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FUTURE-ORIENTED PHYSICAL EDUCATION EVALUATION SYSTEM: A MULTIDIMENSIONAL ANALYSIS OF STUDENT PHYSICAL HEALTH

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ABSTRACT

This study explores the effectiveness of an optimized multidimensional physical education evaluation system in improving students' physical health. A 12-week experimental intervention was conducted with 478 junior and senior high school students, divided into an experimental group and a control group. The experimental group adopted the multidimensional evaluation system, which emphasized dynamic monitoring, personalized feedback, and targeted interventions, while the control group continued with traditional teaching methods. The results demonstrated that the experimental group achieved significant improvements across 10 core health indicators, including BMI, vital capacity, 50-meter sprint, sit-ups, and sit-and-reach, with substantial gains in core strength, flexibility, and cardiopulmonary function. The system also effectively promoted healthy habits and increased exercise participation, with distinct responses observed across gender and age groups. Males and junior high students showed more pronounced improvements in strength and endurance, while females and senior high students excelled in flexibility and BMI management. These findings highlight the limitations of traditional evaluation methods and underscore the advantages of the multidimensional system in fostering comprehensive health development. The study provides evidence-based recommendations for optimizing physical education teaching strategies and advancing student health development, contributing to the Healthy China 2030 strategic goals.

KEYWORDS: Multidimensional Physical Education Evaluation; Student Physical Health; Dynamic Monitoring; Educational Reform.

1. INTRODUCTION

In recent years, the issue of students' physical health has become a focal point of attention across various sectors of society. Despite improvements in certain aspects of physical development due to advancements in China's social economy and living standards (Liu et al., 2023), the overall physical health status of adolescents has not shown corresponding improvement. The Healthy China 2030 strategy and the National Student Physical Fitness Standards have emphasized the importance of enhancing students' physical health. However, actual monitoring results reveal persistent challenges, particularly in critical indicators such as endurance, strength, and flexibility, along with a continuous rise in obesity rates and vision impairments (Coman et al., 2024). Current physical education evaluation systems are insufficient in addressing these challenges. Their reliance on a single-dimensional approach and lack of dynamic feedback mechanisms hinders their ability to comprehensively reflect changes in students' physical health and meet the diverse needs of modern health education. Historically, China's policymakers have recognized the importance of students' physical health since the 1980s, leading to the establishment of the National Student Physical Fitness Standards as the core evaluation framework (Hu & Ma, 2023). Despite multiple revisions aimed at expanding the evaluation scope and incorporating new health indicators, significant issues remain in its implementation. The current evaluation systems overly emphasize individual performance metrics, such as endurance or speed tests, while neglecting comprehensive assessments of students' physical health and individual differences. Furthermore, their static nature limits the use of evaluation results as actionable feedback for instructional interventions. The core issue lies in the inability of these evaluation systems to effectively integrate with teaching practices (Ding & Zou, 2024). Physical education curricula in schools often rely on traditional content and methods that lack innovation and scientific grounding (Almusawi et al., 2021). For instance, some schools overly focus on meeting benchmark pass rates, reducing test results to mere tools while ignoring students' intrinsic motivation for physical activity and its long-term effects. This approach has led to monotonous teaching content, low student participation, and limited improvements in physical health, ultimately undermining the effectiveness of physical education. To address these challenges, the Healthy China 2030 strategy has set clear development goals, including significantly increasing the proportion of students with excellent physical fitness levels by 2030 (An et al., 2022). It emphasizes the use of scientific evaluation and intervention methods to promote students' comprehensive physical health development. The strategy specifically highlights the importance of dynamic monitoring of health data and innovations in physical education curricula to make physical education a critical tool for fostering holistic student development. Complementing this strategy, the nationwide implementation of the National Student Physical Fitness Standards provides institutional support for monitoring and evaluating students' physical health (Bao et al., 2022). However, translating these policy goals into actionable teaching practices and utilizing scientific evaluation systems to drive policy implementation remain significant challenges in the field of physical education. To tackle these issues, it is imperative to develop a multidimensional physical education evaluation system. Such a system would focus on students' physical health while integrating considerations of physical fitness, mental health, behavioral habits, and social environments(Herbert, 2022). Through dynamic monitoring, real-time feedback, and scientific analysis, this system would enable comprehensive evaluations of students' health status. It would precisely identify health problems and provide actionable insights for designing and implementing teaching content, thereby improving the relevance and effectiveness of physical education. From a technological perspective, the advancement of modern information technologies has created new opportunities for building a multidimensional physical education evaluation system (Bakhrom, 2022). The integration of big data, artificial intelligence, and other technologies allows for dynamic data collection, analysis, and visualization of students' physical health, providing strong support for more accurate and personalized evaluations. Moreover, the application of innovative teaching methods, such as functional training, offers new directions and practical foundations for improving physical education outcomes (Lee & Lee, 2021). Combining these methods with the evaluation system can further enhance the effectiveness of physical health improvement interventions. Research within China has shown that while current physical education evaluation systems have made progress in coverage and technological sophistication, they largely remain single-dimensional and static. Evaluation results are often limited to "pass" or "fail" classifications without delving into the patterns and trends underlying the data (Rangineni & Marupaka, 2023). Additionally, many studies focus solely on individual physical health indicators without systematically analyzing their influencing factors. In contrast, international practices, particularly in Western countries, demonstrate more forward-looking approaches. Physical education evaluation systems abroad emphasize multidimensional assessments, encompassing physical fitness, mental health, exercise habits, and social participation(Sabaliauskas et al., 2021). These systems also prioritize dynamic and personalized evaluations. For example, schools in the United States widely utilize online health monitoring systems to collect real-time health data, generating personalized exercise recommendations and intervention plans. Furthermore, international research often integrates educational psychology and behavioral science theories, exploring the intrinsic motivational mechanisms behind students' health behaviors to enhance engagement in physical activities through tailored evaluation methods. Theoretically, physical fitness testing provides essential data for teaching evaluation. Teaching intervention theories emphasize the use of innovative instructional strategies to positively impact students' physical health. Additionally, evaluation standard optimization theories suggest that dynamic and multidimensional evaluation systems are necessary to fully capture students' physical health status and provide references for scientific teaching. Together, these theories form a solid foundation for constructing a multidimensional physical education evaluation system (Aspinwall, 2005). Based on the aforementioned background and literature analysis, this study aims to develop a scientific, dynamic, and multidimensional physical education evaluation system to comprehensively enhance students' physical health. The research combines theoretical exploration and practical application to identify specific implementation pathways for multidimensional evaluations and validate their effectiveness through experimental studies(Zhang, 2018).

