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Article

An empirical study on the impact of curriculum reform in physical education on students' physical health and exercise habits

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Abstract: This study investigated the impact of a reformed physical education (PE) curriculum on middle school students' physical health and exercise habits in Beijing, China. Using a quasi-experimental design, 1187 students were assessed at baseline, post-intervention, and follow-up. The reformed curriculum, featuring student-centered learning and technology-enhanced instruction, led to significant improvements in physical health indicators such as BMI, cardiovascular fitness, and muscular strength. Additionally, the proportion of students meeting WHO physical activity guidelines increased significantly in the intervention group compared to the control group, alongside notable improvements in exercise frequency, duration, and intrinsic motivation. By addressing both physical health outcomes and behavioral changes, this study highlights the effectiveness of a comprehensive and contextually tailored PE curriculum. These findings contribute new evidence to the limited body of research on PE reforms in China and offer actionable insights for developing strategies to promote active lifestyles and overall well-being among adolescents.

Keywords: physical education reform; adolescent health; exercise habits; quasi-experimental design; cardiovascular fitness; intrinsic motivation; body composition; physical activity guidelines; school-based intervention; Chinese students

1. Introduction

In recent decades, the global decline in youth physical fitness has become a pressing concern for educators, health professionals, and policymakers alike [1]. This trend is particularly evident in China, where rapid economic development and lifestyle changes have led to a significant decrease in students' physical health indicators [2]. Despite the recognized importance of physical education (PE) curricula in promoting student health and cultivating lifelong exercise habits, China continues to face challenges in effectively addressing these issues [3]. In response, the Chinese government has introduced a series of PE curriculum reforms aimed at enhancing students' physical fitness levels and fostering a culture of regular physical activity [4].

Although international reforms such as the SPARK program in the United States and Finland's health-oriented PE curriculum have shown promising results in improving student fitness and activity levels, China-specific research remains scarce [5–6]. Existing studies on PE curriculum reforms in China often suffer from methodological limitations, including small sample sizes, lack of rigorous experimental designs, and inadequate consideration of long-term effects [7]. Furthermore, few studies comprehensively evaluate the impact of PE reforms on

both physical health indicators and exercise habits, an essential perspective for understanding the broader effectiveness of such interventions [8]. Recent studies have highlighted the transformative potential of physical education (PE) reforms on improving students' physical fitness and mental health through innovative teaching approaches, such as game-based or technology-enhanced interventions [9,10]. These reforms not only address immediate health outcomes but also foster long-term behavioral changes, such as increased participation in regular physical activity and improved self-efficacy [11,12]. Moreover, the integration of tailored PE strategies has been shown to positively impact adolescents' health by mitigating sedentary lifestyles and improving cardiovascular endurance and muscular strength [13,14]. However, there remains a critical need to adapt these strategies to the Chinese context, considering cultural and socioeconomic differences, to optimize their effectiveness and sustainability [15].

This study seeks to address these gaps by evaluating the impact of recent PE curriculum reforms on the physical health and exercise habits of middle school students in China. Using a quasi-experimental design, this research compares pre- and post-reform changes in physical fitness indicators, including body mass index (BMI), cardiovascular endurance, and muscular strength, alongside exercise frequency, duration, and attitudes toward physical activity. It hypothesizes that the reformed curriculum will significantly improve students' physical health and foster greater engagement in and enjoyment of physical activities. Additionally, it anticipates that these effects may vary depending on factors such as gender, age, and initial fitness levels.

By providing empirical evidence on the effectiveness of PE curriculum reforms, this study aims to contribute to the optimization of PE policies and practices in China. The findings will not only inform future curriculum development but also address critical gaps in the literature by offering a comprehensive evaluation of both health and behavioral outcomes. Furthermore, this research will support cross-cultural comparisons and facilitate the exchange of best practices in PE reform, contributing to the international body of knowledge on effective strategies for improving youth health and well-being.

2. Research methods

2.1. Study design

The study employs a quasi-experimental design to evaluate the impact of physical education (PE) curriculum reforms on middle school students' physical health and exercise habits. The selection of this design was based on its capacity to evaluate the impacts of interventions in authentic educational settings where randomization is not feasible [16]. The research will follow a pretest-posttest control group design, wherein measurements will be conducted both before and after the implementation of the new PE curriculum.

Two cohorts of middle schools will be selected: an intervention group implementing the reformed PE curriculum and a control group maintaining the traditional curriculum. Schools will be matched based on demographic and socioeconomic factors to ensure comparability. Data collection will be conducted at

three time points: baseline (T0), immediately after a one-year implementation period (T1), and one-year post-implementation (T2). This longitudinal approach allows for the assessment of both immediate and sustained effects of the curriculum reform. To visualize the study design, a framework diagram has been created using the DiagrammeR package in R. **Figure 1** illustrates the flow of the research process, including group allocation, intervention implementation, and data collection points.

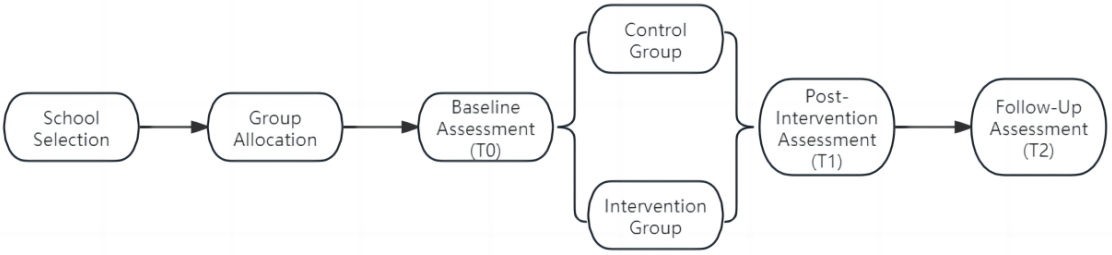

Figure 1. Framework for quasi-experimental study design to assess PE curriculum reform effects.

