

AI Empowering the Transformation of Physical Education Teaching A Study on the Paradigm Transformation Path and the Mechanism of Improving College Students' Physical Health

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ABSTRACT Driven by educational digitalization and the Healthy China 2030 initiative, university physical education is increasingly expected to provide personalized instruction and precise health interventions. To address the limitations of conventional teacher-centered teaching models, this study investigates the paradigm transformation of physical education empowered by artificial intelligence. An intelligent closed-loop framework integrating data acquisition, health assessment, personalized intervention, and dynamic feedback is established. Wearable sensing devices and intelligent analytics are employed to monitor exercise load, physical fitness indicators, and learning behaviors in real time. AI-based recommendation algorithms are then utilized to generate adaptive exercise strategies and individualized training pathways. The proposed framework improves teaching precision, student engagement, and health-management effectiveness. The study provides methodological support for intelligent sports education and offers references for wearable sensing, physiological signal analysis, and intelligent health-monitoring systems.

INDEX TERMS artificial intelligence, physical education, wearable sensing, physiological signal analysis, intelligent health monitoring

I. INTRODUCTION

A. RESEARCH BACKGROUND

DRIVEN by the Healthy China 2030 strategy and digital transformation, university physical education functions as a core carrier for student health, mirroring the structural precision of morphology and industrial material manufacturing excellence in its mission to enhance physical fitness and impart sports skills. This systematic approach ensures that the cultivation of healthy habits and sportsmanship follows a standardized, reproducible pedagogical framework, enabling consistent instructional delivery and measurable student health outcomes across different educational settings. In recent years, the reform of physical education teaching in Chinese universities has achieved certain results, but still faces deep-seated structural contradictions: traditional physical education teaching is characterized by “teacher centered, classroom based, and unified teaching”, which is difficult to meet the diverse sports needs of college students, personalized physical fitness improvement goals, and differentiated learning styles; The problems of fixed teaching content, single teaching methods, lack of monitoring of exercise load, and low precision of physical health intervention are prominent, leading to low enthusiasm for

college students' participation in sports, slow improvement of sports skills, and an unfavorable physical health condition. According to data from the Ministry of Education, although the physical health compliance rate of college students in China is steadily increasing, more than 30% of students still have core indicators such as endurance, strength, and flexibility that do not meet the standards. The rates of myopia and obesity remain high, and mental health problems are becoming increasingly prominent [1-3].

B. RESEARCH SIGNIFICANCE

1) Theoretical significance

(1) Constructing a theoretical analysis framework that integrates AI technology, physical education teaching, and physical health, enriching the interdisciplinary research system of educational technology, physical education, and health promotion theory, and providing new theoretical perspectives and analytical paradigms for physical education research in the intelligent era [4];

(2) In depth analysis of the internal mechanism and paradigm shift logic of AI empowering physical education teaching, revealing the role of technological integration in reconstructing core elements such as physical education

teaching objectives, content, methods, and evaluation, and improving the theoretical system of technology empowering educational transformation [5];

(3) Establish a closed-loop mechanism for AI to empower the physical health of college students, clarify the full process path of “data collection intelligent diagnosis personalized intervention dynamic feedback”, and expand the technical application boundaries of physical health promotion theory;

(4) Explore the key nodes and adaptation principles of the deep integration of AI and physical education teaching, and provide theoretical references and methodological support for similar research on digital transformation of education [6].

2) Practical significance

(1) To provide universities with a set of “implementable, scalable, and assessable” AI enabled sports teaching transformation solutions, to solve the pain points of traditional teaching such as insufficient personalization, low accuracy, and single evaluation, and to improve the quality and efficiency of sports teaching;

(2) Through personalized exercise program push, intelligent regulation of exercise load, and dynamic monitoring of physical health, the enthusiasm and skill level of college students’ sports participation are significantly improved, promoting the improvement of core indicators of physical health;

(3) Promote the digitization of physical education teaching resources, the intelligence of teaching processes, and the refinement of teaching management, providing replicable and promotable practical paradigms for the digital transformation of physical education in universities;

(4) Assist in the implementation of the Healthy China 2030 strategy, enhance the health literacy and physical fitness of college students, and provide solid support for cultivating socialist builders and successors with comprehensive development in morality, intelligence, physical fitness, aesthetics, and labor.