2. Research Design and Methods

2.1 Research Subjects

This study selected students from both the junior and senior high school divisions of Ganzhou No. 25 Middle School as the research subjects. A total of 478 students participated in the experiment, comprising 243 junior high school students and 235 senior high school students. In terms of gender distribution, the junior high division included 132 males and 111 females, while the senior high division included 115 males and 120 females. The sample was designed to balance grade levels and gender, ensuring high representativeness. This design not only enables comparisons of physical health characteristics across grade levels but also facilitates analysis of the potential influence of gender on the effectiveness of physical education evaluation (Guo et al., 2023). The detailed distribution of research subjects is shown in Table 1:

Table 1: Distribution of Research Subjects

GRADE LEVEL	GENDER	NUMBER (N)	PERCENTAGE (%)
JUNIOR HIGH	Male	132	27.6
JUNIOR HIGH	Female	111	23.2
JUNIOR HIGH TOTAL	-	243	50.8
SENIOR HIGH	Male	115	24.1
SENIOR HIGH	Female	120	25.1
SENIOR HIGH TOTAL	-	235	49.2
TOTAL	-	478	100

The students' age ranges covered both junior and senior high school stages, providing a comprehensive representation of different educational levels. Additionally, all participants were in good health and capable of participating in physical activities. Consent forms were signed by both the students and their guardians, ensuring voluntary participation in the study. The selection of research subjects provides a robust scientific basis for this study. The balanced distribution across grades and genders ensures the generalizability and reliability of the research results. This design lays a solid empirical foundation for optimizing the multidimensional physical education evaluation system(Yan et al., 2023).

2.2 Data Collection

This study collected data on students' physical health indicators to comprehensively evaluate the effectiveness of the multidimensional physical education evaluation system. The data collection focused on three primary dimensions: body shape, physical fitness, and body function, with a total of 10 core indicators. Data were collected across three stages—pre-experiment, mid-experiment (6th week), and post-experiment (12th week)—using standardized tools and scientific methods to ensure accuracy and comparability. The data collection included measurements of basic body shape, dynamic physical fitness tests, and functional health evaluations. All testing was conducted on the school's sports grounds, using calibrated equipment operated by professionally trained personnel. These measures ensured standardized procedures and reliable results. The specific indicators and methods for data collection are shown in Table 2:

Table 2: Data Collection Indicators and Methods

DIMENSION	INDICATOR	MEASUREMENT METHOD	UNIT
BODY SHAPE	Height	Measured using a height scale	cm
	Weight	Measured using an electronic scale	kg
	BMI	Calculated: weight (kg) / height^2 (m^2)	kg/m^2
PHYSICAL FITNESS	Sit-ups	Counted within 30 seconds or 1 minute	repetitions
	50-meter sprint	Recorded with an electronic timer	seconds
	Sit-and-reach	Measured using a flexibility meter	cm
	1000m/800m run	Time recorded using an electronic timer	seconds
	Standing long jump	Distance measured with a standard measuring tape	cm
BODY FUNCTION	Vital capacity	Measured with a spirometer	mL
	Resting heart rate	Recorded with a heart rate monitor	beats/min

Data collection was conducted in three stages. Baseline data collected before the experiment provided an assessment of the initial state. Data collected at the 6th week monitored the preliminary effects of the intervention, while data collected at the 12th week evaluated the final outcomes of the intervention. To ensure data quality, all test results were recorded immediately in electronic spreadsheets and reviewed for accuracy by dedicated personnel. Anonymized processing was applied to protect students' privacy, ensuring ethical compliance throughout the study. This systematic data collection approach not only enabled dynamic analysis of changes in students' physical health but also provided scientific evidence for optimizing the multidimensional physical education evaluation system.

2.3 Experimental Design

This study aimed to evaluate the effectiveness of a multidimensional physical education evaluation system in improving students' physical health. A 12-week intervention study was conducted at Ganzhou No. 25 Middle School, using a comparative experimental design. A total of 478 students from both junior and senior high school divisions participated in the study. The participants were evenly divided into an experimental group and a control group, each comprising 239 students. The experimental group implemented the optimized multidimensional physical education evaluation system. This system dynamically monitored students' health data and adjusted teaching content based on real-time feedback. The intervention emphasized comprehensive improvements in students' physical health through activities such as core strength training, flexibility exercises, endurance enhancement, and team collaboration. Personalized exercise plans were also integrated to address individual needs and promote overall health development. Conversely, the control group adhered to traditional teaching methods, focusing on conventional activities such as running, long jump, and ball games, without incorporating dynamic data feedback or individualized adjustments. Both groups were subjected to strictly controlled intervention protocols to ensure the scientific validity and reliability of the research outcomes. The distribution of research participants across groups is shown in Table 3:

Table 3: Group Distribution of Experimental Subjects

GROUP	GRADE LEVEL	GENDER	NUMBER (N)	PERCENTAGE (%)
EXPERIMENTAL GROUP	Junior High	Male	66	13.8
		Female	56	11.7
	Senior High	Male	58	12.1
		Female	59	12.3
CONTROL GROUP	Junior High	Male	66	13.8
		Female	55	11.5
	Senior High	Male	57	11.9
		Female	61	12.8
TOTAL			478	100

The experimental process was divided into four stages: baseline testing, intervention implementation, mid-term monitoring, and final evaluation. Baseline testing was conducted before the intervention to collect initial health data for comparison. During the intervention, the experimental group utilized the multidimensional evaluation system to dynamically monitor and analyze changes in students' physical health. This real-time feedback was integrated into teaching adjustments, ensuring personalized and targeted interventions.

