

# Effects of Circuit Training Program on Improving The Physical Fitness of The Grade 6-Boys in Primary School

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## Abstract

This study investigated the impact of a circuit training program on the physical fitness of grade 6 boys. Using a quasi-experimental design, 60 boys from Dongfeng Road Primary School were divided into an experimental group (n=30) and a control group (n=30) via matched-pairs assignment. The experimental group underwent an 8-week circuit training program (3 times/week, 40 min/session), while the control group performed traditional physical training. Physical fitness was assessed via the 50-meter sprint (speed), standing long jump (muscle power), and 1000-meter run (cardiorespiratory endurance). Data were analyzed using one-way repeated-measures ANOVA and independent samples t-tests. The investigation revealed that after 8 weeks, both groups showed significant improvements ( $p < 0.05$ ). Notably, the experimental group achieved significant improvement in the 1000-meter run after only 4 weeks (mean improvement: 10.3 seconds,  $p < 0.05$ ), whereas the control group showed no significant change. At 8 weeks, the experimental group significantly outperformed the control group in the standing long jump (189.83 cm vs. 182.17 cm,  $p < 0.01$ ). These findings demonstrate that circuit training is more efficient than traditional physical training, particularly in enhancing muscle power and cardiorespiratory endurance, providing an effective optimization strategy for primary school physical education.

**Keywords:** Circuit Training, Physical Fitness, Grade 6 Boys

## Introduction

Against the backdrop of the "Opinions on Comprehensively Strengthening and Improving School Physical Education in the New Era" (General Office of the CPC Central Committee & General Office of the State Council, 2020) and the "Implementation Plan for Deepening the Reform of the High School Examination and Enrollment System in Inner Mongolia Autonomous Region" (General Office of the People's Government of Inner Mongolia Autonomous Region, 2022), improving students' physical fitness has become an important goal of school physical education. In Inner Mongolia, China, the first exam for students graduating from primary school and entering middle school (three months after graduation) includes a physical fitness test (PFT). This test primarily reflects students' physical fitness during primary school, and the results directly affect their admission to higher grades. Therefore, physical fitness is extremely important for upper-primary school students. Previous physical fitness test data show that most boys are weaker in speed, muscle power,

and cardiorespiratory, requiring more scientific and systematic training methods to improve these areas. Traditional physical training methods often focus on repetitive practice of single items, which can easily lead to boredom among students, and training efficiency is difficult to maximize within the limited class time. Circuit training, as a method of enhancing physical fitness by rotating through multiple training stations within a fixed time, is characterized by multiple stations, high density, multiple forms, and strong adjustability. Therefore, exploring the impact of circuit training on the physical fitness of grade 6 boys not only helps enrich primary school physical training methods but also provides scientific experimental evidence for accurately improving students' physical fitness, which has significant practical educational value.

This study focuses on grade 6 boys at Dongfeng Road Primary School in Saihan District, Hohhot, and aims to address the following core question: In an 8-week physical training program, is the circuit training program significantly effective in improving students' speed (50-meter sprint), muscle explosiveness (standing long jump), and cardiorespiratory (1000-meter run)? Is it superior to traditional physical training?

The overall conclusion of this article is that circuit training is a highly effective physical fitness improvement program that aligns with the physical and mental development characteristics of primary school students. Compared to traditional physical training, circuit training, through its well-designed station loads, can more comprehensively stimulate the body to produce physiological adaptations, especially showing significant immediate advantages in improving cardiorespiratory and muscle power during the initial intervention period (the first four weeks). Through comparative experiments, this study demonstrated that the scientific implementation of circuit training can significantly and sustainably improve the overall physical fitness of grade 6 boys.

## Objectives

1. To study the effects of a circuit training program on improving the physical fitness of grade 6 boys.
2. To compare the differences between circuit training programs and traditional physical training in improving the physical fitness of grade 6 boys.

## Literature Review

Circuit training, first proposed by Morgan and Adamson of the University of Leeds in 1953, is based on setting up multiple training stations according to the training goals. Trainees complete the exercises at each station sequentially and repeat the cycle. Physiologically, circuit training follows the principles of "progressive overload" and "biological adaptation." High-density, multi-station training not only effectively recruits more motor units and improves the coordination of the neuromuscular system but also induces the body to undergo a mixed aerobic and anaerobic metabolism while maintaining a high heart rate, thereby comprehensively improving muscle strength, explosive power, and cardiorespiratory (Morgan & Adamson, 1957).

Circuit training has significant advantages in improving the basic physical fitness of school-aged children. Studies have shown that modular circuit training is more effective in improving cardiovascular function and skeletal muscle strength in students aged 10-12 who are in a sensitive period of growth and development (Mayorga-Vega et al, 2013).

