Research on the Precision Teaching Model of Physical Fitness and Health for College Students Driven by Big Data — Design of Personalized Exercise Prescription Based on Physical Fitness Monitoring Data

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Abstract: With the increasingly prominent individualized differences in physical health problems among college students, the traditional "one size fits all" physical education teaching model is unable to meet the needs of precise intervention. This study developed a big data-driven precision teaching model for college students' physical fitness and health. Based on multi-source data such as physical fitness testing, campus running systems, and wearable devices, a five-level closed-loop system was established, consisting of a data layer, analysis layer, decision-making layer, implementation layer, and feedback layer. This model divides students' physical types (such as weak endurance/insufficient strength) through clustering algorithms, intelligently generates personalized exercise prescriptions based on weak indicators, and designs a linkage mechanism and dynamic adjustment rules between in class and out of class activities. Taking overweight students with insufficient endurance as an example, the effectiveness of the mapping rule library between physical fitness indicators and exercise parameters was verified. The model has the advantages of low technological threshold, teacher empowerment, and precise intervention, providing a new path to solve the contradiction of "weak physical fitness cannot train and strong physical fitness cannot eat enough", and providing technical support for the implementation of sports education integration policies.

***Keywords*:** big data-driven; physical health; personalized intervention

1. Introduction

In recent years, the overall physical health level of Chinese university students has shown a stable and positive trend, but some key indicators such as endurance and strength are still not optimistic. Physical health problems have shown significant individual differences and uneven intervention effects. The traditional physical education teaching model in universities is mainly based on "unified teaching and collective training", which makes it difficult to provide precise guidance for students with different physical foundations, exercise abilities, and health needs, resulting in a structural contradiction of "weak physical groups not receiving effective improvement, and sports advantage groups lacking challenge space". How to break through the limitations of "flood irrigation" teaching and achieve precise identification, intervention, and evaluation of students' physical health promotion has become an important topic in the reform of physical education in universities in the new era[1].

The rapid development of big data technology provides a new path to solve the above-mentioned problems. Based on the National Student Physical Health Standards testing, campus smart running system, wearable devices and other platforms, universities have accumulated a massive amount of student physical fitness monitoring data such as BMI, lung capacity, endurance running results, strength project performance, etc. These data contain rich information on individual health status and development potential. However, the current utilization of such data by most universities still remains at the level of statistical reporting and result disclosure, without delving into its application value in guiding personalized teaching, resulting in a phenomenon of "data dormancy". The deep integration of big data technology with physical education teaching and the construction of a "data-driven decision-making" precise teaching model are key breakthroughs in improving the effectiveness of physical education in universities.

2. Construction of a precision teaching model for physical fitness and health of college students driven by big data

2.1 Mode architecture and closed-loop operation

This model constructs a five-level closed-loop system consisting of a data layer, an analysis layer, a decision layer, an implementation layer, and a feedback layer, with the aim of building a system centered on students' physical health, personalized exercise prescriptions as the carrier, and big data technology as the support. The data layer integrates multiple sources of physical fitness data (such as physical test scores, campus running records, wearable devices, etc.) to establish a standardized health database; The analysis layer uses clustering algorithms to classify students' physical types (such as weak endurance/insufficient strength), and locates individual weaknesses through radar charts; The decision-making layer generates personalized exercise prescriptions based on weaknesses, including key parameters such as target performance, exercise intensity, and matching weaknesses; Implement layered training in the classroom and push prescription tasks through an app outside of class; The feedback layer evaluates the improvement of physical fitness every 4 weeks, dynamically adjusts prescription parameters, and forms a closed-loop optimization[2].

2.2 Core Innovative Design

2.2.1 A data-driven prescription generation engine

Table 1. Establishing a mapping rule library for "physical fitness indicators exercise parameters"

Recommended Strength Formula for Physical Shortcomings
BMI ≥ 24 S low jogging/elliptical target heart rate=(207-0.7) ✖ Age) ✖ zero point six
Pull up ≤ 2 times elastic band rowing RPE5-6 level (10 level)

2.2.2 In class and out of class linkage mechanism

In the classroom, differentiated training is implemented by grouping according to physical fitness (endurance group focuses on interval running); outside of class, the app automatically supervises prescription execution (such as matching preset pace for campus running)[3].

2.2.3 Dynamic adaptation rules

Compliance rate>80% → increase intensity according to the 10% rule; If the compliance rate is less than 50%, it will trigger manual intervention by the teacher.

2.3 Advantages of Mode Implementation

Low tech threshold, relying on existing physical testing systems and campus running apps in universities, without the need for additional hardware; Empowering teachers and providing prescription generation tools to reduce the difficulty of personalized teaching; Student oriented, solving the structural contradiction of "weak physical fitness cannot practice, and strong physical fitness cannot eat enough".

3. Methodology for Personalized Exercise Prescription Design Driven by Physical Fitness Data

This study takes student C as an example, a 20-year-old male with a BMI of 25.8 (overweight) and a 1000m score of 5'30 "(failing). The core weakness is obesity combined with insufficient endurance.

3.1 Conversion Path from Data to Action

Accurately diagnose and target, based on physical health profiles (such as BMI, endurance running, strength test data), identify 1-2 core weakness indicators; The goal setting can be quantified, and the improvement needs can be transformed into numerical goals, such as short-term (4 weeks) 1000m score improvement of 10 seconds, BMI decrease of 0.5, and long-term (semester) passing the National Physical Fitness Test endurance project. The specific reference parameters for matching the four elements are shown in Table 2.

Table 2. Four elements of parameter matching

Element Design Rules Student C Plan
The project mainly focuses on low joint load fat burning exercise, swimming (70%), and dynamic cycling.
Low to moderate intensity target heart rate (60% -)% heart rate control 130-150bpm
The duration starts from 20 minutes, with a weekly increase of 5% from 20 minutes in the first week to 25 minutes in the fourth week.
Balancing the need for weight loss and recovery with a frequency of 4 times per week (3 aerobic+1 strength)

3.2 Teacher system collaborative decision-making mechanism

After the system screens and automatically generates prescription drafts, teachers may manually optimize the plan based on the actual situation of students

3.3 Dynamic Adjustment and Safety Control

In the 4-week feedback node, when the compliance rate is ≥ 80%, the intensity can be increased by 5%; when the compliance rate is ≤ 50%, interesting projects can be added. Pay attention to the safety red line during exercise, and jumping movements are prohibited if BMI ≥ 26; high intensity interval training is prohibited when resting blood pressure is ≥ 140/90mmHg[4].

4. Implementation path and development prospects of the model

4.1 Phased Implementation Path

In the preparation phase (1 semester), we will build a school level physical fitness and health data platform, integrate physical testing, campus running and other systems, and develop a lightweight prescription generation tool (Excel plugin or WeChat mini program). During the pilot phase (1 academic year), 2-3 classes will be selected from compulsory physical education courses to verify the feasibility of the model and train teachers in data interpretation and prescription adjustment skills. During the promotion phase (2-3 years), it will be included in the school-wide physical education curriculum reform plan, accompanied by the revision of the teaching syllabus, the establishment of a "student physical fitness digital file", and the tracking of long-term health benefits[5].

4.2 Application prospects and prospects

In the short term, promote the establishment of a physical fitness data alliance among 10 universities within the province, and share the mapping rule library; long term, connect with the "National Student Health Big Data Platform" to provide empirical support for the integration of sports and education policies; technological iteration, introduction of AI algorithms to predict the risk of sports injuries, and optimization of prescription safety.

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