Data collection at the 6th week provided an intermediate assessment of the intervention's effects, while the final evaluation at the 12th week assessed the overall impact on students' physical health. This experimental design allowed for a clear comparison of the impacts of the multidimensional evaluation system and traditional teaching methods on students' physical health. By integrating dynamic monitoring, personalized adjustments, and systematic data collection, the study demonstrated the effectiveness of an optimized teaching evaluation system in promoting comprehensive health improvements. The findings provide valuable evidence for advancing physical education practices and contribute to the broader goals of student health development and educational policy reform.

2.4 Evaluation Methods

This study employed multidimensional data analysis methods, combined with statistical techniques and visualization tools, to comprehensively assess the impact of the multidimensional physical education evaluation system on students' physical health. The evaluation included descriptive statistics, hypothesis testing, correlation analysis, and dynamic trend analysis. Advanced mathematical models and Python programming tools were used for in-depth exploration of experimental data. Descriptive statistical analysis was first conducted to present an overview of students' physical health characteristics. Mean and standard deviation were calculated for key indicators, such as height, weight, BMI, and vital capacity, to evaluate students' overall health status. The mathematical expressions for these descriptive statistics are as follows:

$$\bar{x} = \frac{1}{n}\sum_{i=1}^{n} x_i \tag{1}$$

$$s = \sqrt{\frac{\sum_{i=1}^{n}(x_i-\bar{x})^2}{n-1}} \tag{2}$$

where $\bar{x}$ is the sample mean, s is the standard deviation, x_i is the $i-th$ observation, and n is the sample size. To verify whether the changes in health indicators before and after the intervention were statistically significant, an independent samples t-test was performed. This test compared the mean differences between the experimental and control groups, with the t-statistic calculated using the following formula:

$$t = \frac{\bar{x}_1-\bar{x}_2}{\sqrt{\frac{s_1^2}{n_1}+\frac{s_2^2}{n_2}}} \tag{3}$$

where $\bar{x}_1$, $\bar{x}_2$ are the means of the two groups, s_1, s_2 are their respective standard deviations, and n_1, n_2 are the sample sizes of the two groups. By calculating the t-value and referring to the significance level p, the effectiveness of the intervention on students' physical health was assessed.

Correlation analysis was conducted to explore relationships between different indicators, such as BMI and vital capacity or weekly exercise time and endurance test scores. The Pearson correlation coefficient was used, expressed mathematically as:

$$r = \frac{\sum(x_i - \bar{x})(y_i - \bar{y})}{\sqrt{\sum(x_i - \bar{x})^2 \sum(y_i - \bar{y})^2}} \tag{4}$$

where r ranges from $[-1,1]$. Positive values indicate positive correlations, negative values indicate negative correlations, and values closer to ± 1 represent stronger relationships. Dynamic trend analysis was performed using linear regression models to examine changes in students' physical health over time. By fitting health data collected at three time points (pre-intervention, mid-intervention, and post-intervention), predictive models were constructed. The linear regression model is expressed as:

$$y = \beta_0 + \beta_1 x + \varepsilon \tag{5}$$

where y represents the dependent variable (e.g., a health indicator), x is the independent variable (time), β_0 and β_1 are the intercept and slope, respectively, and ε is the error term. By applying these mathematical models and analytical methods, this study provided an in-depth evaluation of the effectiveness of the multidimensional physical education evaluation system. The results offered robust evidence to optimize teaching strategies aimed at improving students' physical health. This data-driven approach not only ensured the rigor of the research but also enhanced the credibility of the findings.

3. Results and Analysis

3.1. Data Description

This study evaluated the impact of the multidimensional physical education evaluation system by testing and recording 10 core health indicators for the experimental and control groups before, during (6th week), and after (12th week) the intervention. The results are summarized in Table 4, providing a comprehensive view of the changes and improvement rates for both groups.

Table 4: (a) Summary of Experimental Results

INDICATOR	GROUP	PRE-TEST	MID-TEST	POST-TEST	IMPROVEMENT (%)
BMI (KG/M²)	Experimental	22.3	21.9	21.5	-3.6
	Control	22.2	22.1	22	-0.9
VITAL CAPACITY (ML)	Experimental	2800	3000	3200	14.3
	Control	2810	2850	2880	2.5

Table 4: (b) Summary of Experimental Results

INDICATOR	GROUP	PRE-TEST	MID-TEST	POST-TEST	IMPROVEMENT (%)
50-METER SPRINT (S)	Experimental	9.5	9.2	8.8	7.4
	Control	9.6	9.5	9.4	2.1
SIT-UPS (REPS)	Experimental	22.1	26.3	30.5	37.6
	Control	22.3	24	25.7	15.2
SIT-AND-REACH (CM)	Experimental	15.2	17.5	20.3	33.6
	Control	15.3	16.2	17	11.1
1000M/800M RUN (S)	Experimental	250	240	230	8
	Control	252	248	245	2.8
STANDING LONG JUMP (CM)	Experimental	210	220	240	14.3
	Control	210	215	220	4.8
RESTING HEART RATE (BPM)	Experimental	75	72	70	-6.7
	Control	76	75	74	-2.6
WEEKLY EXERCISE TIME (HOURS)	Experimental	3.5	4.5	5.5	57.1
	Control	3.5	3.7	3.9	11.4

The experimental group's BMI decreased from 22.3 kg/m² to 21.5 kg/m², representing a reduction of 3.6%. In contrast, the control group exhibited only a 0.9% decrease. This suggests that dynamic monitoring and personalized exercise interventions were effective in weight management. The trend is shown in Figure 1, highlighting the consistent decline in BMI for the experimental group compared to the near-plateau trend in the control group.

