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A Data-Driven Approach to Adolescent Health Using Personalized Sports Prescriptions

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ABSTRACT

This study presents an mHealth-based intervention using wearable devices and personalized sports prescriptions to improve adolescent physical health. A 12-week experiment was conducted with 312 junior high school students, randomly assigned to intervention and control groups. The intervention group received customized exercise plans supported by real-time physiological monitoring in addition to regular physical education; the control group followed standard classes only. Data on physical fitness (body mass index [BMI], lung capacity, 50-meter run, grip strength) and mental well-being were collected. Results showed significant improvements in the intervention group across all physical indicators ($p < 0.05$). The findings suggest that integrating wearable technology and data-driven prescription models into school health programs can effectively promote adolescent health, offering a scalable digital health solution within educational settings.

KEYWORDS

Adolescent Health, mHealth Intervention, Personalized Sports Prescription, Wearable Technology, Health Information System, Data-Driven Health Promotion

INTRODUCTION

In recent years, adolescent physical health has drawn increasing public attention due to societal and educational changes (Newman & Anderson-Butcher, 2021; Strömmer et al., 2020). Numerous authoritative studies, both domestic and international, have indicated a general decline in physical fitness among youth, including rising obesity rates and insufficient participation in physical activity (D'Anna et al., 2024; Guo et al., 2024). For instance, the latest round of the National Student Physical Fitness and Health Survey in China revealed a consistent decline in fundamental physical indicators such as endurance and explosive power among middle school students over the past decade (X. Dong et al., 2023; L. Zhang et al., 2025). The rate of excellent physical health among Chinese adolescents is significantly lower than that of their peers in developed countries (Y. Dong et al., 2019). In some urban middle schools, the proportion of overweight and obese students has even reached as high as 25% (Peltzer et al., 2014). These trends highlight an urgent need for effective interventions to improve adolescent physical health.

Beyond the decline in physical fitness, the mental health status of adolescents has also raised concerns. Several studies suggest a correlation between weakened physical condition and psychological

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issues such as anxiety and depression (Jenkinson et al., 2024; Lim et al., 2012). Physical inactivity may not only impair physical development, but also negatively affect emotional regulation and cognitive function (Bidzan-Bluma & Lipowska, 2018). Given these intertwined health risks, a comprehensive and integrated approach to promoting adolescent well-being is imperative.

Physical education and regular exercise are widely recognized as key strategies for improving adolescent physical health (Kumar et al., 2015; Zhu et al., 2024). However, traditional models often emphasize standardized instruction while neglecting individual differences (Cao & Shi, 2024). This "one-size-fits-all" approach may fail to effectively motivate students or accommodate varying fitness levels and interests (Rukavina et al., 2015). As a result, student engagement and long-term adherence to physical activity remain suboptimal (Middleton et al., 2013).

To address this challenge, researchers in Western countries have explored the application of exercise prescription—a method commonly used in clinical rehabilitation and adult fitness—in youth physical education settings (Downs et al., 2021). Exercise prescription involves tailoring physical activity plans to an individual's specific needs, capabilities, and goals. Early studies have shown promising results in enhancing motivation, participation, and overall fitness outcomes among adolescents (Owen et al., 2014).

Despite its potential, the implementation of exercise prescription-based interventions in primary and secondary schools within China remains limited (Xu et al., 2024). There is a lack of empirical research and established teaching frameworks or evaluation criteria tailored to the Chinese context (Gao et al., 2014). Therefore, this study aims to design and evaluate a scientifically grounded exercise prescription intervention specifically for Chinese adolescents. By conducting rigorous experimental analysis, we hope to provide evidence-based insights into how personalized physical education can be effectively implemented to enhance youth physical health and inform future policy and curriculum development.

LITERATURE REVIEW

Adolescent physical health intervention has always been one of the core topics in sports science research (van Sluijs et al., 2021; J. Zhang et al., 2024). In recent years, with the increasing prominence of public health issues, especially the increasing obesity rate and declining physical fitness among adolescents, how to improve the physical fitness of adolescents through scientific and effective sports intervention has become the focus of academic research (Bermejo-Cantarero et al., 2024). A large number of studies have shown that systematic physical exercise can not only significantly improve adolescents' basic physical fitness indicators such as strength, endurance, and flexibility, but also have a positive impact on psychological adjustment and social skills development.

In this context, exercise prescription, as a scientific training program based on individual characteristics, has gradually been widely used in adolescent physical intervention practice. Studies have pointed out that the core of exercise prescription lies in "personalization" and "dynamic adjustment," that is, designing targeted training plans according to different ages, genders, basic physical conditions, and behavioral habits (Li et al., 2024). This intervention method not only improves the effectiveness of sports participation, but also enhances students' interest and persistence in sports activities.

Lehtonen et al. (2022) found that the use of a hierarchical exercise prescription intervention strategy can effectively improve students' aerobic endurance and muscle strength, and its effect shows good stability in long-term tracking. This shows that introducing a personalized exercise prescription mechanism in school physical education courses will help build a more sustainable health promotion path.

In addition, the development of information technology has also provided new support means for exercise intervention. For example, Bayoumy et al. (2021) proposed combining smart wearable devices with exercise prescription systems to monitor the exercise load and physiological reactions of