teachers. With the advancement of society and the development of technology, smart sports services, characterized by intelligence and informatization, have emerged, providing new solutions for the problems in the development of school physical education. Existing research mainly focuses on smart sports venues^[1-3] and the empowerment of physical education teaching through smart sports^[4-5], while there is limited exploration into the mechanism of smart sports services for school physical education and student physical health.

Therefore, this study takes smart sports services for school physical education and student physical health as its research subject, exploring and analyzing their connotations and mechanisms, to better promote the reform and development of school physical education through smart sports services.

1 Connotation of Smart Sports Services for School Physical Education and Student Physical Health

1.1 School Physical Education and Student Physical Health

There is a close relationship between school physical education and student physical health. First, school physical education provides students with ample opportunities for physical activity. School sports courses typically allocate time for exercise and activities, allowing students to engage in various aerobic exercises, strength training, and flexibility activities. This helps to foster students' awareness and interest in physical activities, enhancing their physical fitness and health levels. Second, school physical education contributes to improving students' mental health. Physical activities not only strengthen the body but also reduce stress and anxiety, alleviating the pressures of academic life. Physical exercise stimulates the release of dopamine and endorphins, the "happiness hormones," enhancing students' mood and sense of well-being, thereby improving their mental health. Furthermore, school physical education helps to develop students' social skills and teamwork spirit. During sports activities, students need to cooperate with others to complete tasks and solve problems. By participating in physical activities with their classmates, students can form friendships, cultivate good interpersonal skills, and improve their ability to work in teams. This is crucial for their overall development and social competency. Additionally, school physical education helps cultivate good life habits and health behaviors. Through physical activities, students can develop positive life attitudes and healthy lifestyles. They learn to maintain a balanced diet, ensure good sleep habits, and engage in regular physical exercise, thereby improving their physical fitness and maintaining good health.

1.2 Smart Sports and Smart Sports Services

With the development and application of technologies such as big data and artificial intelligence in various industries, research in the field of smart sports has emerged, empowering the development of the sports industry. There is no unified definition of smart sports; however, existing studies have summarized the technologies, characteristics, and functions of smart sports applications. Smart sports integrate emerging information technologies such as the Internet of Things, cloud computing, big data, and artificial intelligence into the sports field, enabling intelligent decision-making functions such as prediction, planning, and judgment through data collection, analysis, and processing. Smart sports are characterized by intelligence, ecosystem integration, scenarization, sensing and measurement, resource allocation, demand alignment, and innovation stimulation^[6-9]. Smart sports services refer to an emerging form of support and service for sports, achieved through the use of information technology to integrate various resources. Smart sports provide intelligent services across different areas of sports, and this study focuses on their application in school physical education and student physical health.

Specifically, it uses information and internet technologies combined with the characteristics and needs of school physical education to offer intelligent, personalized, and customized services.

1.3 Scope of Smart Sports Services in School Physical Education

Based on the development needs of school physical education and student physical health, the application of smart sports in this field mainly includes four aspects: (1) Data Collection and Analysis. Smart sports services can collect data on students' participation in physical activities through various means, such as sensors and smart devices, including running distance, heart rate, and exercise trajectories. By analyzing and mining this data, educators can assess students' physical health and provide personalized teaching and training. (2) Teaching Assistance and Management. Smart sports services can offer a range of teaching tools and management platforms to assist teachers with course design, lesson planning, student performance assessment, and other tasks. Through smart sports services, teachers can better understand students' learning progress and provide personalized guidance and support. (3) Sports Resource Sharing and Exchange. Smart sports services can establish platforms for sharing school sports resources, promoting smart sports knowledge and experience, and facilitating communication and cooperation among schools. Students can access richer sports resources through these services, participating in various online and offline sports activities to enhance their skills and interest in sports. (4) Health Management and Services. Smart sports services can provide health management and services, including monitoring physical health data, health assessments, and personalized health advice. Through smart sports services, schools can better focus on students' physical and mental health and provide corresponding health support.