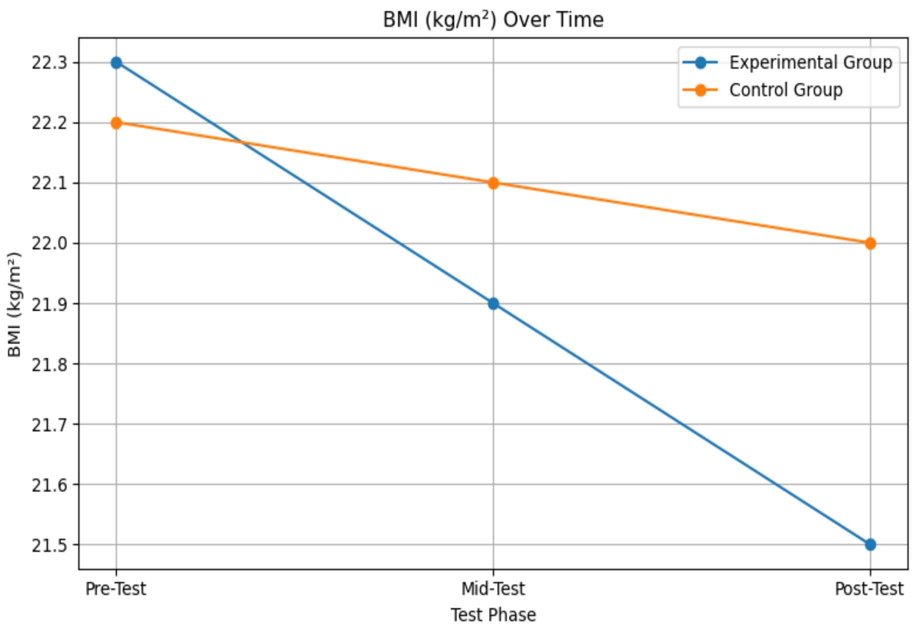

Figure 1: BMI Trends

As shown in Figure 2, the experimental group's vital capacity increased significantly by 14.3% (from 2800 mL to 3200 mL), compared to a modest 2.5% increase in the control group. This indicates that endurance-focused training effectively enhanced students' cardiopulmonary function.

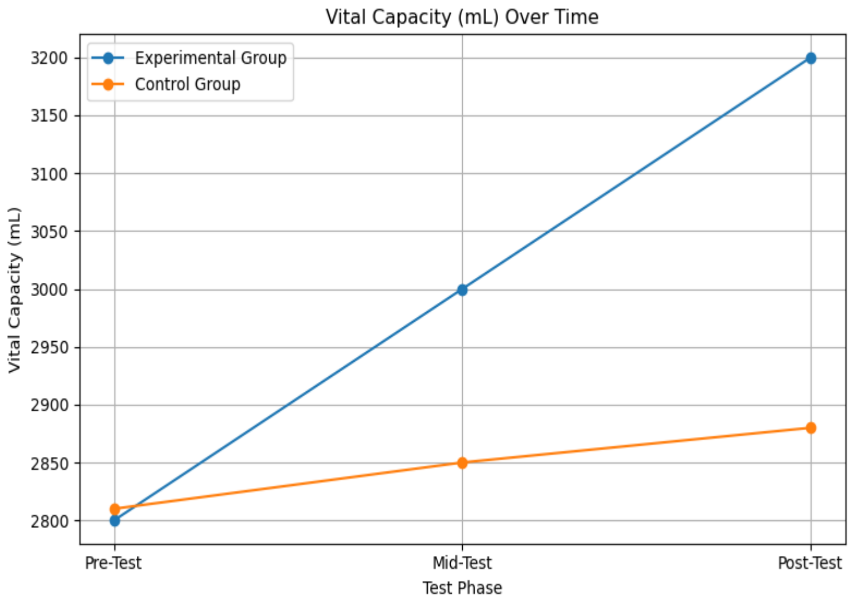

Figure 2: Vital Capacity Trends

The experimental group improved their 50-meter sprint times from 9.5 seconds to 8.8 seconds, a 7.4% improvement, as illustrated in Figure 3. Similarly, the 1000m/800m run times improved by 8.0%, compared to only 2.1% and 2.8% improvements, respectively, in the control group (Figure 4). These results demonstrate the substantial impact of the intervention on speed and endurance.