In recent years, circuit training has gained widespread attention in the field of youth physical education and sports training because of its high efficiency and multifunctionality.

Multiple studies have shown that compared to traditional teaching or single-method training, circuit training has a more significant advantage in simultaneously improving muscle power and cardiorespiratory. Regarding muscle power improvement, circuit training effectively stimulates the neuromuscular system through high-density strength training exercises. Pang Kaihui (2024) Studies have found that, compared with the control group that used traditional physical training, the experimental group that used circuit training showed a significant improvement in explosive power indicators such as the standing long jump. Circuit training has a unique advantage in enhancing cardiorespiratory. Short-term structured circuit training can effectively improve students' cardiorespiratory function (Marinho et al,2022).

In summary, the advantage of circuit training lies in its ability to combine high-intensity strength training with sustained physiological stress. By shortening the rest intervals between sets and increasing the variety of movements, circuit training allows the body to perform muscle exertion exercises while maintaining a high heart rate. This dual intervention model of "strength + endurance" is the key to its superior effectiveness compared to traditional physical training. Therefore, circuit training has proven to be a more efficient and practical training system than traditional methods for improving 50-meter sprint performance (representing speed), standing long jump performance (representing explosive power), and 1000-meter run performance (representing cardiorespiratory) (Yang Baiyang, 2021).

Shuba (2020) research confirms that circuit training can be seamlessly integrated into physical education classes. Studies of 9–10-year-old children have shown that scientifically designed circuit training methods can effectively optimize elementary school physical education, significantly increasing class density. Kuyliyevich (2023) Experiments have demonstrated that using circuit training in elementary school physical education classes is significantly more effective than traditional teaching systems, improving students' overall physical fitness level by 12.5%. The application of circuit training in the "practice in every class" component of junior high school physical education classes has shown that this model not only addresses the problem of low student interest in practice but also enables the completion of high-intensity physical fitness build-up within a limited time (Yuan Sifan, 2022).

## Research Methodology

### Research Design

This study employed quasi-experimental design and was conducted at Dongfeng Road Primary School to investigate the impact of a circuit training program on the physical fitness of grade 6 students. The study participants were grade 6 boys from Dongfeng Road Primary School. Sixty boys were selected using purposive sampling and divided into experimental and control groups. The experimental group received an 8-week circuit training program, whereas the control group received routine physical fitness training. They were trained three times a week for 40 min each time.

The selection criteria were as follows: 1) Grade 6 boys. 2) Able to participate in training continuously (8 weeks). 3) In good health, without any disease or injury. 4) Voluntary participation; 5) In the pre-experiment test, the 50-meter sprint time was  $>8.2s$ , the standing long jump time was  $<195$  cm, and the 1000-meter run time was  $>270s$ .

The exclusion criteria were as follows: 1) history of serious injury or illness. 2) Inability to guarantee attendance during the study period; 3) In the pre-experiment tests, a 50-meter sprint time  $\leq 8.2s$ , a standing long jump time  $\geq 195$  cm, and a 1000-meter run time  $\leq 270s$ .

### **Ethical considerations**

All procedures of this study were approved by the Ethics Committee of the Inner Mongolia Normal University of China Ethics Committee with approval number IMNU-2025-11-10115.

### **Research Instruments**

**Training Plan:** Based on the fundamental characteristics of circuit training, multiple items, short duration, and high efficiency," training programs with high safety, moderate technical difficulty, and suitability for grade 6 students were selected from running and jumping exercises. The final plan identified eight training stations: fast shuffle. 20-meter sprint. high Knee. high Knee Run. straight-leg jumps. tuck Jumps. rope kipping. 20-meter shuttle run.

Each training session lasted 40 min, including 8 min of warm-up, 24 min of circuit training, and 8 min of cool-down. The circuit training consisted of three rounds, with each station's training time being 25-35 seconds and rest periods of 3-5 minutes between rounds. The station training time and rest periods between rounds were gradually adjusted as the students adapted.

The content validity of the research instrument was assessed by five experts in the field. The Scale-level Content Validity Index was 0.92, indicating excellent content validity and suitability for the formal survey.

**Testing:** The testing tools were based on the "National Student Physical Fitness and Health Standards (2014 Revision)" (Ministry of Education. 2014). The 50-meter sprint, standing long jump, and 1000-meter run were selected. The testing process was standardized and conducted by the same personnel to ensure the reliability and validity of the data.

### **Data Collection**

1. Physical fitness tests (50-meter sprint, standing long jump, 1000-meter run) were conducted before the experiment, and data were collected.

2. The participants were divided into experimental and control groups.

3. The experimental group underwent circuit training, whereas the control group underwent traditional physical training.

4. The training program lasted for eight weeks, with three training sessions per week (Monday, Wednesday, and Friday). Each training session lasted for 40 min.