C . CURRENT RESEARCH STATUS AT HOME AND ABROAD

(1) While existing literature has explored isolated AI applications, there remains a scarcity of integrated theoretical frameworks that bridge technology, pedagogy, and health outcomes. This study specifically addresses this gap by synthesizing these elements into a formalized ‘perception-diagnosis-interventionfeedback-optimization’ closed-loop mechanism, moving beyond the fragmented approaches found in current research;

(2) The research on the path of paradigm change in physical education teaching is not in-depth enough, and there is a lack of systematic reconstruction of core elements such as teaching objectives, content, methods, and evaluation;

(3) The research on the mechanism of improving physical health is still superficial and has not revealed the transmis-

sion path of AI technology from teaching intervention to health outcomes;

(4) Empirical research is weak, lacking support from large-scale and long-term tracked teaching experimental data, and the reliability and generalizability of research conclusions are insufficient [6].

This article conducts systematic theoretical and empirical research to address the aforementioned research gaps.

D. RESEARCH IDEAS AND INNOVATIVE POINTS

1) Research Approach

This article follows the technical route of “theoretical construction current situation analysis path design mechanism establishment empirical verification conclusion recommendations”:

1. Sort out the relevant theoretical foundations, define core concepts, and construct a theoretical analysis framework for AI empowering the transformation of physical education teaching;

2. Thoroughly analyze the paradigm limitations of traditional physical education teaching and the transformative potential of AI empowerment;

3. Design a three-level paradigm change path of “technology layer pattern layer target layer”;

4. Establish a closed-loop mechanism to enhance the physical health of college students through AI empowerment;

5. Select universities to conduct a 16 week empirical teaching experiment to test the effectiveness of the transformation path and improvement mechanism;

6. Summarize research conclusions, propose policy recommendations and future prospects.

2) Innovation points

(1) Theoretical innovation: Construct a three-level paradigm change path of “technology layer mode layer target layer” and a closed-loop improvement mechanism of “perception diagnosis intervention feedback optimization” for physical health, enriching the theoretical system of AI empowered education transformation and physical health promotion;

(2) Content innovation: Systematically reconstruct the core elements of AI empowered physical education teaching, including goals, content, methods, and evaluation, to form a complete teaching paradigm and fill the gap in existing research on the integration of the entire teaching process.

II. CORE CONCEPTS AND THEORETICAL FOUNDATIONS

A. DEFINITION OF CORE CONCEPTS

The mechanism of improving physical fitness and health refers to the internal logic and path of AI empowered physical education teaching through a series of intermediate variables (such as sports participation enthusiasm, sports skill level, reasonable exercise load, healthy habit formation, etc.), which affects the physical fitness and health of college students. It is reflected in the full chain transmission process

of “technology application teaching transformation behavior change health improvement” [7-8].

B. THEORETICAL ANALYSIS FRAMEWORK

Based on the above theoretical foundation, this article constructs a theoretical analysis framework for “AI technology input - physical education teaching transformation - physical fitness and health output”:

AI technology input layer: including core technology tools such as data collection technology (sensors, computer vision), intelligent analysis technology (machine learning, deep learning), personalized recommendation technology, virtual simulation technology, etc;

The transformation layer of physical education teaching: as an intermediate core link, it includes paradigm changes in all elements such as teaching philosophy, teaching objectives, teaching content, teaching methods, teaching evaluation, and teaching management;

Physical health output layer: including multidimensional physical health improvement results such as body shape, physiological function, physical fitness, sports skills, health habits, and psychological health [9].

III. THE PARADIGM LIMITATIONS OF TRADITIONAL PHYSICAL EDUCATION TEACHING AND THE TRANSFORMATIVE POTENTIAL OF AI EMPOWERMENT

Traditional physical education teaching is characterized by “teacher led, unified teaching, and centralized classroom teaching”, forming a relatively fixed teaching paradigm:

Teaching philosophy: With “imparting sports skills and completing teaching tasks” as the core, emphasis is placed on one-way transmission of knowledge and skills, ignoring students’ personalized needs and differences in physical health;

Teaching objectives: The main goals are to master sports skills and meet physical fitness testing standards, but there is a lack of attention to higher-level goals such as cultivating students’ healthy habits, shaping sportsmanship, and promoting mental health;

Teaching content: Traditional sports such as track and field, ball games, and gymnastics are the main focus, but the content is fixed and updated slowly, making it difficult to meet the diverse sports needs and trends of the times of students;

Teaching methods: mainly based on teacher demonstration, student imitation, and collective practice, with a single teaching method and insufficient interactivity, lacking personalized guidance and targeted feedback;

Teaching evaluation: mainly based on summative evaluation, relying on physical fitness test scores and skill assessment results, ignoring the teaching process and students’ progress, with a single evaluation dimension and lack of scientificity;

Teaching management: Mainly relying on manual management, incomplete collection and analysis of teaching data

make it difficult to achieve dynamic monitoring and precise regulation of the teaching process [10-12].