2 Basic Elements of Smart Sports Services for School Physical Education and Student Physical Health

2.1 Policies Providing Support and Guidance for Smart Sports Services in School Physical Education

The development of smart sports services for school physical education and student physical health needs to be grounded in a favorable policy environment. The formulation and implementation of government policies play a crucial role in the development and promotion of smart sports services in school physical education. Various departments in China have successively issued documents regarding smart sports, providing policy support for its development. The "Outline for Building a Strong Sports Nation" issued by the General Office of the State Council in September 2019 proposed to "promote the intelligent development of national fitness." In October 2021, the General Administration of Sports of China released the "14th Five-Year Plan for Sports Development," which emphasized "clarifying the development direction of sports informatization, focusing on strengthening digital transformation, intelligent upgrades, and integrated innovation, as well as constructing new infrastructure and building data center systems."

In July 2022, the General Administration of Sports mentioned in the "Work Plan on Promoting Economic Stability and Boosting Consumption through Sports" that the integration of sports with new technologies such as 5G, big data, and artificial intelligence should be accelerated, with a strong emphasis on developing digital sports. In December 2022, the Central Committee of the Communist Party of China and the State Council issued the "Strategic Plan for Expanding Domestic Demand (2022-2035)," which encourages the development of smart tourism, smart broadcasting, and smart sports. In recent years, several documents addressing school physical education and student physical health have been issued. The 2022 "Compulsory Education Physical Education and Health Curriculum Standards (2022 Edition)" was implemented, emphasizing the cultivation of students' sports abilities, healthy behaviors, and sports ethics as the three core competencies. The Ministry of Education issued the "2023 National Comprehensive Prevention and Control Plan for Children's Myopia," which explicitly includes physical health status in government performance assessments, further highlighting the importance of physical education and health courses. These documents clarify the goals and tasks of school physical education, reflecting the importance of physical education and the increasing focus on student physical health issues. The support provided by policies has laid a foundation for the introduction of smart sports services in school physical education, promoting the development of smart sports services in this field. Only under the support of policies can smart sports services in school physical education achieve better development and operational outcomes.

2.2 Technology as the Foundation of Smart Sports Services in School Physical Education

The success of smart sports services in school physical education cannot be achieved without technological support. Technology plays an essential role in smart sports services and has a positive impact on the relationship between school physical education and student physical health. Available technological support includes sensor technology, virtual reality (VR) and augmented reality (AR), mobile applications, and artificial intelligence (AI).

Firstly, sensor technology is one of the key technologies in smart sports services. Sensors can be used to detect students' movement data, such as posture, step count, heart rate, and sleep quality. By combining sensors with smart devices, students' activity data can be recorded and monitored in real-time, providing valuable feedback and guidance for both coaches and students. The advantage of sensor technology lies in its high accuracy and real-time capabilities, helping students better understand their physical activity and improve their skills and health. Secondly, virtual reality (VR) and augmented reality (AR) technologies are widely used in school physical education. By using VR or AR devices, students can participate in various sports activities and training without the need for actual venues or equipment. These technologies create immersive experiences, allowing students to engage in physical activities virtually. The characteristics of VR and AR technologies extend students' activity space, offering more exercise options while increasing their interest and enjoyment in physical sports. Moreover, mobile applications are also commonly used tools in smart sports services. By downloading and installing mobile apps, students can access information and guidance related to exercise anytime and anywhere. These applications often feature personalized functions, offering customized exercise plans and health recommendations based on students' needs and abilities.