5. Physical fitness tests (50-meter sprint, standing long jump, 1000-meter run) were conducted on both groups of participants in the fourth and eighth weeks, and data were collected.

### **Data Preparation and Analysis**

In this study, the researchers used the SPSS statistical software to process the test data, following these steps:

1. The mean, standard deviation, t-value, and p-value for the experimental and control groups were calculated before the experiment, after 4 weeks, and after 8 weeks.

2. A one-way repeated-measures ANOVA was used to compare the trends in physical fitness changes in the experimental and control groups at different stages. For indicators showing significant changes, multiple comparison corrections were performed using the Bonferroni test. The statistical significance threshold was set at  $p < 0.05$ .

### **Research Finding**

The effects of circuit training on the physical fitness of grade 6 boys at Dongfeng Road Primary School are as follows:

**Table 1:** Comparison of Physical Performance Indicators Between Experimental and Control Groups Across Different Training Stages

| Time                      | Test Project            | Experimental group<br>Mean $\pm$ SD | Control group<br>Mean $\pm$ SD | T      | P     |
|---------------------------|-------------------------|-------------------------------------|--------------------------------|--------|-------|
| Before training           | 50-meter sprint(s)      | 9.75 $\pm$ 1.07                     | 9.76 $\pm$ 0.84                | -0.030 | 0.977 |
|                           | Standing long jump(cm.) | 162.73 $\pm$ 12.53                  | 163.23 $\pm$ 14.88             | -0.141 | 0.889 |
|                           | 1000-meter run(s)       | 307.87 $\pm$ 37.65                  | 308.63 $\pm$ 31.72             | -0.085 | 0.932 |
| After 4 weeks of training | 50-meter sprint(s)      | 9.50 $\pm$ 1.03                     | 9.63 $\pm$ 0.85                | -0.556 | 0.580 |
|                           | Standing long jump(cm.) | 174.47 $\pm$ 10.56                  | 170.93 $\pm$ 15.01             | 1.054  | 0.296 |
|                           | 1000-meter run(s)       | 297.57 $\pm$ 35.48                  | 304.60 $\pm$ 31.45             | -0.813 | 0.420 |
| After 8 weeks of training | 50-meter sprint(s)      | 9.26 $\pm$ 0.99                     | 9.48 $\pm$ 0.88                | -0.943 | 0.349 |
|                           | Standing long jump(cm.) | 189.83 $\pm$ 12.48                  | 182.17 $\pm$ 16.84             | 1.999  | 0.050 |
|                           | 1000-meter run(s)       | 278.97 $\pm$ 33.06                  | 293.60 $\pm$ 31.12             | -1.765 | 0.083 |

\* $P \leq 0.05$ 

Table 1 shows that before the experiment, the 50-meter sprint time was  $9.75 \pm 1.07$  s for the experimental group and  $9.76 \pm 0.84$  s for the control group. The standing long jump time was  $162.73 \pm 12.53$  cm for the experimental group and  $163.23 \pm 14.88$  cm for the control group. The 1000-meter run time was  $307.87 \pm 37.65$  s for the experimental group and  $308.63 \pm 31.72$  s for the control group. There were no significant differences in any of the physical fitness indicators between the experimental and control groups before training (p-values were all greater than 0.05). This indicates that there was no significant difference in the baseline physical fitness levels of the two groups before the experiment, making them comparable to each other.

After 4 weeks of experimentation, various indicators of both groups of subjects showed varying degrees of change. The experimental group's 50-meter sprint time was  $9.50 \pm 1.03$  s, while the control group's was  $9.63 \pm 0.85$  s; the standing long jump time was  $174.47 \pm 10.56$  cm, while the control group's was  $170.93 \pm 15.01$  s; and the 1000-meter run time was  $297.57 \pm 35.48$  s, while the control group's was  $304.60 \pm 31.45$  s. Although the average performance of the experimental group was better than that of the control group, the t-test results showed no significant difference ( $p > 0.05$ ).

After 8 weeks of experimentation, the experimental group's lead in various indicators further widened: 50-meter sprint: The experimental group's average time improved to  $9.26 \pm 0.99$  s, while the control group was  $9.48 \pm 0.88$  s. Although the experimental group was numerically superior, the difference is not statistically significant at this point. ( $p=0.349$ ). Standing long jump: The experimental group ( $189.83 \pm 12.48$  cm) and the control group ( $182.17 \pm 16.84$  cm) showed a further widening of the gap, The difference is significant. ( $p=0.050$ ). 1000-meter run: The experimental group ( $278.97 \pm 33.06$  s) demonstrated better cardiorespiratory compared to the control group ( $293.60 \pm 31.12$  s). The difference was not significant. ( $p=0.083$ )

