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The Construction of a Multidimensional Physical Education Curriculum System and Its Impact on University Students' Physical Activity

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Abstract: *Although university students in China generally demonstrate a high level of sports-related knowledge, their actual participation in physical activity remains insufficient, contributing to declining physical fitness and increasing obesity prevalence. This study aimed to develop a multidimensional physical education (PE) curriculum and to examine its effects on university students 'physical activity behaviours. A triaxial accelerometer (ActiGraph GT3X+) was used to objectively assess sedentary behaviour and physical activity intensity. The curriculum system comprised three tiers—competition-based courses, specialised skill courses, and health-oriented fitness and weight-loss courses—designed to address students 'diverse abilities and needs. The results indicated that participation in the multidimensional PE curriculum led to increases in moderate-to-vigorous physical activity (MVPA) across all course types. Notably, the proportion of students meeting the World Health Organisation's recommended MVPA levels increased to 100% after one semester of intervention. Conclusion: The multidimensional PE curriculum exerts a significant positive influence on university students 'physical activity behaviours and offers practical implications for physical education reform in higher education.*

Keywords: *Physical education curriculum; Physical activity; Moderate-to-vigorous physical activity; University students; Curriculum reform*

1. Introduction

University students 'physical activity and health management have become central concerns in both educational policy and public health research. Previous studies have consistently shown that, despite possessing relatively high levels of sports-related cognition, Chinese university students exhibit low levels of regular physical activity, resulting in declining physical fitness and an increased risk of obesity and other non-communicable diseases. With the advancement of the national "Healthy China" strategy, enhancing physical activity participation among university students has become a key objective of higher education reform.

Physical education courses represent the primary institutional mechanism for promoting physical activity among university students.Based on the requirements of the "Four-in-One" concept, some studies propose a linkage mechanism between physical education courses and sports competitions, advocating for the integration of in-class and extracurricular activities. A new curriculum system characterized by the integration of competition into classes[1], class-based competitions, and diversification is considered a new model for university physical education reform in the new era, effectively enhancing students' physical education literacy, strengthening their athletic abilities, and promoting the formation of positive exercise habits[2]. However, most existing studies remain conceptual in nature, with limited empirical evidence based on objective physical activity measurements.

Guided by the educational philosophy of "health first," this study developed a multidimensional PE curriculum characterised by competition integration and stratified instruction. The curriculum includes competition-based courses, specialised skill courses, and health-focused fitness and weight-loss courses, aiming to accommodate students 'heterogeneous physical abilities and interests. Using tri-axial accelerometer sensor (ActiGraph GT3X+), this study empirically examined the effects of the curriculum on sedentary behaviour and physical activity levels, providing evidence-based recommendations for optimising PE curriculum design in higher education.

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2. Research Background

Physical education is a core component of university education and serves as a critical platform for enhancing students ’physical fitness and sports literacy. The central goal of PE curriculum reform is the implementation of the “health first” educational principle. Internationally, university PE curricula tend to emphasize student-centered learning, flexibility, and inclusivity, with a strong focus on individual differences and holistic development. These curricula often integrate physical skill development with social competence, motivation, and lifelong physical activity engagement.

2.1 Background Analysis

Since 2013, China has introduced the "Physical Education and Health Curriculum" in primary and secondary schools to enhance students' physical education literacy. The Shanghai Municipal Education Commission has proposed a phased physical education philosophy: "interest-based in primary school, diversification in junior high, specialization in high school, and personalization in university." However, due to varying resources across regions, after 12 years of physical education, students' motor skills and physical fitness vary greatly, and most students still have not mastered one sports skill. From the perspective of enhancing students' lifelong physical education literacy, university physical education curriculum reform should increasingly focus on students' personalized development, emphasizing the practical application of motor skills and knowledge.

University students are mostly aged 18-22. Their physical and mental characteristics include mature cognitive functions, with thinking exhibiting more logic and rationality; their physiological development is largely mature, self-awareness begins to mature, willpower strengthens, socialization improves significantly, emotions are diverse, the need for social interaction is strong, and personality tends towards maturity and improvement. There are significant individual differences in physical condition and skill level.