The convenience and ease of use of mobile apps allow students to better manage their physical activity and health. Additionally, artificial intelligence (AI) technology plays a significant role in smart sports services. By analyzing large amounts of exercise data and health information, AI can assist students in evaluating and predicting their physical activity levels, offering personalized training programs and health advice. The advantage of AI is its ability to handle complex data and patterns, providing more accurate and effective guidance for students. Technology plays an essential role in enhancing the management and operational efficiency of school physical education. With modern information technologies, smart sports services enable the digitization and intelligence of school sports management. By using advanced hardware and software, real-time data collection and analysis of students' physical fitness can be achieved, offering accurate assessments and monitoring. This provides teachers and coaches with more comprehensive and precise data support, helping them design training programs and teaching plans. Technology also facilitates the sharing and allocation of school sports resources, improving teaching outcomes. Furthermore, technology can enhance students' participation and enthusiasm in sports. Traditional physical activities are often constrained by time, space, and other factors, making it difficult to meet the diverse needs of students. Through smart sports services, students can access personalized fitness plans and choose and organize their activities based on personal preferences. Technology can also provide gamified teaching methods, increasing students' engagement and interest, and motivating them to actively participate in physical activities. Additionally, technology offers intelligent health monitoring and management. With wearable devices and smart hardware, schools can monitor students' physical status and vital signs in real-time, promptly detecting abnormalities and health issues. Through intelligent data analysis and warning systems, schools can take timely intervention measures to ensure students' physical health. Moreover, technology can provide personalized health management services, including proper dietary guidance and scientific exercise plans, helping students develop healthy living habits and behaviors. As technology continues to evolve, more advanced technologies will be applied to school physical education, providing more comprehensive and effective support for students' physical health.

2.3 Realistic Needs of School Physical Education as the Motivation for Smart Sports Services

With the promulgation of new curriculum standards and the introduction of policies related to school physical education, new requirements have been set for the reform of school physical education. In terms of talent cultivation, there is a focus on developing students' "sports abilities, healthy behaviors, and sports ethics" as part of their physical education literacy. "Teaching, practicing, and competing regularly" are essential aspects of deepening and improving the school sports teaching reform and evaluation mechanisms. In the evaluation process, more attention is now being paid to the establishment of a comprehensive evaluation system based on "knowledge, abilities, behaviors, and health," and the introduction of technologies such as artificial intelligence for evaluation. In terms of teaching content, school physical education has faced challenges such as "complex technical movements, lack of situational creation, and insufficient interest guidance," while teaching methods have been confined to "teacher explanation and demonstration" and "students repeating exercises."

The teaching process has been difficult to quantify, record, supervise, and summarize, and evaluation methods have mainly focused on students' athletic skills and physical health, with issues such as insufficient teacher qualifications and lack of specialization^[10-11].

Regarding student physical health, statistics show that the overall myopia rate among children and adolescents reached about 52.7% in 2022, while the overweight and obesity rate among children aged 6–17 was nearly 20%, and over 10% of children under the age of 6 were overweight or obese. Although the percentage of students with good physical health improved from 23.8% in 2020 to 33% in 2022, it still falls short of the State Council's goal of achieving a 50% or greater "good health" rate by 2022 and a 60% or greater rate by 2030. The testing process for physical health involves substantial work for physical education teachers, including "testing, recording, integrating, formatting, and uploading." It also raises concerns about how to provide feedback on test results and offer personalized guidance. These issues require responses through reforms in school physical education. National policies, the need for improved student physical health, and challenges in school physical education practices have led to new requirements for the reform of school physical education. As an emerging form of school physical education service, smart sports services aim to meet the practical needs of users, including students, parents, and teachers, in sports activities. Some schools have already begun implementing smart sports to address these issues. Therefore, smart sports will play a crucial role in the ongoing reform, and the realistic needs of school physical education will drive the development of smart sports services.

3 Mechanisms of Smart Sports Services in School Physical Education and Student Physical Health

3.1 Process of Smart Sports Services in School Physical Education

The service process of smart sports services in school physical education aims to provide personalized services for students' physical health through intelligent technologies and data analysis. This process includes the following steps:

(1) *Data Collection and Analysis*: In smart sports services, data such as students' exercise data, physical indicators, and mental state during physical activities are collected using sensing devices and sensors. This data is then transmitted and stored on cloud servers. Subsequently, data analysis algorithms are applied to process and interpret individual students' data, constructing a comprehensive evaluation model for students' physical health.