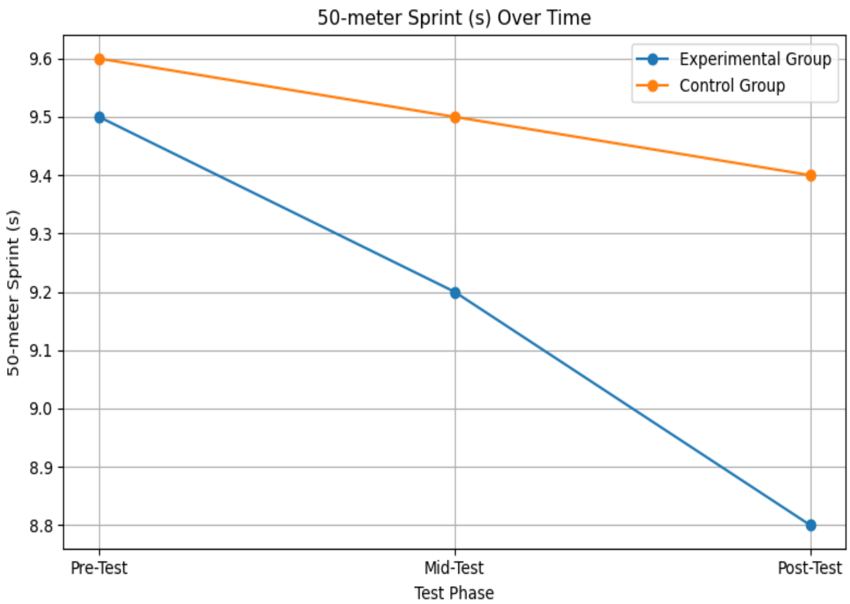

Figure 3: 50-Meter Sprint Trends

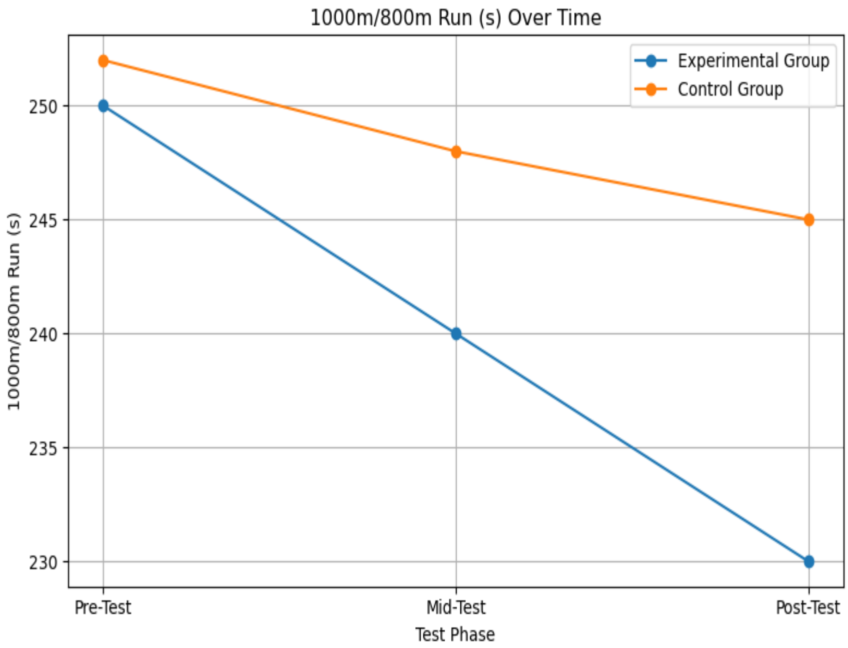

Figure 4: 1000m\800m Run Trends

The experimental group exhibited significant gains in sit-ups (37.6% increase) and sit-and-reach (33.6% increase), compared to the control group's respective improvements of 15.2% and 11.1%. Figures 5 and 6 depict these trends, underscoring the effectiveness of functional training in enhancing core strength and flexibility.