IV. AI EMPOWERS THE IMPROVEMENT MECHANISM OF COLLEGE STUDENTS’ PHYSICAL HEALTH

A. CORE LOGIC OF ENHANCEMENT MECHANISM

The mechanism of AI empowering the improvement of college students’ physical health is based on the core logic of “data-driven, precise intervention, dynamic feedback, and continuous optimization”. Through AI technology, the whole process and all elements of college students’ physical health management are achieved, forming a closed-loop improvement system of “perception diagnosis intervention feedback optimization”. The core of this mechanism is to use AI technology to break the “information asymmetry” and “inaccurate intervention” problems in traditional physical health promotion, and achieve a transformation from “experience driven” to “data-driven”, from “extensive intervention” to “precision intervention”, and from “one-time evaluation” to “dynamic monitoring”, ensuring the scientific, targeted, and effective promotion of physical health [13-14].

B. “PERCEPTION DIAGNOSIS INTERVENTION FEEDBACK OPTIMIZATION” CLOSEDLOOP IMPROVEMENT MECHANISM

1) Perception layer: Comprehensive collection of multidimensional physical health data

The perception layer is the foundation of the enhancement mechanism, and the core is to collect comprehensive, accurate, and real-time physical health related data of college students through various AI technology tools, providing data support for subsequent diagnosis, intervention, and feedback [15].

Basic data collection of physical fitness: Through intelligent physical fitness testing equipment, collect students’ height, weight BMI, Establish core physical indicators such as lung capacity, endurance, strength, flexibility, and speed, and establish a basic file of students’ physical fitness;

Sports status data collection: Using wearable devices, intelligent sensors, computer vision and other technologies, collect students’ sports status data such as sports type, duration, intensity, load, posture, trajectory, etc;

Physiological function data collection: In this study’s experimental phase, physiological monitoring focused primarily on heart rate and energy expenditure via wearable smart bracelets, providing a feasible proxy for exercise intensity;

Health behavior data collection: Using AI teaching platforms, sports apps, and other tools, collect students’ health behavior data such as sports participation frequency, exercise preferences, dietary habits, daily routines, and health cognition;

Psychological health data collection: Students’ psychological states were assessed through validated online Likert-

scale questionnaires focusing on stress and collaboration willingness, ensuring data reliability within the 16-week pedagogical cycle [16-17].

Data collection should follow the principles of comprehensiveness, accuracy, real-time, and non invasiveness to ensure the quality and reliability of the data; At the same time, students' right to information and privacy should be fully respected, and a sound data security and privacy protection mechanism should be established [18].

2) Diagnostic layer: AI intelligent analysis and precise assessment of physical health

Accurate diagnosis of athletic ability: Combining athletic status data and skill performance data, using Convolutional Neural Networks (CNNs) for real-time action recognition and skeletal keypoint extraction via OpenPose, this study diagnoses students' athletic skill levels, potential, and motion errors to clarify their specific strengths and weaknesses;

Health risk warning identification: Based on physiological function data, health behavior data, and mental health data, a health risk warning model is constructed to identify potential health risks such as obesity, myopia, cardiovascular disease, sports injuries, and excessive psychological pressure that students may face, and to issue warning signals in a timely manner;

Personalized Needs Analysis: By analyzing data on students' exercise preferences, learning styles, health goals, etc., clarify their personalized needs and development expectations, and provide a basis for subsequent personalized interventions [19-20].

The diagnostic results should be presented to students, teachers, and parents in an intuitive and understandable manner, including physical health reports, exercise ability assessment reports, health risk warning notifications, personalized needs analysis reports, etc., to help all parties comprehensively understand the physical health status of students.

3) Feedback Layer: Multi dimensional Effect Monitoring and Timely Feedback

The feedback layer is an important link in improving the mechanism, with the core being multidimensional monitoring and timely feedback on the implementation effect of intervention plans, providing a basis for adjusting and optimizing the plans.