This design allows for a comprehensive assessment of the PE curriculum reform's impact, controlling for potential confounding variables and providing insights into both short-term and long-term effects on students' physical health and exercise habits.

2.2. Study subjects

The study will encompass a diverse cohort of middle school students, meticulously selected to represent the heterogeneous demographic landscape of urban and suburban areas in Beijing, China. Utilizing a stratified sampling approach, we will recruit approximately 1200 students (600 per group) from 20 middle schools, ensuring a balanced representation across socioeconomic strata, academic performance levels, and geographical locations. Participants aged between 12 to 15 years old will be included as they are in the crucial developmental period of early adolescence. To mitigate potential confounds, schools will be matched based on salient characteristics such as student body size, faculty qualifications, and available physical education facilities. Rigorous inclusion criteria will be applied to ensure participants are free from chronic health conditions that might impede physical activity engagement. Furthermore, to enhance the study's ecological validity, we will strive for equitable gender distribution, include students with varying baseline fitness levels, and implement double-blind experiments to minimize experimenter and participant knowledge bias. This carefully curated sample will provide a robust foundation for elucidating the nuanced effects of PE curriculum reforms across diverse student populations, thereby enhancing the generalizability and practical applicability of our findings.

2.3. Interventions

The intervention comprises a comprehensive, multi-faceted Physical Education (PE) curriculum reform designed to enhance students' physical health and foster enduring exercise habits. This innovative program integrates evidence-based practices from international PE models, tailored to the Chinese educational context.

The reformed curriculum emphasizes student-centered learning, diverse physical activities, and health literacy education. It incorporates high-intensity interval training (HIIT) sessions, sports skills development, and mindfulness practices to address both physical and mental well-being. Additionally, the intervention includes technology-enhanced learning components, such as wearable fitness trackers and mobile applications, to promote self-monitoring and goal-setting behaviors. To ensure fidelity of implementation, PE teachers in the intervention group will undergo intensive professional development workshops and receive ongoing support throughout the study period. The curriculum is structured to provide 150 minutes of PE per week, distributed across three 50-minute sessions, aligning with WHO recommendations for youth physical activity. Control group schools will maintain their traditional PE curriculum, typically consisting of 90 minutes of PE per week with a focus on sports-specific skills and fitness testing. **Figure 2** illustrates the key components and structure of the intervention.

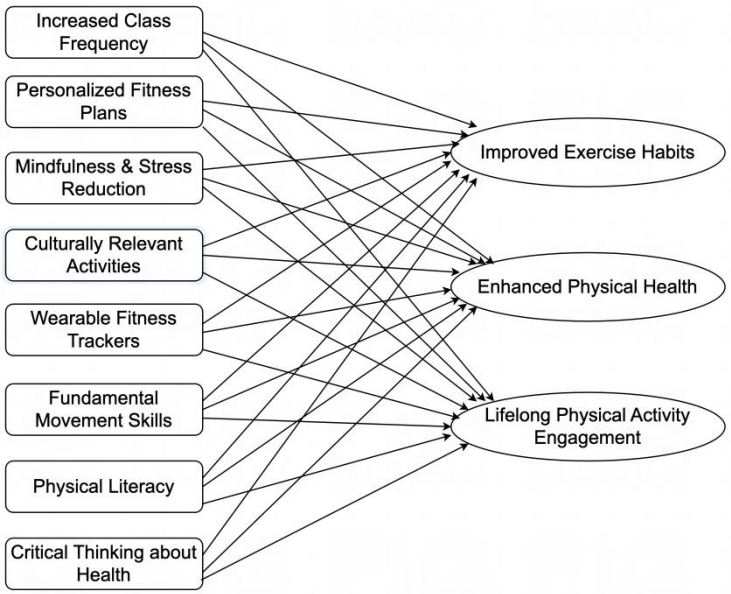

Figure 2. Conceptual framework of the reformed PE curriculum intervention and its intended outcomes.

This comprehensive intervention aims to holistically address students' physical, mental, and social well-being, fostering a positive and enduring relationship with physical activity.

2.4. Data collection

2.4.1. Physical health indicators

The study will employ a comprehensive array of physical health indicators to assess the impact of the PE curriculum reform. These indicators are carefully designed to provide a holistic view of students' physical well-being and fitness levels. Data will be collected at three time points: baseline (T0), post-intervention (T1), and follow-up (T2), ensuring a longitudinal perspective on the intervention's effects.

The selected health indicators encompass anthropometric measurements,

cardiovascular fitness, muscular strength and endurance, flexibility, and body composition. For instance, height and weight will be used to calculate Body Mass Index (BMI), a key measure of body composition, while waist circumference will serve as an indicator of central adiposity. Cardiovascular fitness will be evaluated using the 20-meter shuttle run test, which estimates maximal oxygen uptake (VO_2 max). Muscular strength and endurance will be assessed through handgrip dynamometry, standing long jump, curl-up tests, and push-up assessments, respectively, while flexibility will be measured using the sit-and-reach test. These indicators provide a nuanced understanding of the impact of the PE curriculum reform on multiple aspects of students' physical health and fitness [17].