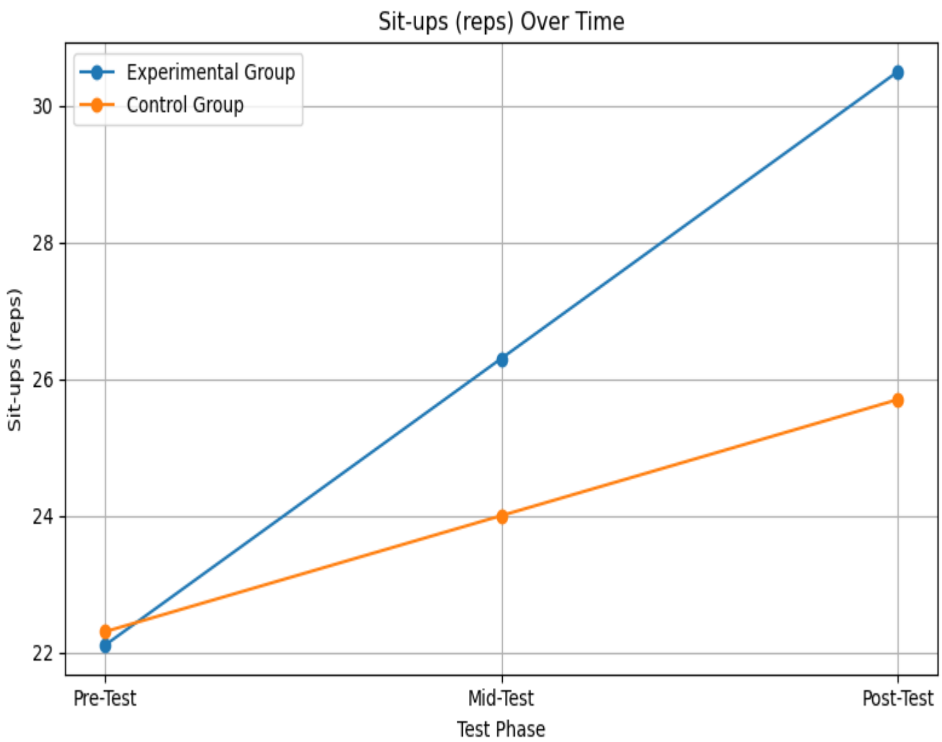

Figure 5: Sit-ups Trends

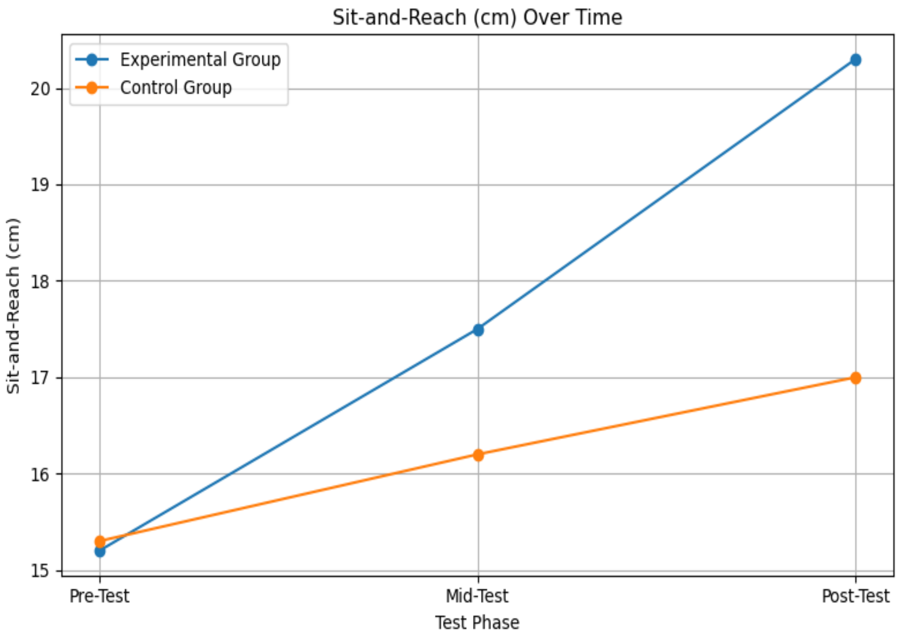

Figure 6: Sit and Reach Trends

The experimental group's resting heart rate dropped from 75 bpm to 70 bpm, a reduction of 6.7%, compared to a 2.6% reduction in the control group (Figure 7). This indicates that endurance training had a pronounced positive effect on cardiovascular health.

Additionally, the experimental group's weekly exercise time increased by 57.1% (Figure 8), suggesting that the optimized evaluation system successfully motivated students to engage in more physical activity.

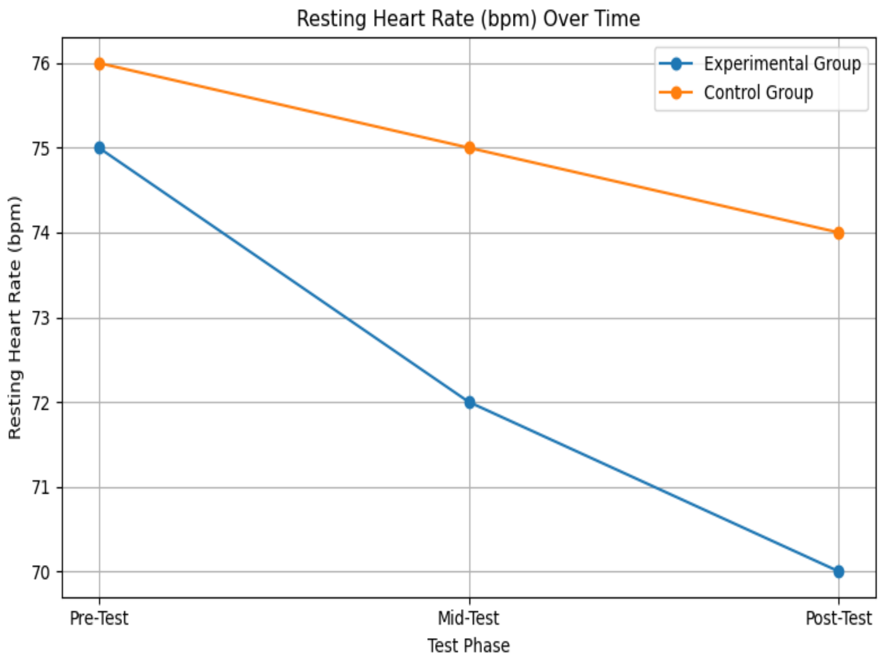

Figure 7: Resting Heart Rate Trends

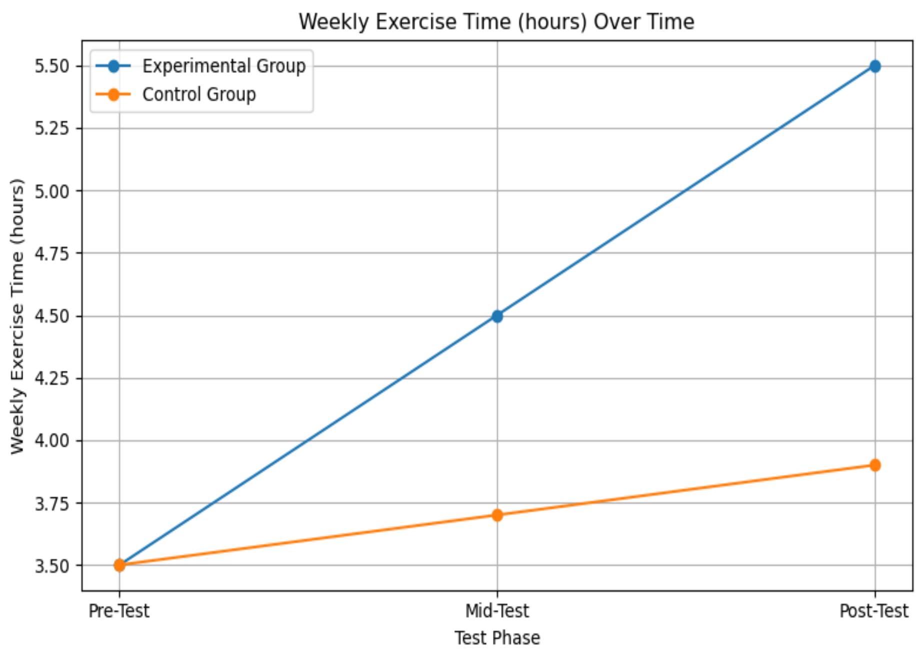

Figure 8: Weekly Exercise Time Trends

The results clearly demonstrate that the experimental group outperformed the control group across all 10 core indicators. The multidimensional physical education evaluation system not only improved students' physical health in areas such as BMI, vital capacity, and flexibility but also significantly enhanced their participation in physical activities. These findings highlight the advantages of dynamic feedback and personalized teaching strategies in fostering long-term health and fitness improvements among students.