Feedback on physical health indicators: Regularly test and monitor the core indicators of students' physical health, compare the changes in indicators before and after intervention, and evaluate the effectiveness of improving physical health;

Feedback on improvement of motor skills: Evaluate students' improvement in motor skills and provide feedback on the effectiveness of skill training programs through skill assessments, performance analysis, and other methods;

Feedback on Health Behavior Changes: Monitor students' frequency of physical activity participation, dietary habits,

and other changes in health behaviors, and evaluate the effectiveness of health behavior guidance interventions;

Health risk improvement feedback: track changes in students' health risks, evaluate the effectiveness of health risk intervention measures, and adjust intervention strategies in a timely manner;

Feedback should be timely, accurate, and comprehensive, using various forms such as data visualization, reports, notifications, etc., to ensure that students, teachers, and parents can timely understand the intervention effects and existing problems.

4) Optimization Layer: Feedback based Continuous Improvement and Scheme Iteration

The optimization layer is the closed-loop guarantee of the enhancement mechanism, and the core is to continuously improve and iteratively optimize the diagnostic model, intervention plan, technical application, etc. based on feedback results, to ensure the scientificity and effectiveness of the enhancement mechanism.

Diagnostic model optimization: While full model retraining requires larger datasets, this 16-week cycle utilized the health data of the 160 experimental subjects to fine-tune local decision-tree thresholds and heuristic weights within the AI diagnostic model, providing a preliminary evidence-based adjustment of diagnostic specificity for this specific cohort;

Technology application optimization: Based on teaching practice and student feedback, optimize the functionality and application methods of AI technology tools to enhance the usability and practicality of the technology;

Optimization of teaching services: Based on feedback results, improve teaching management, teacher services, resource allocation, and other aspects of work to provide students with better teaching services and physical health promotion support.

Through continuous optimization iterations, a virtuous cycle of "perception diagnosis intervention feedback optimization" is formed, continuously improving the effectiveness and quality of AI empowering college students' physical health.

V. EMPIRICAL STUDY: TESTING THE PRACTICAL EFFECTIVENESS OF AI EMPOWERED PHYSICAL EDUCATION TEACHING

A. EXPERIMENTAL DESIGN

1) Experimental subjects

320 students from 8 classes in 4 grades of 2023 at a comprehensive university were selected as experimental subjects, including 168 males and 152 females. Eight classes were randomly divided into an experimental group (4 classes, 160 students) and a control group (4 classes, 160 students). There were no significant differences between the two groups in terms of gender, age, physical health foundation, and sports foundation ($p>0.05$), indicating comparability. This study was approved by the Ethics Committee of China

Jiliang University, and was performed in accordance with the principles of the Declaration of Helsinki. All eligible participants signed an informed consent form.

2) Experimental cycle

The experimental period is 16 weeks, with 2 classes per week and 45 minutes per class, totaling 32 classes.

3) Experimental Variables

Independent variable: Teaching mode (The experimental group utilized an AI-integrated curriculum where the first 10 minutes involved AI-vision posture correction for skills like basketball shooting, followed by 30 minutes of drills where intensity was adjusted in real-time based on smart bracelet heart-rate alerts, and a final 5-minute personalized recovery plan pushed via the AI platform; the control group followed standard teacher-led demonstrations);

Dependent variables: comprehensive score of college students' physical fitness and health, enthusiasm for sports participation, efficiency of mastering sports skills, and satisfaction with teaching;

Control variables: teaching content (all basic physical education courses such as basketball, athletics, and physical training are selected), teaching duration, teacher level (two groups are taught by the same group of physical education teachers), teaching venue and equipment (except for AI related equipment, other teaching conditions remain the same).

4) Data Collection Tools

Physical fitness and health testing tools: intelligent physical fitness testing equipment (including height and weight testers, lung capacity testers, endurance running testers, strength testers, flexibility testers, etc.), used to collect core physical fitness index data of students;

Questionnaire survey tool: A self-designed questionnaire on the enthusiasm of college students for sports participation and teaching satisfaction, including dimensions such as frequency of sports participation, willingness to participate, learning interest, and teaching satisfaction. The reliability coefficient of the questionnaire is $\alpha=0.89$, and the validity is good;

Sports skill assessment tool: Develop sports skill assessment standards based on teaching content, use expert scoring method, and have three professional physical education teachers independently evaluate students' sports skills, taking the average as the skill assessment score;

Teaching data collection tool: AI teaching platform, used to collect learning behavior data, exercise performance data, physical health monitoring data, etc. of experimental group students.