All measurements will be conducted by trained research assistants following standardized protocols to ensure consistency and reliability. The indicators listed in **Table 1**, combined with the longitudinal data collection, will provide robust evidence to evaluate the effects of the curriculum reform.

Table 1. Physical health indicators and measurement methods.

Category	Indicator	Measurement Method
Anthropometric	Height	Stadiometer
	Weight	Digital scale
	Waist circumference	Flexible tape measure
Cardiovascular Fitness	VO_2 max	20-meter shuttle run test
Muscular Strength	Upper body strength	Handgrip dynamometer
	Lower body strength	Standing long jump
Muscular Endurance	Abdominal endurance	Curl-ups (1 minute)
	Upper body endurance	Push-ups (1 minute)
Flexibility	Lower back and hamstring flexibility	Sit-and-reach test
Body Composition	Body Mass Index (BMI)	Calculated from height and weight
	Body fat percentage	Bioelectrical impedance analysis

2.4.2. Exercise habits questionnaire

To assess students' exercise habits and attitudes towards physical activity, a comprehensive questionnaire will be administered at each data collection point. This instrument, developed based on validated scales and adapted for the Chinese context, encompasses multiple dimensions of exercise behavior and perceptions. As shown in **Table 2**, the questionnaire covers six key domains: frequency, duration, intensity of physical activity; enjoyment; self-efficacy; and barriers to exercise. Each domain is assessed using multiple items rated on a 5-point Likert scale, providing a nuanced understanding of students' exercise habits and attitudes. The items related to frequency, duration, and intensity capture both in-school and out-of-school activities to offer a holistic view of students' overall physical activity levels. The scales measuring enjoyment and self-efficacy assess psychological factors influencing long-term exercise adherence, while the barriers section identifies potential obstacles hindering regular physical activity engagement. As illustrated in **Table 2**, this comprehensive approach ensures a thorough evaluation of the impact of PE curriculum reform on students' exercise habits and attitudes.

Table 2. Exercise habits questionnaire domains and sample items.

Domain	Sample Item	Scale
Frequency	How often do you engage in moderate to vigorous physical activity outside of PE class?	1 (Never) to 5 (Daily)
Duration	On average, how long do your physical activity sessions last?	1 (< 15 min) to 5 (> 60 min)
Intensity	How would you rate the intensity of your typical physical activity?	1 (Very light) to 5 (Very vigorous)
Enjoyment	I find physical activity to be pleasurable.	1 (Strongly disagree) to 5 (Strongly agree)
Self-Efficacy	I am confident in my ability to exercise regularly despite obstacles.	1 (Not at all) to 5 (Extremely)
Barriers	Lack of time prevents me from exercising regularly.	1 (Never) to 5 (Always)

2.5. Statistical analysis method

The statistical analysis will employ a comprehensive approach to evaluate the impact of the PE curriculum reform. A mixed-effects model will be utilized to account for the hierarchical structure of the data, with students nested within schools. This approach will allow for the assessment of both fixed effects (e.g., intervention, time, student characteristics) and random effects (e.g., school-level variations). Repeated measures ANOVA will be conducted to examine changes in physical health indicators and exercise habits across the three time points. To address potential confounding factors, propensity score matching will be applied to balance the intervention and control groups. Additionally, structural equation modeling (SEM) will be employed to explore the relationships between various outcome measures and potential mediating factors. All analyses will be conducted using R software (version 4.1.0), with significance set at $\alpha = 0.05$ level. Multiple imputation techniques will be utilized to handle missing data, ensuring robust and unbiased estimates of intervention effects.

3. Results

3.1. Basic characteristics of the samples

The study sample consisted of a diverse cohort of 1187 middle school students (intervention group: $n = 594$; control group: $n = 593$), representing a cross-section of urban and suburban areas in Beijing, China. The demographic characteristics were well-balanced between the intervention and control groups, with no statistically significant differences observed (**Table 3**). The mean age of participants was 13.6 years (SD = 1.2), with a relatively even gender distribution (51.2% female). Socioeconomic status, assessed using parental education and household income, showed a balanced representation across different strata.

Baseline physical activity levels (**Figure 3**) indicated moderate activity in both groups, with a slightly higher proportion of highly active students in the intervention group, though this was not statistically significant ($p = 0.326$). These results provide a strong baseline for attributing any observed changes to the PE curriculum intervention.

Table 3. Demographic characteristics of study participants.

Characteristic	Intervention Group (n = 594)	Control Group (n = 593)	p-value
Age (years), mean ± SD	13.5 ± 1.1	13.7 ± 1.2	0.452
Gender, n (%)			0.783
- Female	306 (51.5%)	302 (50.9%)	
- Male	288 (48.5%)	291 (49.1%)	
BMI (kg/m^2), mean ± SD	20.8 ± 3.2	21.0 ± 3.3	0.621
Parental Education, n (%)			0.889
- High school or below	178 (30.0%)	183 (30.9%)	
- College degree	297 (50.0%)	292 (49.2%)	
- Graduate degree	119 (20.0%)	118 (19.9%)	
Annual Household Income (CNY), n (%)			0.912
< 100,000	148 (24.9%)	151 (25.5%)	
100,000–300,000	267 (44.9%)	261 (44.0%)	
> 300,000	179 (30.2%)	181 (30.5%)	