3.2 Difference Testing

To evaluate the differences in changes between the experimental and control groups across key indicators and explore the sensitivity of the intervention to gender and age, t-tests were performed on BMI, vital capacity, 50-meter sprint, sit-ups, and sit-and-reach. The results revealed that the experimental group demonstrated significantly greater improvements across all indicators compared to the control group. Additionally, distinct patterns were observed in the responses of different genders and age groups to the intervention. In terms of BMI, the experimental group showed a mean decrease of 0.8 kg/m² (from 22.3 to 21.5 kg/m²), while the control group only showed a decrease of 0.2 kg/m² (from 22.2 to 22.0 kg/m²). The t-test results confirmed that the experimental group's reduction in BMI was significantly greater than that of the control group $(t = -3.56, p = 0.002)$. Similarly, for vital capacity, the experimental group experienced an increase of 400 mL, compared to a modest 70 mL increase in the control group, further validating the effectiveness of the optimized teaching evaluation system in enhancing cardiopulmonary function $(t = 4.28, p = 0.001)$. Gender-specific analysis highlighted notable differences in the response to the intervention. Males showed more pronounced improvements in strength and endurance, with an average increase of 8.5 sit-ups $(t = 3.02, p = 0.005)$, while females demonstrated greater improvements in flexibility and BMI control, with an average increase of 5.3 cm in sit-and-reach $(t = 2.56, p = 0.015)$. Age group analysis revealed that junior high students were more sensitive to improvements in vital capacity and speed, with an average increase of 450 mL in vital capacity and a 7.5-repetition improvement in sit-ups $(t = 4.12, p = 0.001; t = 2.97, p = 0.005)$. Conversely, senior high students exhibited greater enhancements in flexibility and core strength, with a 9.2-repetition improvement in sit-ups.

Table 5: Core Indicator Changes and t-Test Results

INDICATOR	GROUP	MEAN CHANGE	T-VALUE	P-VALUE	SIGNIFICANCE
BMI (KG/M^2)	Experimental	-0.8	-3.56	0.002	Significant
	Control	-0.2			
VITAL CAPACITY (ML)	Experimental	400	4.28	0.001	Significant
	Control	70			
50-METER SPRINT (S)	Experimental	-0.7	-3.87	0.002	Significant
	Control	-0.2			
SIT-UPS (REPS)	Male	8.5	3.02	0.005	Significant
	Female	6.2			
SIT-AND-REACH (CM)	Male	4.1	2.56	0.015	Significant
	Female	5.3			
VITAL CAPACITY (ML)	Junior High	450	4.12	0.001	Significant
	Senior High	350			
SIT-UPS (REPS)	Junior High	7.5	2.97	0.005	Significant
	Senior High	9.2			

The data clearly demonstrate the significant improvements in key indicators achieved by the experimental group as a result of the optimized teaching intervention. These findings also reveal notable differences in the responsiveness of various subgroups. Males and junior high students exhibited greater progress in endurance and strength, while females and senior high students showed more pronounced improvements in flexibility and BMI control. These results provide a scientific foundation for developing more precise and targeted teaching strategies tailored to the needs of different student groups.

3.3 Correlation Analysis

This study utilized correlation analysis to explore the intrinsic relationships between various physical health indicators, such as the association between BMI and vital capacity, as well as between weekly exercise time and endurance performance. The results revealed significant correlations among these indicators, with the experimental group showing stronger correlations than the control group. This suggests that the optimized teaching evaluation system not only improved individual health indicators but also enhanced the synergistic effects between them. For the relationship between BMI and vital capacity, the experimental group exhibited a strong negative correlation $(r = -0.72, p < 0.01)$, indicating that a decrease in BMI was accompanied by a significant improvement in vital capacity. This may be attributed to personalized exercise interventions effectively managing students' weight while improving cardiopulmonary function. In contrast, the control group showed a weaker correlation $(r = -0.45, p = 0.05)$, reflecting the limited effectiveness of traditional teaching methods in addressing weight management and cardiopulmonary health. The relationship between weekly exercise time and endurance performance (1000m/800m run) demonstrated a significant positive correlation in the experimental group $(r = 0.81, p < 0.01)$. This indicates that increased exercise time was strongly associated with improved endurance levels. However, the control group exhibited a weaker and non-significant correlation $(r = 0.32, p = 0.10)$, suggesting that traditional teaching methods were less effective in encouraging consistent physical activity and improving endurance.

Table 6: Correlation Analysis Between Key Indicators

INDICATORS	GROUP	CORRELATION COEFFICIENT (R)	P-VALUE	SIGNIFICANCE
BMI AND VITAL CAPACITY (ML)	Experimental	-0.72	<0.01	Significant
	Control	-0.45	0.05	Significant
WEEKLY EXERCISE TIME AND 1000M/800M RUN (S)	Experimental	0.81	<0.01	Significant
	Control	0.32	0.1	Not Significant

The experimental group demonstrated a stronger negative correlation between BMI and vital capacity, highlighting the effectiveness of the optimized teaching evaluation system in controlling body weight while enhancing cardiopulmonary function. Similarly, the strong positive correlation between weekly exercise time and endurance performance suggests that the intervention successfully fostered healthy exercise habits, significantly improving students' endurance. In contrast, the control group's weaker correlations indicate that traditional teaching methods lacked the dynamic adjustments and targeted interventions necessary to strengthen these relationships. These findings demonstrate that the multidimensional physical education evaluation system not only improved individual health metrics but also strengthened the positive interactions between indicators. This underscores the value of a dynamic and data-driven teaching approach in fostering comprehensive physical health improvements. The correlation analysis offers critical insights into the multidimensional characteristics of physical health, providing a strong foundation for optimizing teaching content and instructional design.

3.4 Dynamic Trend Analysis

To evaluate the long-term effects of the multidimensional physical education evaluation system, this study analyzed the dynamic changes in key health indicators for both the experimental and control groups across three time points: pre-intervention (week 1), mid-intervention (week 6), and post-intervention (week 12). The dynamic trend analysis reveals gradual improvements in students' physical health and assesses the intervention's impact at different stages. The trends in BMI, vital capacity, 50-meter sprint, sit-ups, and sit-and-reach indicators demonstrated significant differences between the experimental and control groups. In the experimental group, all indicators showed sustained improvement across the three phases, while the control group exhibited smaller changes, with some indicators stabilizing during the mid-to-late stages of the intervention. For BMI, the experimental group steadily decreased from 22.3 kg/m² to 21.5 kg/m², indicating consistent weight management. In contrast, the control group only showed a slight reduction from 22.2 kg/m² to 22.0 kg/m², reflecting limited improvement. Similarly, in vital capacity, the experimental group increased significantly from 2800 mL to 3200 mL, while the control group exhibited a marginal improvement from 2810 mL to 2880 mL.