(2) *Personalized Diagnosis and Customized Plans*: Based on the results of data analysis, the smart sports service system provides personalized health diagnoses according to the specific conditions of each student. By comparing the students' physical health indicators with standard reference values, the system can assess their overall health status. At the same time, personalized health plans are formulated based on students' actual needs and potential risks. These plans include exercise programs, nutritional guidance, and psychological counseling.

(3) *Service Tracking and Monitoring*: The smart sports service system tracks students' data and behavior during physical activities. Through real-time monitoring of students' exercise status, heart rate, exercise endurance, and other related indicators, the system can promptly detect any physical abnormalities or potential risks. The system also monitors the frequency and duration of students' participation in physical activities to assess their level of engagement in sports.

(4) *Personalized Feedback and Motivation*: The smart sports service system provides personalized feedback to students by interpreting the data and information to help them better understand their physical condition, exercise performance, and health needs. The system can also offer motivation based on students' progress and performance, using forms like points, rewards, etc., to encourage students to actively participate and continue their exercise routines.

(5) *Effect Evaluation and Improvement*: The smart sports service system evaluates and improves the service effectiveness through data analysis and comparison. The system tracks and evaluates students' physical health status over time, allowing for the timely detection and correction of potential issues or deficiencies. Additionally, the system continuously improves service quality and enhances user experience based on feedback and needs from students, to meet their actual requirements and expectations.

Through the above process, the service flow of smart sports services in school physical education effectively promotes the improvement of students' physical health. This process combines the power of technology and education, merging personalized services with comprehensive assessments, and offering students more accurate and practical health guidance and improvement measures. This will help improve students' enthusiasm for sports, promote physical and mental health development, and ultimately enhance the overall physical health level of students^[15-19].

3.2 Mechanism of Smart Sports Services in School Physical Education

(1) Facilitating Convenient and Intelligent School Sports Management

The campus smart sports system, based on technologies such as the Internet of Things (IoT), cloud computing, and big data analysis, establishes an integrated, informational, and intelligent school sports management platform. This platform includes physical fitness data, comprehensive sports ability, physical health knowledge, student health records, exercise prescriptions, and sports interventions, integrating physical fitness testing, physical education curriculum management, and comprehensive evaluation. It unites the management department, schools, teachers, and parents on the same platform. This system allows for real-time collection, observation, and supervision of student physical health data. Through data mining and intelligent algorithms, it provides a basis for school sports regulation and decision-making, curriculum reforms in physical education and health, personalized exercise recommendations, health assessments, and advice for students, teaching support for teachers, and real-time student health information and communication channels for parents. At the same time, it effectively facilitates data sharing and communication between the management department, schools, and families, creating a new educational model where the school leads, students are autonomous, and parents participate, thereby improving the quality of physical education.

(2) Promoting Accurate and Engaging Physical Education

In physical education, teachers can design lessons based on students' physical conditions and exercise abilities. During classes, wearable devices record real-time data such as steps, heart rate, and calories burned, which are transmitted via Bluetooth to mobile phones or computers. Teachers can monitor each student's exercise health status in real-time and intervene promptly if necessary to ensure safety.

The intensity and density of exercises can be visualized, allowing for data-backed adjustments to the exercise load. The system intelligently stratifies students, aiding teachers in differentiated instruction so that all students can exercise "scientifically," improving the quality of classroom activities. After the class, the data generated can be used to create multidimensional reports, providing feedback for teachers' reflection and teaching improvement. The intelligent transformation of the school's sports environment and equipment helps stimulate students' interest in physical activities. Virtual reality (VR) technology, for example, enables students to experience various sports scenes and engage with athletes in a virtual environment, enhancing participation and interest in sports. Additionally, multimedia technologies used by teachers can enrich teaching scenarios, making physical education classes more engaging.