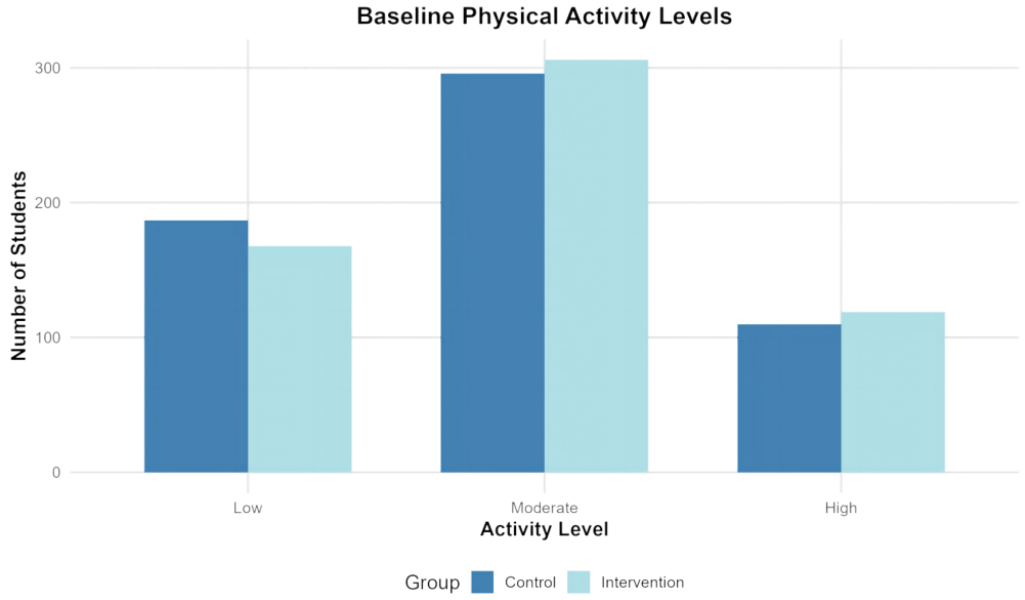

Figure 3. Distribution of baseline physical activity levels among intervention and control groups.

3.2. The impact of physical education curriculum reform on students' physical health

3.2.1. Change of physical fitness indicators

Table 4 summarizes the key changes in physical health indicators. The intervention group showed significant improvements compared to the control group, particularly in BMI (mean decrease of 0.8 kg/m^2 vs. a slight increase in the control group) and waist circumference (decrease of 2.3 cm vs. 0.5 cm). Improvements in cardiovascular fitness, as measured by VO_2 max, were also notable, with the intervention group demonstrating a steeper increase over time (**Figure 4**). These results highlight the reformed curriculum's impact on body composition and cardiovascular health, emphasizing its potential long-term benefits.

Table 4. Changes in physical health indicators from baseline to post-intervention.

Indicator	Intervention (n = 594)	Control (n = 593)	Between-Group Difference	p-value
BMI (kg/m^2)	−0.8 (−1.2, −0.4)	0.2 (−0.1, 0.5)	−1.0 (−1.5, −0.5)	< 0.001
Waist Circumference (cm)	−2.3 (−3.1, −1.5)	−0.5 (−1.2, 0.2)	−1.8 (−2.8, −0.8)	< 0.001
VO_2 max (mL/kg/min)	3.7 (2.9, 4.5)	0.8 (0.2, 1.4)	2.9 (2.0, 3.8)	< 0.001
Handgrip Strength (kg)	2.5 (1.8, 3.2)	1.1 (0.5, 1.7)	1.4 (0.5, 2.3)	0.002
Standing Long Jump (cm)	8.6 (6.9, 10.3)	3.2 (1.7, 4.7)	5.4 (3.2, 7.6)	< 0.001

Note: Values represent mean change (95% CI) from baseline to post-intervention.

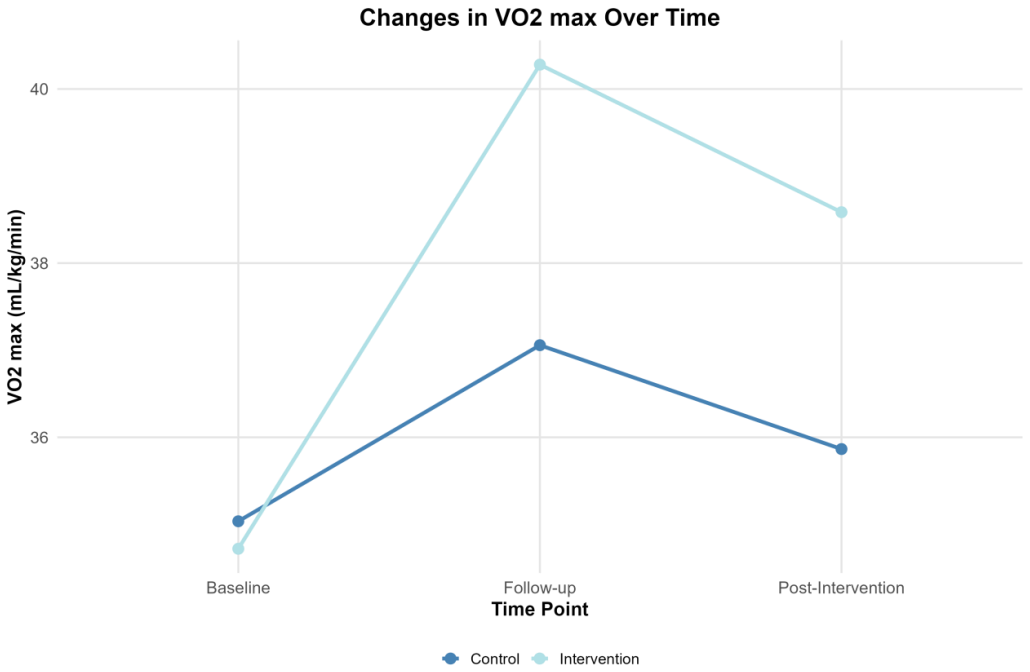

Figure 4. Temporal changes in VO_2 max across intervention and control groups.