Physical activity, also known as "PA," refers to any bodily movement produced by skeletal muscles that requires energy expenditure, including activities in various contexts (e.g., work, exercise, household chores, recreation). The amount of physical activity can be measured by frequency, intensity, and duration (WHO, 2020). The health benefits of regular physical activity, especially moderate-to-vigorous physical activity, have been proven to help preventing and managing non-communicable diseases (heart disease, diabetes, stroke, etc.), maintaining a healthy weight, improving sleep quality, and promoting mental health[3]. To gain maximum health benefits and promote physical and mental well-being, the World Health Organization first published guidelines on recommended levels of physical activity for adults in 2010 and updated the guidelines on physical activity and sedentary behavior in 2020. In China, the National Health Commission's Center for Disease Control and Prevention, in its first "Chinese Physical Activity Guidelines 2021" released in September 2021, recommended that adults aged 18-64 should engage in 150-300 minutes of moderate-intensity or 75-150 minutes of vigorous-intensity aerobic activity per week, or an equivalent combination of moderate- and vigorous-intensity activity (Chinese Physical Activity Guidelines Writing Committee, 2022). It is reported that the global population shows a trend of physical inactivity, with approximately 27.5% having insufficient physical activity. In China, the proportion of adults aged 18 and over with insufficient physical activity rose from 17.9% in 2010 to 22.3% in 2018 [4]. This indicates that Chinese adults also show a trend of insufficient physical activity. The reasons for young people's lack of physical activity are diverse, primarily including: 1. Lack of motivation; 2. Inability to enjoy the fun of exercise due to lack of appropriate motor skills; 3. Lack of participation opportunities (e.g., no sports or competitive situations for students with high skill levels to showcase their abilities); 4. Lack of supportive environments (e.g., obese and physically weak students lack supportive environments and professional guidance)[5]. Research confirms that physical inactivity negatively affects the physical and mental health of university students, for example, increasing the risk of chronic diseases (cardiovascular disease, obesity, etc.), impairing mental health (depression, anxiety, stress), reducing academic performance, and affecting sleep quality[6]. Universities, as the living environment where most students study away from home for the first time, should provide a supportive environment to help them establish healthy lifestyle behavior patterns that can last a lifetime. Among these, physical education courses play a crucial role in cultivating students' healthy lifestyle behaviors.

Universities represent a critical life stage during which individuals develop independent lifestyles and long-term health behaviors. Accordingly, higher education institutions bear a responsibility to provide supportive environments and structured opportunities that promote sustained physical activity. Within this context, physical education courses play a pivotal role in shaping students ’exercise behaviors and health trajectories.

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2.2 Construction of the Multi-Dimension Physical Education Curriculum System

Guided by the principles of people-centered development and health first, and informed by a systematic review of existing research, this study takes into account the physical and psychological characteristics of university students, their current level of physical education literacy, and the sports resources and faculty strengths of our university. On this basis, we propose an innovative physical education teaching model characterized by the integration of competition into coursework, universal participation, literacy enhancement, and lifelong benefits. With a focus on the lifelong development of all students, the model seeks to improve physical education literacy across five dimensions: sports awareness, sports skills, sports behavior, physical health, and sports knowledge. Accordingly, a multidimensional physical education curriculum system for general universities is constructed (see Table 1).

Table 1. Multi-Educational Curriculum System

Course	Target Students	Main Objectives
High-Level Sports Team Training	Specially recruited athletes	High-level competitive ability
Competition Course	Students with Athletic Expertise	Enhance practical ability
Specialized Course	Ordinary students	master a motor skill
Physical Fitness, Health & Weight Loss	Students with low physical fitness	Improve physical fitness
Health Care Class	Students with physical discomfort	Promote health
Physical Fitness Test	Junior & Senior students	Enhance physical fitness
PE Retake Course	Students who failed PE make-up exam	Remedial study
Elective Course	Undergraduate students	Enhance sports interest & ability

The multidimensional curriculum system enhances the alignment between course classification and students ’diverse needs. Competition-oriented courses are designed for students with specialized skills, aiming to strengthen practical competence through structured league systems. Specialized skill courses are provided for general students to stimulate interest in physical activity and improve sport-specific motor skills through instructional competitions. Health and weight-management courses are offered for students with weaker physical fitness, employing task-driven teaching approaches to increase engagement in exercise and foster the development of regular physical activity

2.2.1 Advanced Physical Education Course (Competition Class)

Targeting all undergraduates with certain sports skills and abilities, the main course objectives are to stimulate students' specialized interest, enhance practical ability, and problem-solving skills in complex situations. The teaching content arrangement adheres to being conducive to the comprehensive development of students' specialized abilities and beneficial to the development of the project team. Based on the project characteristics and student levels, an integrated "learning-training-competition" teaching plan is developed. Using competition as the core content of the course, students identify problems in actual competition, formulate targeted training plans and countermeasures with the team, and then test them on the field, enhancing effectiveness, stimulating student potential, and creating a good atmosphere that values sports.