(3) Ensuring Fair and Efficient Physical Education Examinations

Whether it is for physical education and health course exams, physical tests in entrance exams, or student physical health assessments, these evaluations serve as assessments of the effectiveness of physical education and health courses. In the context of physical education, process evaluation and the storage and analysis of data impose high demands on teachers. In traditional manual testing, particularly for skill-level assessments, subjective judgment can affect test results, and the large workload and difficulty in analyzing data can create challenges. Currently, smart sports technologies are applied in these evaluation processes. For instance, video technology can capture students' performance data, using 3D human posture estimation, motion target detection, tracking, action behavior recognition, and quality analysis to achieve 360° movement posture analysis, precisely identifying violations and evaluating exercise ability. Smart sports fields can recognize violations in various sports exam items, avoiding inconsistencies in scores from different evaluators and ensuring fairness. Additionally, examination systems integrate scheduling, management, evaluation, and real-time monitoring, providing intelligent evaluation and real-time scoring during exams, which streamlines the entire exam process and ensures efficiency. In physical fitness testing, technologies such as facial recognition systems and AI systems provide more accurate, intelligent, and efficient testing services. The back end processes data entry, analysis, and reporting, generating multi-dimensional reports that can be accessed by students, teachers, and parents. This intelligent approach simplifies the testing process and generates consistent, fair evaluations.

(4) Empowering Students for Personalized and Active Physical Exercise

Physical exercise is a critical approach for developing students' core competencies in physical education and health courses. However, common issues include unstable exercise behavior and habits, insufficient time for sports activities on campus, and a disconnect between students' awareness and actual engagement in physical exercise. Addressing how to improve students' recognition, interest in sports, and the cultivation of exercise habits is crucial. Smart sports services aim to provide personalized exercise plans for students. By collecting individual health data and utilizing intelligent devices and sensors for monitoring, smart sports services can create exercise plans tailored to the individual differences of each student, optimizing their workout results.

This personalized service not only increases students' enthusiasm for physical exercise but also enhances their fitness levels and health awareness. Through technologies like computer vision, human posture recognition, facial recognition, and gesture recognition, campuses are equipped with interactive and technologically advanced smart devices, such as sit-up training stations, jump rope smart screens, 50-meter running stations, standing long jump training stations, and AI-based fun screens. These devices facilitate autonomous and enjoyable exercise, thereby igniting students' interest and potential. Data collected from these devices is analyzed and used to organize campus sports competitions, encouraging greater student participation in physical activities and fostering a vibrant campus sports culture. Thus, smart sports services provide a foundation for personalized, engaging, and active physical exercise among students.

4 Conclusion

Smart sports services, as an emerging sports service model, have a broad application prospect in school physical education. With societal progress and technological development, smart sports services characterized by intelligence and informatization continue to emerge, bringing new opportunities for the development of school physical education. This paper, based on the definition of smart sports services and their role in school physical education and student health, outlines the essential elements and mechanisms of their application. It aims to reveal the related factors and mechanisms of smart sports services in school physical education and student physical health, providing insights into the reform and development of school physical education. However, current applications still face challenges, such as insufficient technical support, high equipment costs, data privacy protection issues, and the need for customized teaching plans and service systems for teachers and students. Future research needs to explore how to better integrate smart sports services with school physical education and student physical health for further development.

Disclosure

Author's contribution

This article is designed and written by Yongsen Liu and Bin Ji. Mufan Zhang is responsible for literature collection and organization. Meanwhile, Bin Ji is the project manager and has approved the author and corresponding author of this study.

All authors have read and agreed with the published version of the manuscript.

Financing Statement

Not applicable.

Institutional Review Board Statement

Not applicable.

Informed Consent Statement

Not applicable.

Data Availability Statement

Not applicable.

Conflict of interest

The authors deny any conflict of interest.

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