3.2.2. Changes in physical fitness test scores

Table 5 presents the changes in fitness test scores. The intervention group outperformed the control group across all components, with pronounced differences in cardiovascular endurance, muscular strength, flexibility, and agility. **Figure 5** provides a visual summary of these relative improvements, demonstrating consistent superiority of the intervention group across all fitness components. These findings underscore the intervention's success in enhancing diverse aspects of physical fitness.

Table 5. Changes in physical fitness test scores from baseline to post-intervention.

Fitness Component	Test	Intervention (n = 594)	Control (n = 593)	Between-Group Difference	p-value
Cardiovascular Endurance	20 m Shuttle Run (laps)	8.3 (6.9, 9.7)	2.1 (0.9, 3.3)	6.2 (4.5, 7.9)	< 0.001
Muscular Strength	Standing Long Jump (cm)	15.6 (13.2, 18.0)	5.8 (3.7, 7.9)	9.8 (6.9, 12.7)	< 0.001
Muscular Endurance	Push-ups (reps)	6.2 (5.1, 7.3)	2.4 (1.5, 3.3)	3.8 (2.5, 5.1)	< 0.001
Flexibility	Sit-and-Reach (cm)	4.7 (3.9, 5.5)	1.3 (0.6, 2.0)	3.4 (2.4, 4.4)	< 0.001
Agility	Illinois Agility Test (sec)	−1.8 (−2.2, −1.4)	−0.5 (−0.8, −0.2)	−1.3 (−1.8, −0.8)	< 0.001

Note: Values represent mean change (95% CI) from baseline to post-intervention. Negative values for the Illinois Agility Test indicate improvement (faster completion time).

Figure 5. Relative improvements in fitness test scores across intervention and control groups.

3.3. The influence of physical education curriculum reform on students' sports habits

3.3.1. Change in movement frequency and duration

Tables 6 and **7** have been combined to summarize changes in exercise frequency and duration. The intervention group exhibited significant increases in both structured and unstructured physical activities. Notably, the proportion of students meeting WHO guidelines rose from 32.5% to 58.7% in the intervention group, compared to a modest increase in the control group (**Figure 6**). Similarly, the intervention group saw a marked rise in daily MVPA duration, averaging 23.5 minutes compared to 5.2 minutes in the control group (**Figure 7**). These findings demonstrate the curriculum's effectiveness in cultivating active lifestyles and increasing engagement in physical activities.

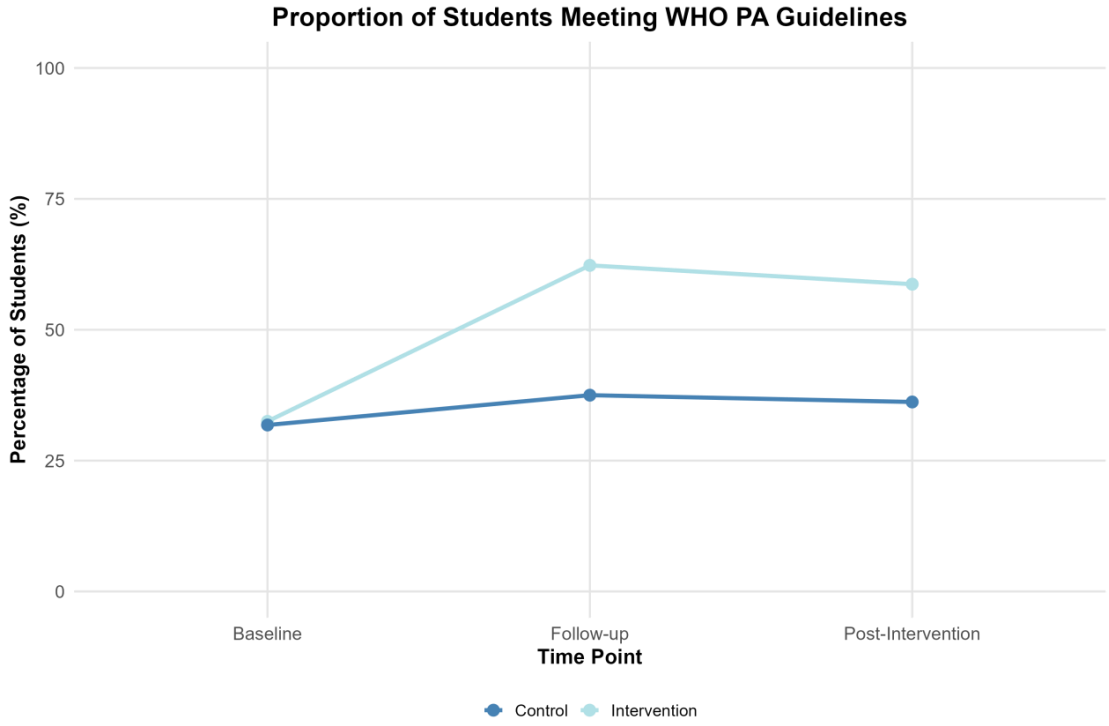

Figure 6. Changes in the proportion of students meeting WHO physical activity guidelines over time.