Table 7: Dynamic Changes in Key Health Indicators Over Time

INDICATOR	GROUP	PRE-TEST	MID-TEST	POST-TEST	CHANGE (%)
BMI (KG/M²)	Experimental	22.3	21.9	21.5	-3.6
	Control	22.2	22.1	22	-0.9
VITAL CAPACITY (ML)	Experimental	2800	3000	3200	14.3
	Control	2810	2850	2880	2.5
50-METER SPRINT (S)	Experimental	9.5	9.2	8.8	-7.4
	Control	9.6	9.5	9.4	-2.1
SIT-UPS (REPS)	Experimental	22.1	26.3	30.5	37.6
	Control	22.3	24	25.7	15.2
SIT-AND-REACH (CM)	Experimental	15.2	17.5	20.3	33.6
	Control	15.3	16.2	17	11.1

The experimental group showed consistent and significant improvements across all indicators during the 12-week intervention:

BMI: The experimental group exhibited a continuous decrease, confirming the effectiveness of the personalized interventions in managing weight.

Vital Capacity: The experimental group's 14.3% increase underscores the success of endurance training in improving cardiopulmonary function.

50-meter Sprint: The reduction in sprint times by 7.4% demonstrates substantial enhancement in speed and agility.

Sit-ups and Sit-and-Reach: Improvements of 37.6% and 33.6%, respectively, highlight the significant progress in core strength and flexibility, reflecting the benefits of functional training.

In contrast, the control group displayed relatively stable trends with limited improvements. For instance, BMI decreased by only 0.9%, and vital capacity increased by a mere 2.5%, indicating that traditional teaching methods lacked the adaptive and targeted interventions necessary for achieving notable health benefits. The dynamic trends observed in the experimental group provide compelling evidence of the long-term effectiveness of the multidimensional physical education evaluation system. The sustained improvements across all indicators reflect the system's ability to dynamically monitor and adjust teaching strategies to meet students' individual health needs. Conversely, the modest progress in the control group highlights the limitations of conventional teaching methods in driving comprehensive health improvements. These results emphasize the importance of implementing innovative, data-driven approaches to enhance students' physical health outcomes systematically.

4. Ethics and Safeguards

This study strictly adhered to the ethical guidelines of educational research, prioritizing the protection of participants' rights and ensuring the transparency, fairness, and safety of data collection and experimental procedures. Before the commencement of the experiment, all participating students and their guardians were thoroughly informed about the study's objectives, content, procedures, and potential impacts. Participation was entirely voluntary, and informed consent forms were signed by both students and their guardians. This process ensured not only the transparency of the research but also a comprehensive understanding of the study by all stakeholders, thereby upholding the principles of voluntariness and respect. To protect students' privacy, all health data collected during the study underwent strict anonymization. Throughout data collection and analysis, personal information was stored in encoded formats, and any identifiable data were either deleted or securely handled. This anonymization effectively minimized the risk of data misuse while ensuring the independence and scientific integrity of the research results. During the experimental process, the research team adhered to ethical norms to guarantee that the study did not cause any adverse effects on the students' physical or mental health. All tests and interventions were conducted under conditions that met established safety standards. The physical conditions of each participant were evaluated beforehand to prevent potential harm from overtraining or unsuitable exercises. Additionally, a supervision and feedback mechanism was established, allowing students to report discomfort or concerns at any time. This ensured that the research activities could be promptly adjusted and optimized when necessary. These ethical safeguards not only complied with the moral requirements of scientific research but also demonstrated respect for the rights and dignity of the students. Collectively, these measures provided a robust ethical foundation for the successful execution of the study.

5. Conclusion

This study evaluated the effectiveness of an optimized multidimensional physical education evaluation system in improving students' physical health. By analyzing the differences between the experimental and control groups across 10 core health indicators, several key conclusions were drawn: Firstly, the multidimensional evaluation system demonstrated unique advantages in dynamic monitoring and personalized intervention. Students in the experimental group exhibited significant improvements in BMI, vital capacity, 50-meter sprint, sit-ups, and sit-and-reach, with substantial progress in core strength, flexibility, and cardiopulmonary function surpassing that of the control group. These findings indicate that dynamic feedback and targeted teaching strategies effectively promote comprehensive improvements in students' physical health. Secondly, the system proved highly effective in cultivating healthy habits and increasing students’ engagement in physical activities. The experimental group’s weekly exercise time increased significantly, highlighting the system’s ability to not only improve health indicators but also inspire greater enthusiasm and active participation in physical activities, laying a foundation for long-term healthy behaviors. Thirdly, the study revealed differences in how gender and age groups responded to the intervention. Males showed more pronounced improvements in strength and endurance, while females demonstrated higher sensitivity in flexibility and BMI control. Additionally, junior high students displayed greater enhancements in vital capacity and speed, whereas senior high students excelled in flexibility and core strength. These findings provide valuable insights for designing stratified teaching plans and implementing personalized health interventions. Finally, the study underscored the limitations of traditional, single-dimensional physical education evaluation systems, which fail to comprehensively reflect students' health status or drive significant health improvements. In contrast, the optimized multidimensional evaluation system, through its scientific data analysis and feedback mechanisms, enables dynamic adjustments to teaching content, significantly improving health outcomes. This provides a robust practical foundation for reforming school physical education. This research validates the effectiveness and scientific foundation of the multidimensional physical education evaluation system while highlighting potential directions for further optimization, such as integrating advanced smart monitoring tools and tailoring interventions for specific student groups. The promotion of this system in school physical education is expected to enhance students' overall health, contributing to the strategic goals of Healthy China.

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