A selective enrollment system is implemented to establish sports competition classes composed of students with advanced sport-specific skills and strong theoretical knowledge. These classes are open to students from different academic years and are credit-bearing, corresponding to PE 2, PE 3, and PE 4 as either compulsory or elective courses. The curriculum is centered on league-based competitions, complemented by specialized independent training, ensuring that each student participates in at least one high-intensity competition per week. Course scheduling is determined through consultation between instructors and students, with competition and training plans for the following semester finalized during the selection process, enabling students in the competition classes to plan their academic schedules in advance.

Selection Process for Sports Competition Courses:One semester in advance, responsible instructors for each sport specialization identify and select eligible students, assigning roles according to individual expertise (e.g., athlete, referee, or event management staff). Following the signing of a letter of intent, the finalized student list is submitted to the Sports Department office. Selected students are then informed not to participate in the standard PE course selection for that semester. The Sports Department’s teaching secretary consolidates the student lists for each sport-specific competition class and submits them to the Academic Affairs Office, which centrally schedules and arranges the sports competition courses for the

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upcoming semester.

Integrated Sports Competition & Management CurriculumFor mainstream sports—such as football, basketball, and volleyball—the semester centers on a structured league format. Students earn credits through a hybrid of competitive play and rigorous training. Operating under a professional club management model, students are assigned specific roles tailored to their expertise. This structure fosters social responsibility and, through strategic role-swapping, builds a deep sense of collective identity. For niche sports like floorball and flag football, the curriculum integrates directly with club activities. By tying credits to club participation, the program ensures specialized depth, consistent practice, and a vibrant competitive culture that encourages lifelong fitness.

2.2.2 Specialized Physical Education Course

Specialized course learning for ordinary students adopts small-class teaching, with classes not exceeding 30 students. The main course objectives are to improve students' specialized techniques and tactics, physical fitness, and enhance their interest and participation in specialized sports. Simplified teaching competitions are appropriately introduced in the classroom. Through practical situational teaching, students' interest in exercise is stimulated, and their ability to cooperate and persevere is cultivated. Students independently select sports and class times based on their interests via the academic affairs system.

2.2.3 Health & Weight Loss Course, Physical Fitness Course

The Health and Weight Management Course is primarily designed for students with inadequate physical fitness levels or a high body fat percentage. The course aims to equip students with scientifically sound and effective weight management strategies, increase their interest in physical activity, and foster sustainable exercise habits. To address students ’weight management needs, the course adopts a task-driven, group-based training approach that promotes healthy weight loss, improves overall physical fitness, and cultivates a proactive attitude toward regular exercise. The course selection process follows the model used for sports competition classes, with early student selection and centralized scheduling by the Academic Affairs Office.

3. Research Object and Methods

3.1 Research Object

This study aims to enhance students' physical activity behavior. Based on existing research, a multidimensional competition-integrated curriculum system was constructed, and a physical education teaching experiment was conducted to verify the effect of the multidimensional physical education curriculum system on improving university students' physical activity behavior.

3.2 Research Methods

3.2.1 Literature Review Method

This study conducted a comprehensive literature search using keywords such as “university students,” “physical education curriculum,” “curriculum reform,” “multi-dimensional education,” and “physical activity behavior” across authoritative domestic and international databases, including CNKI, Wanfang, and Web of Science. More than 3,000 relevant articles were collected and systematically organized, reviewed, and analyzed to identify key academic themes and research trajectories. By synthesizing existing theoretical findings and best practices, this process provided a solid theoretical foundation for the present study

3.2.2 Teaching Experiment Method

Experimental design: During the 16-week physical education instruction period for selected classes in the first semester of the 2023–2024 academic year, a multi-dimensional curriculum model deeply integrating learning, training, and competition was implemented. Students ’sedentary behavior and physical activity levels were assessed before and after the intervention to evaluate changes in physical activity behavior resulting from the teaching experiment.

Experimental Subjects: A random selection of students (N=103) from the USST volleyball specialized course, volleyball competition course, and health & weight-loss course served as the teaching experiment subjects. These included 32 students from the volleyball specialized course (31.1%), 13 from

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the volleyball competition course (12.6%), and 58 from the health & weight-loss course (56.3%). The surveyed subjects were primarily university students aged 18 to 20 (95.1%), including 71 males (68.9%) and 32 females (31.1%).