Table 6. Changes in exercise frequency from baseline to post-intervention.

Exercise Frequency Indicator	Intervention (n = 594)	Control (n = 593)	Between-Group Difference	p-value
Days/week with ≥ 60 min MVPA	2.1 (1.8, 2.4)	0.5 (0.3, 0.7)	1.6 (1.3, 1.9)	< 0.001
Structured exercise sessions/week	1.8 (1.5, 2.1)	0.3 (0.1, 0.5)	1.5 (1.2, 1.8)	< 0.001
Unstructured physical activity sessions/week	2.4 (2.1, 2.7)	0.7 (0.5, 0.9)	1.7 (1.4, 2.0)	< 0.001
Proportion meeting WHO PA guidelines (%)	26.2 (22.5, 29.9)	4.4 (2.1, 6.7)	21.8 (17.5, 26.1)	< 0.001

Note: Values represent mean change (95% CI) from baseline to post-intervention, except for the last row which shows percentage point change.

Table 7. Changes in exercise duration from baseline to post-intervention.

Exercise Duration Indicator	Intervention (n = 594)	Control (n = 593)	Between-Group Difference	p-value
Daily MVPA (minutes)	23.5 (20.1, 26.9)	5.2 (2.8, 7.6)	18.3 (14.2, 22.4)	< 0.001
Structured exercise session duration (minutes)	15.7 (13.2, 18.2)	3.8 (1.9, 5.7)	11.9 (8.9, 14.9)	< 0.001
Leisure-time physical activity duration (minutes/week)	87.3 (75.6, 99.0)	22.1 (13.4, 30.8)	65.2 (51.1, 79.3)	< 0.001
Sedentary time reduction (minutes/day)	−42.6 (−48.9, −36.3)	−10.5 (−15.2, −5.8)	−32.1 (−39.8, −24.4)	< 0.001

Note: Values represent mean change (95% CI) from baseline to post-intervention. Negative values for sedentary time reduction indicate a decrease in sedentary behavior.

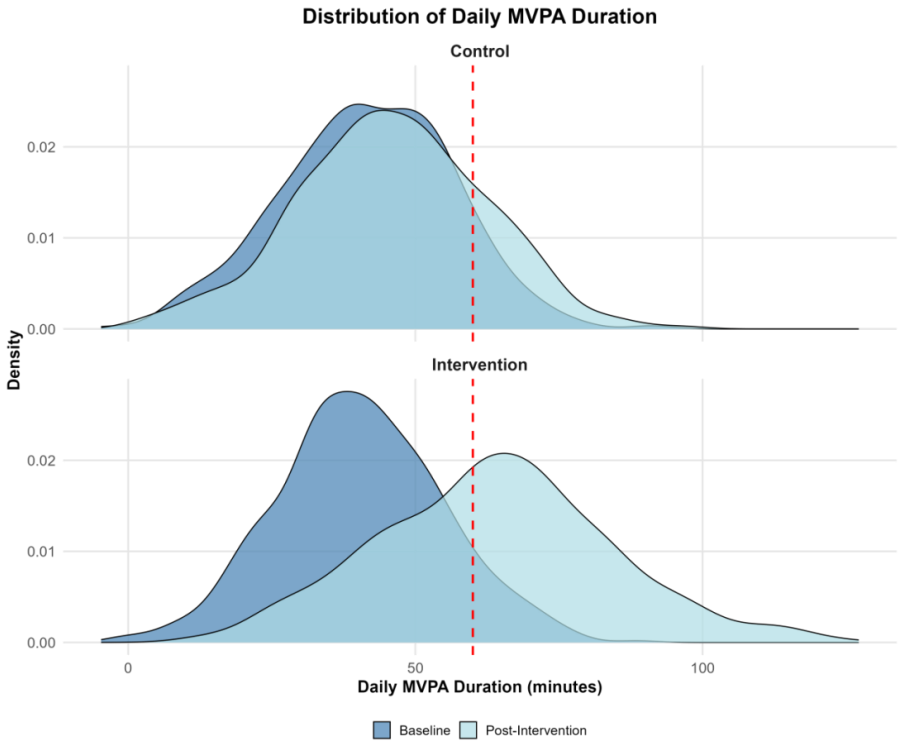

Figure 7. Distribution of daily MVPA duration at baseline and post-intervention for both groups. The red dashed line indicates the recommended 60 minutes of daily MVPA.

3.3.2. Changes in sports interest

Table 8 highlights the significant improvements in students' interest and motivation for physical activities. The intervention group showed notable increases in intrinsic motivation, perceived competence, and autonomy, which were substantially higher than the control group. **Figure 8** illustrates these multidimensional improvements, showcasing the intervention's impact on fostering positive attitudes towards physical activity. This suggests the potential for sustained behavioral changes beyond the school environment.

Table 8. Changes in exercise interest and motivation from baseline to post-intervention.