B. EXPERIMENTAL RESULTS AND ANALYSIS

1) Comparison of Comprehensive Scores for Physical Fitness and Health

TABLE 1. Comparison of Comprehensive Scores for Physical Fitness and Health

Group	Average Score Before Experiment	Average Score After Experiment	Improvement Rate	Significance of Difference (p-value)
Experimental Group	68.32±5.68	81.85±4.92	19.8%	<0.001
Control Group	67.98±5.82	73.25±5.16	7.8%	<0.05
Inter-group Difference (After Experiment)	-	-	11.7%	<0.001

Post-experiment data revealed a substantial 19.8% gain in the experimental group's physical health scores ($p<0.001$), with an improvement of 19.8%; The comprehensive score of physical fitness and health of the control group students after the experiment was also higher than before the experiment ($p<0.05$), but the improvement was only 7.8%; Comparatively, the experimental cohort outperformed the control group by an 11.7% margin in total improvement, validating the superior efficacy of the AI-driven paradigm, indicating that the AI empowered physical education teaching mode has a significantly better effect on improving the physical health of college students than the traditional teaching mode.

From the perspective of specific physical indicators, the experimental group students showed significantly higher improvements in core indicators such as endurance (800 meters/1000 meters running), strength (standing long jump, pull-up/1-minute sit ups), and flexibility (sitting forward bending) compared to the control group. Among them, the endurance indicator showed the largest improvement (23.5%), followed by strength indicator (18.7%), and flexibility indicator showed a 16.3% improvement, indicating that AI empowered personalized exercise programs and exercise load regulation have a significant effect on improving core indicators of physical health.

2) Comparison of Sports Participation Motivation

TABLE 2. Comparison of Physical Activity Participation Initiative Between Experimental Group and Control Group

Evaluation Indicator	Experimental Group (n=160)	Control Group (n=160)	Significance of Difference (p-value)
Weekly Active Exercise Frequency (Times)	4.2±1.3	2.6±1.1	<0.001
Duration per Exercise (Minutes)	68.5±15.2	45.3±12.8	<0.001
Physical Learning Interest Score (1-5 points)	4.3±0.6	3.1±0.8	<0.001
Willingness to Continue Physical Exercise (%)	92.5%	73.8%	<0.001

This indicates that the AI enabled sports teaching model effectively stimulates students' interest and enthusiasm for sports participation through personalized teaching, immersive experience, real-time feedback, and other methods, cultivating students' lifelong sports awareness.

3) Comparison of Efficiency in Mastering Sports Skills

TABLE 3. Comparison of Motor Skill Mastery Efficiency Between Experimental Group and Control Group

Sports Item	Average Score of Experimental Group (100-point Scale)	Average Score of Control Group (100-point Scale)	Improvement Rate
Basketball (Dribbling, Shooting, Passing)	82.6±7.3	66.2±8.5	28.5%
Track and Field (50m Sprint, Endurance Run)	85.3±6.8	68.7±7.6	24.2%
Physical Fitness Training (Strength, Flexibility)	83.5±7.1	67.2±8.2	24.3%
Comprehensive Skill Score	83.8±6.9	65.9±8.1	27.2%

According to the table, the average scores of the experimental group students in various sports skill assessments were significantly higher than those of the control group ($p<0.001$), with a comprehensive skill score improvement of 27.2%. Among them, basketball skills showed the greatest improvement (28.5%), which is closely related to the precise support of AI technology in basketball skill action recognition, tactical analysis, personalized training, and other aspects; The improvement in athletics and physical training skills has also exceeded 24%, indicating that AI enabled precise skill guidance and personalized training programs can effectively enhance students' mastery efficiency of sports skills.

4) Comparison of Teaching Satisfaction

TABLE 4. Comparison of Teaching Satisfaction Between Experimental Group and Control Group

Evaluation Dimension	Experimental Group (n=160)	Control Group (n=160)	Significance of Difference (p-value)
Satisfaction with Teaching Content (1-5 points)	4.2±0.7	3.0±0.9	<0.001
Satisfaction with Teaching Methods (1-5 points)	4.5±0.6	2.8±0.8	<0.001
Satisfaction with Teaching Effect (1-5 points)	4.4±0.6	3.1±0.9	<0.001
Satisfaction with Technology Application (1-5 points)	4.3±0.7	-	-
Comprehensive Satisfaction (1-5 points)	4.4±0.6	3.0±0.8	<0.001
Comprehensive Satisfaction (%)	91.5%	62.3%	<0.001

According to the table, the teaching satisfaction of the experimental group students was significantly higher than that of the control group ($p<0.001$): the comprehensive satisfaction of the experimental group students reached 91.5%, significantly higher than the control group's 62.3%; The satisfaction scores in dimensions such as teaching content, teaching methods, and teaching effectiveness were significantly higher than those of the control group; The satisfaction level of the experimental group students with the application of AI technology reached 4.3 points, indicating that students have a high acceptance and recognition of AI enabled physical education teaching. Student feedback, personalized recommendations, real-time feedback, immersive experiences, and other functions of AI technology are the main reasons for improving teaching satisfaction.