3.2.3 Measurement Method

A triaxial accelerometer (ActiGraph GT3X+) was employed to assess students 'sedentary behavior and daily physical activity levels, with particular emphasis on moderate-to-vigorous physical activity (MVPA). This device is a sophisticated motion sensor that estimates physical activity intensity and duration by detecting acceleration across the sagittal, coronal, and horizontal planes, thereby providing relatively objective and accurate measurements[7]. Triaxial accelerometers are now widely used in physical activity research worldwide. Accordingly, the ActiGraph GT3X+ (Fort Walton Beach, USA) was selected to measure university students 'physical activity levels in this study.Physical activity intensity was classified using the cut-point criteria proposed by Freedson (1998), expressed in counts per minute (CPM). The intensity thresholds were defined as follows: sedentary behavior (0–99 CPM), light physical activity (100–1951 CPM), moderate physical activity (1952–5724 CPM), and vigorous physical activity (≥5725 CPM).

Specific Procedures:A total of 103 students enrolled in the volleyball specialization course, volleyball competition course, and the health and weight management course were selected to wear accelerometers to monitor their physical activity levels over seven consecutive days.First, after obtaining students ' informed consent through signed consent forms, participants were instructed on proper wearing procedures and precautions. The accelerometer was worn on the right hip throughout the monitoring period and was to be removed only during bathing, swimming, or sleeping.Second, device initialization was conducted using the ActiLife software provided with the accelerometer. The sampling interval was set to 60 seconds, and the sampling frequency was set to 30 Hz. Following initialization, devices were distributed to students with instructions to comply with the prescribed wearing protocol.Third, device distribution and monitoring were carried out during two measurement periods in the first semester of the 2023–2024 academic year. For the first measurement period, devices were distributed on September 19, 2023, worn continuously from September 20 to September 26, and collected on September 27. For the second measurement period, devices were distributed on December 14, 2023, worn continuously from December 15 to December 21, and collected on December 22.Finally, data collection and processing were performed. Valid data were screened prior to analysis. A valid day was defined as at least 480 minutes of wear time, and inclusion required a minimum of three valid days within the seven-day monitoring period, including at least two weekdays and one weekend day. Based on the valid data, students 'sedentary behavior, light-intensity physical activity, and moderate-to-vigorous physical activity levels were calculated.

3.2.4 Mathematical Statistics Method

This study used SPSS 26.0 (IBM Corp., Armonk, NY, USA) statistical software for analysis. Descriptive statistics (mean ±standard deviation, frequency analysis) were used to describe participants' demographic characteristics, physical activity behavior, sedentary behavior, and MVPA compliance rate. Paired-sample t-tests were used to determine differences in participants' physical activity levels at different measurement times. The statistical significance level was set at $p < 0.05$.

4. Research Results

4.1 Results of Different Intensity Physical Activity and Sedentary Behavior

This study employed triaxial accelerometers to evaluate changes in physical activity and sedentary behavior among students enrolled in different physical education courses, including the Volleyball Specialized Course, Volleyball Competition Course, and Health and Weight Management Course. The assessed behaviors comprised daily sedentary time, light physical activity, moderate physical activity, vigorous physical activity, and moderate-to-vigorous physical activity (MVPA). All outcomes are reported asp average daily minutes (mean ±standard deviation) (see Table 2).

The results indicated no statistically significant differences in sedentary behavior or physical activity levels across all intensity categories between the pre- and post-intervention assessments. However, slight post-intervention increases in sedentary time were observed among students in the Volleyball Specialized and Competition Courses, accompanied by decreases in light physical activity across all three course types. In contrast, moderate, vigorous, and moderate-to-vigorous physical activity levels demonstrated

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modest increases among students in all courses, although these changes did not reach statistical significance.

4.2 Physical Activity Guideline Compliance Rate by Course

According to the guidelines of the World Health Organization and the Chinese Center for Disease Control and Prevention, this study assessed the adequacy of university students' physical activity based on accumulating 150 minutes or more of moderate-to-vigorous physical activity per week. The results (Table 3) showed that the physical education activities conducted under the structured teaching model effectively increased the proportion of students meeting the recommended physical activity levels. Specifically, in the Volleyball Specialized Course, the number of students meeting the standard increased from 31 to 32, and the compliance rate increased from 96.9% to 100%. The compliance rate for the Volleyball Competition Course remained at 100%. Among students in the Health & Weight Loss Course, the number meeting the standard increased from 56 to 58, and the compliance rate increased from 96.6% to 100%. These data indicate that a scientifically and reasonably constructed physical education curriculum plays an important role in promoting university students' achievement of the WHO-recommended physical activity levels.