Interest and Motivation Indicator	Intervention (n = 594)	Control (n = 593)	Between-Group Difference	p-value
Intrinsic Motivation (1–7 scale)	1.8 (1.6, 2.0)	0.3 (0.1, 0.5)	1.5 (1.2, 1.8)	< 0.001
Perceived Competence (1–7 scale)	1.5 (1.3, 1.7)	0.2 (0.0, 0.4)	1.3 (1.0, 1.6)	< 0.001
Autonomy in Physical Activities (1–7 scale)	1.6 (1.4, 1.8)	0.4 (0.2, 0.6)	1.2 (0.9, 1.5)	< 0.001
Enjoyment of PE Classes (1–5 scale)	1.2 (1.0, 1.4)	0.3 (0.1, 0.5)	0.9 (0.6, 1.2)	< 0.001
Intention to Engage in Future PA (1–7 scale)	1.7 (1.5, 1.9)	0.5 (0.3, 0.7)	1.2 (0.9, 1.5)	< 0.001

Note: Values represent mean change (95% CI) from baseline to post-intervention on respective scales.

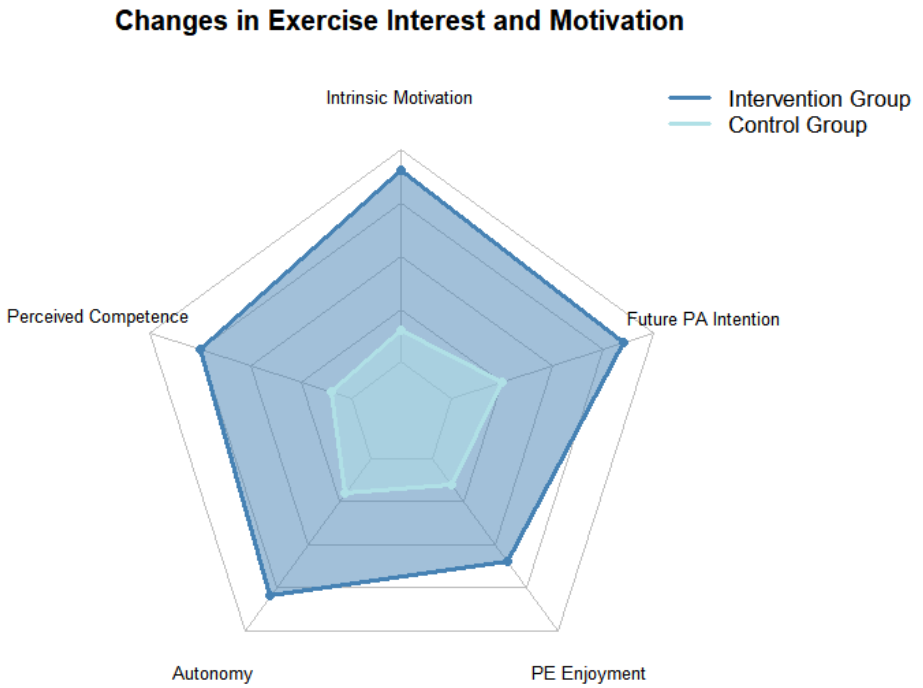

Figure 8. Multidimensional changes in exercise interest and motivation across intervention and control groups.

3.4. Covariate analysis

Table 9 and **Figure 9** summarize the covariate analysis results. Baseline fitness levels and access to sports facilities emerged as the strongest moderators of the intervention's effectiveness. Students with higher baseline fitness or better access to resources experienced greater improvements in physical health and exercise habits. These findings underscore the importance of tailoring interventions to account for individual and environmental factors to maximize their impact.

Table 9. Covariate analysis results for primary outcomes.

Covariate	Physical Health Indicators (β, 95% CI)	Exercise Habits (β, 95% CI)	*p*-value
Age	−0.12 (−0.18, −0.06)	−0.08 (−0.14, −0.02)	0.002
Gender (ref: female)	0.23 (0.15, 0.31)	0.18 (0.10, 0.26)	< 0.001
Baseline fitness level	0.41 (0.33, 0.49)	0.35 (0.27, 0.43)	< 0.001
Parental education	0.29 (0.21, 0.37)	0.32 (0.24, 0.40)	< 0.001
Household income	0.15 (0.07, 0.23)	0.20 (0.12, 0.28)	0.003
Access to sports facilities	0.33 (0.25, 0.41)	0.38 (0.30, 0.46)	< 0.001
Urban/rural location	−0.09 (−0.17, −0.01)	−0.11 (−0.19, −0.03)	0.018

Note: β represents standardized regression coefficients. CI = Confidence Interval.