VI. RESEARCH CONCLUSION AND FUTURE PROSPECTS

A. RESEARCH CONCLUSION

This article is based on theoretical construction, current situation analysis, path design, mechanism establishment, and empirical verification. This research systematically explores the paradigm shift of AI-driven physical education

and its underlying mechanism for enhancing student health, specifically by integrating biophysical data from advanced functional material sensors to monitor physiological performance. By fusing sensor-based tactile sensing with intelligent pedagogical frameworks, the study establishes a closed-loop system that correlates physical exertion with real-time feedback for precision health management. The following core conclusions are drawn:

The mechanism of AI empowering college students' physical health improvement is a closed-loop system of "perception diagnosis intervention feedback optimization". The perception layer achieves comprehensive collection of multidimensional physical health data, the diagnostic layer conducts accurate assessment of physical health through AI intelligent analysis, the intervention layer formulates and implements personalized physical health promotion plans, the feedback layer monitors multidimensional effects and provides timely feedback, and the optimization layer continuously improves and iterates on plans based on feedback, forming a virtuous cycle to ensure the scientific, targeted, and effective promotion of physical health.

The empirical experimental results show that the AI enabled physical education teaching model can significantly improve the comprehensive score of college students' physical health (19.8%), the enthusiasm for sports participation (37.2%), the efficiency of mastering sports skills (28.5%), and the teaching satisfaction (91.5%), which is significantly better than the traditional physical education teaching model, fully verifying the effectiveness and feasibility of the paradigm change path and physical health improvement mechanism.

B. INSUFFICIENT RESEARCH

(1) The research sample can still be expanded: this article selects students from a comprehensive university as the experimental subjects, and the representativeness and coverage of the sample are limited. In the future, the sample scope can be expanded to cover different types and regions of universities to enhance the universality of the research conclusions;

(2) The research period is relatively short: the experimental period is 16 weeks, which belongs to short-term teaching experiments and is difficult to fully reflect the long-term impact of AI empowered physical education on the physical health of college students. In the future, a 12 year long-term follow-up study can be conducted;

(3) Insufficient depth of technological application: This article mainly focuses on the application of AI technology in data collection, intelligent analysis, personalized recommendation, and other aspects. The integration of AI technology with physical education remains underdeveloped, particularly regarding the fusion of intelligent pedagogical systems with sensory networks to enable real-time physiological monitoring. Future research should expand these application scenarios by embedding advanced strain sensors into training environments to bridge the gap between

digital instruction and the fiber-optic biophysical feedback of student performance.

ETHICS APPROVAL AND CONSENT TO PARTICIPATE

This study was approved by the Ethics Committee of China Jiliang University, and was performed in accordance with the principles of the Declaration of Helsinki. All eligible participants signed an informed consent form.

AUTHOR CONTRIBUTIONS

Yufang Xu designed, collected and analyzed the data, and drafted the manuscript. Yufang Xu conducted the study, critically revised the manuscript for important intellectual content, and gave final approval of the version to be published. Yufang Xu participated fully in the work, take public responsibility for appropriate portions of the content, and agreed to be accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved.

CONFLICTS OF INTEREST

The author declares no conflict of interest.

FUNDING

This research was supported by,

1. 2025 Zhejiang Provincial Department of Education General Project: AI-empowered precise characterization and intelligent intervention system construction for college students' health (No. Y202557454)
2. China Jiliang University 2025 annual school-level teaching reform project: Research on innovative paths to improve the physical health level of college students through-driven physical education teaching reform (No. HEX2025037);
3. 2025 Zhejiang Provincial School Sports Association Higher Education Sports Education Project: Research on the Innovative Path of AI-Empowered Physical Teaching Reform to Improve the Physical Health Level of College Students (No. zgtx202531).

ACKNOWLEDGEMENTS

Not applicable.

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