Table 2. Analysis of Pre- and Post-Test Results for Sedentary Behavior and Different Types of Physical Activity

	Volleyball Specialized Course (n=32)						Volleyball Competition Course (n=13)						Health & Weight Loss Course (n=58)					
	Pre			Post			Pre			Post			Pre			Post		
SB (min/d)	553.97	±	129.83	578.97	±	127.85	512.16	±	94.61	597.28	±	153.92	647.63	±	147.44	635.13	±	160.66
LPA (min/d)	118.53	±	30.66	115.59	±	27.31	136.55	±	56.11	124.51	±	44.92	126.54	±	44.27	122.98	±	43.03
MPA (min/d)	52.27	±	16.17	54.41	±	20.47	54.01	±	21.84	54.79	±	21.55	50.60	±	15.50	52.48	±	15.90
VPA (min/d)	1.44	±	1.29	2.20	±	2.69	3.44	±	3.84	4.53	±	5.37	4.46	±	4.84	4.00	±	4.69
MVPA(min/d)	53.70	±	16.68	56.61	±	22.26	57.45	±	24.73	59.32	±	24.44	55.06	±	16.64	56.36	±	17.29

Data described using mean ±standard deviation. SB = Sedentary Behavior, LPA = Light Physical Activity, MPA = Moderate Physical Activity, VPA = Vigorous Physical Activity, MVPA = Moderate-to-Vigorous Physical Activity.

Table 3. Analysis of Pre- and Post-Test Results for Physical Activity Guideline Compliance Rate by Course

	Volleyball Specialized Course (n=32)		Volleyball Competition Course (n=13)		Health & Weight Loss Course (n=58)	
	pre	post	pre	post	pre	post
MVPA Met	31 (96.9)	32 (100.0)	13 (100.0)	13 (100.0)	56 (96.6)	58 (100.0)
MVPA Not Met	1(3.1)	0(0.0)	0(0.0)	0(0.0)	2(3.4)	0(0.0)

Data described using number (percentage). MVPA Met = Weekly moderate-to-vigorous physical activity ≥ 150 min.

5. Discussion

This study used triaxial accelerometers to assess the performance of university students in terms of physical activity and sedentary behavior after participating in the multi-educational physical education curriculum system constructed in this project. The assessment included daily sedentary behavior, light physical activity, moderate physical activity, vigorous physical activity, and moderate-to-vigorous physical activity (all in minutes/day). The classes participating in the assessment included the Volleyball Specialized Course, Volleyball Competition Course, and Health & Weight Loss Course.

First, this study found no significant changes in participants' sedentary behavior and physical activity levels at various intensities between pre- and post-tests, which is consistent with previous research findings[8]. However, it is worth noting that sedentary behavior slightly increased in the post-test for the Volleyball Specialized and Competition Courses, and light physical activity decreased across all three

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classes. This trend might be related to the timing of the pre- and post-tests, as the post-test was conducted in winter. Previous studies have found that seasonal changes affect people's lifestyle behaviors; in winter, sedentary behavior significantly increases, while physical activity decreases [9]. Furthermore, the post-test coincided with the university examination period, requiring students to spend more time on exam preparation, which might have increased academically related sedentary behavior. Additionally, it is noteworthy that students in all three classes showed slight increases in time spent in moderate, vigorous, and moderate-to-vigorous physical activity, although not statistically significant. This trend suggests a potential shift towards a more active lifestyle. It is recommended that future studies extend the intervention period, control for seasonal variables, and introduce psychological motivation scales to explore intrinsic driving factors.

Finally, based on the guidelines of the WHO and the Chinese CDC, this study assessed the compliance rate of participants accumulating 150 minutes or more of moderate-to-vigorous physical activity per week. The results showed that our university's students performed well in terms of MVPA participation, with the pre- and post-test compliance rates for MVPA being significantly higher than those reported in other studies[10]. After one semester of the physical education curriculum intervention, all 103 students participating in this survey met the recommended MVPA levels in the guidelines.

6. Conclusion

In the context of curriculum reform, the multi-educational physical education curriculum system constructed by our university can positively influence university students' physical activity behavior, promoting their active participation in moderate-to-vigorous physical activity to some extent, thereby increasing their MVPA levels and improving the MVPA compliance rate. It is recommended that universities promote the 'Competition Integrated into Courses' model, incorporate league systems into compulsory credits, and simultaneously provide customized courses for students with low physical fitness to achieve 'full coverage' of sports participation.

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