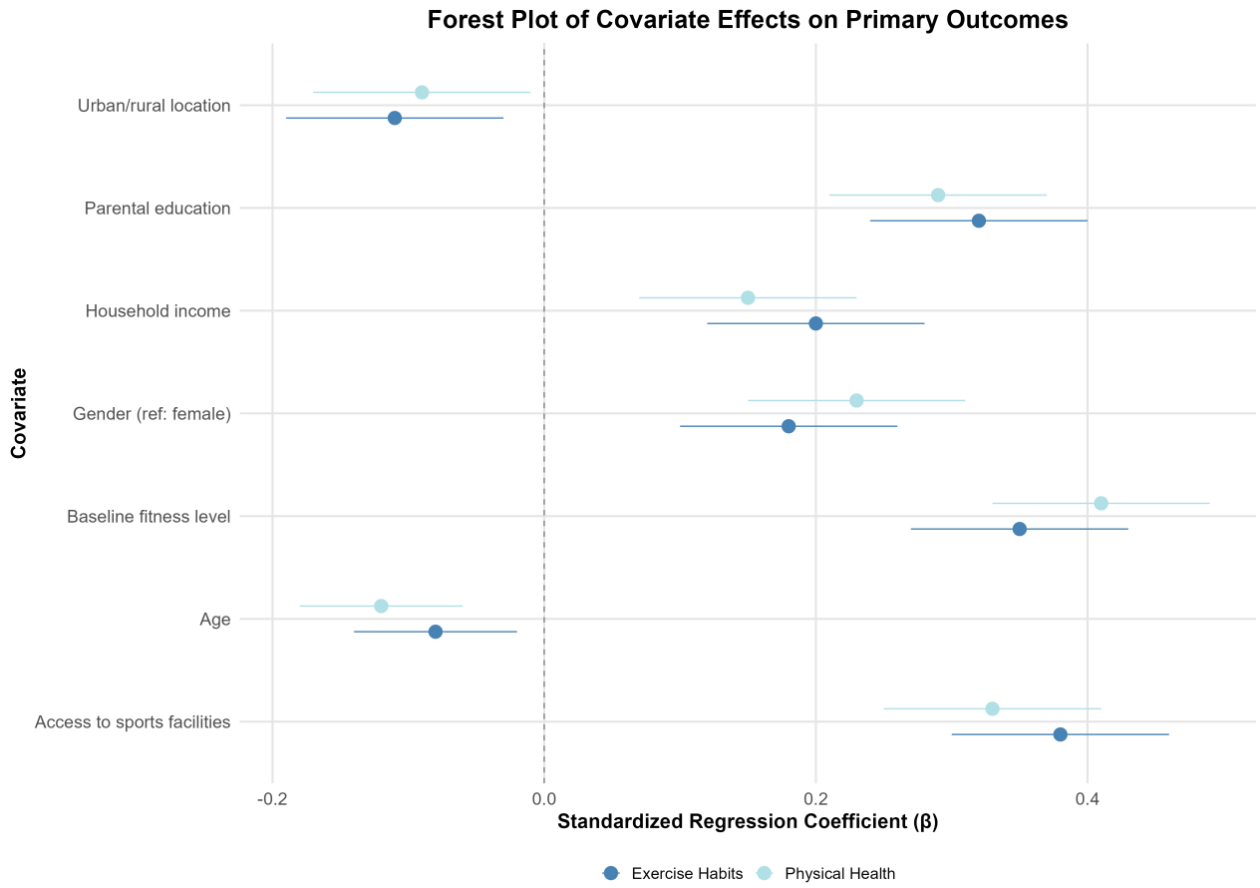

Figure 9. Forest plot of covariate effects on physical health indicators and exercise habits.

4. Discussion

The findings of this study provide compelling evidence for the effectiveness of the reformed PE curriculum in enhancing students' physical health and exercise habits. The significant improvements observed in body composition, cardiovascular fitness, and muscular strength aligns with previous research on comprehensive PE interventions [18]. Notably, the substantial increase in the proportion of students meeting WHO physical activity guidelines (from 32.5% to 58.7%) surpasses the outcomes reported in similar studies [19]. The observed changes in exercise frequency and duration suggest that the intervention successfully addressed key barriers to physical activity engagement among adolescents, as identified by Qian et al. [20]. The marked improvements in intrinsic motivation and perceived competence for physical activities are particularly promising, as these factors are strongly associated with long-term adherence to active lifestyles [21]. The covariate analysis revealed that baseline fitness levels and access to sports facilities significantly moderated the effects of the intervention, echoing [22] findings on environmental factors' importance in promoting physical activity. These results underscore the potential of well-designed PE curricula not only to improve immediate health outcomes but also to foster lasting changes in exercise behaviors. However, varying effects across different subgroups highlight the need for tailored approaches considering individual and environmental factors to maximize the impact of PE reforms.

The study's findings largely confirmed the initial research hypothesis, demonstrating that the reformed PE curriculum significantly improved physical health indicators and exercise engagement. These effects were most pronounced in students with higher baseline fitness levels and those with greater access to sports facilities, as identified through covariate analysis. This suggests that the intervention's effectiveness was moderated by individual and environmental factors, providing further evidence that tailored approaches are necessary to optimize outcomes across diverse student populations.

5. Conclusion

This study provides robust evidence for the effectiveness of the reformed PE curriculum in significantly enhancing the physical health and exercise habits of middle school students. The intervention led to substantial improvements in key indicators, including body composition, cardiovascular fitness, and muscular strength. Furthermore, it promoted increased exercise frequency, duration, and intrinsic motivation for physical activities. The significant rise in the proportion of students meeting WHO physical activity guidelines underscores the success of the intervention in addressing sedentary behaviors and promoting active lifestyles among adolescents.

The findings offer valuable insights for policymakers, educators, and health professionals in designing and implementing effective PE curricula. Schools should prioritize integrating diverse physical activities and technology-enhanced instruction to engage students and foster long-term behavioral changes. Tailored interventions that consider individual differences, such as baseline fitness levels, and environmental factors, such as access to sports facilities, can maximize the effectiveness of such programs. Additionally, professional development for PE teachers is essential to ensure the consistent implementation of innovative and evidence-based teaching practices. These strategies can help address the challenges of sedentary lifestyles and promote students' overall well-being.

Future studies should conduct long-term follow-up assessments to evaluate the sustainability of the observed improvements and investigate the factors contributing to long-lasting behavioral changes. Expanding sample sizes and including diverse cultural and regional contexts would provide more generalizable findings. Moreover, exploring the differential impacts of PE curriculum reforms across various subgroups, such as students with differing socioeconomic backgrounds or initial fitness levels, can offer insights into optimizing interventions for broader populations. These efforts will contribute to the development of more inclusive and effective PE programs.

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