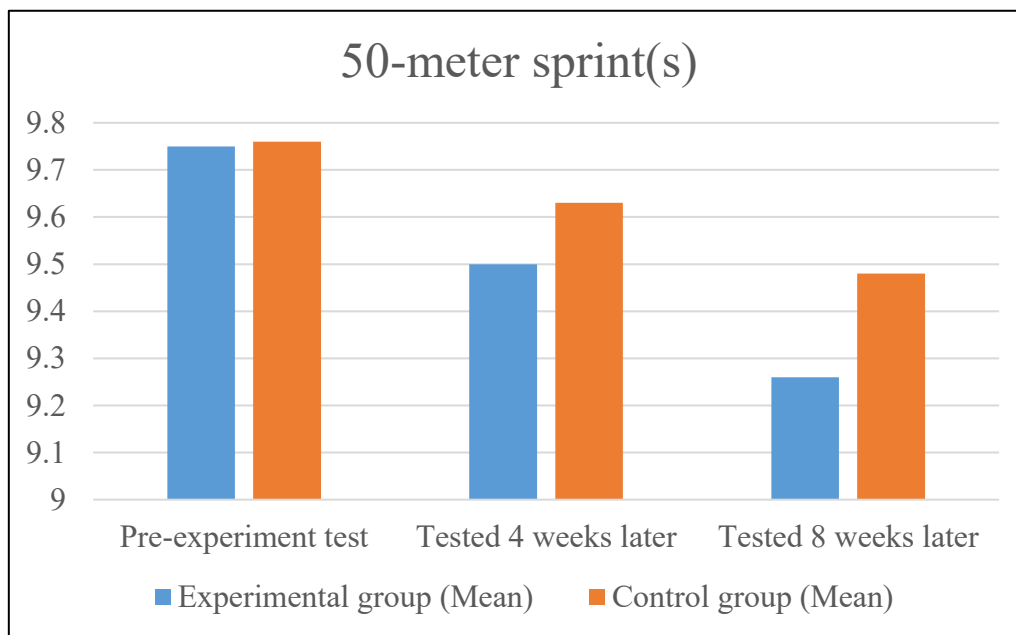


**Figure 1:** Trends In Physical Performance Indicators for Experimental and Control Groups Over the Training Period in the 50-Meter Sprint

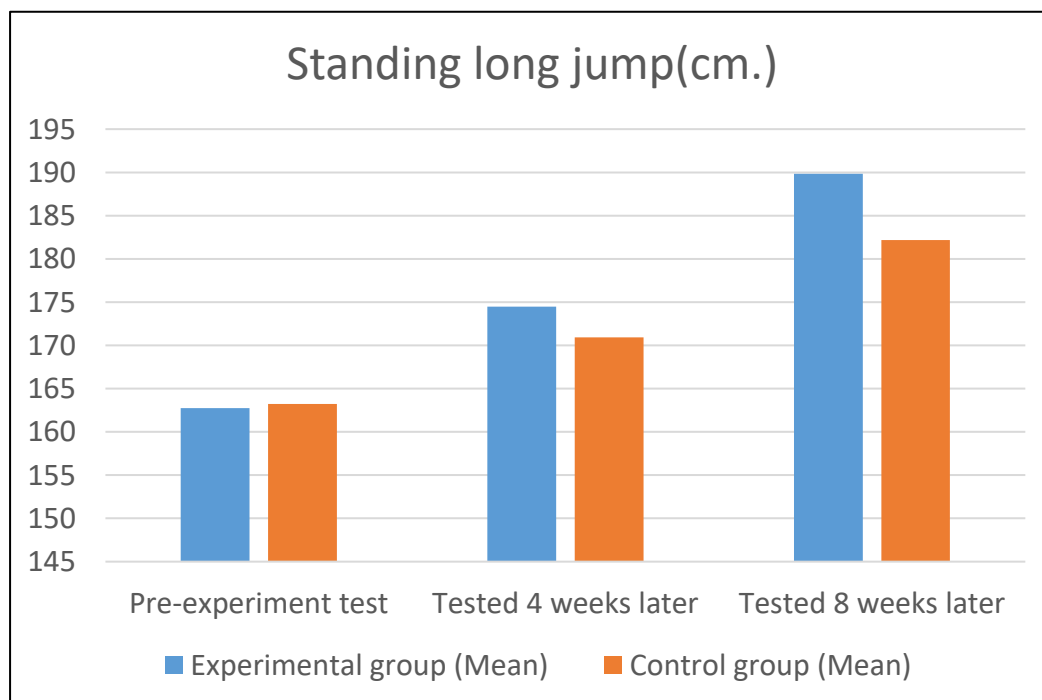


**Figure 2:** Trends in Physical Performance Indicators for Experimental and Control Groups Over the Training Period in the Standing Long Jump

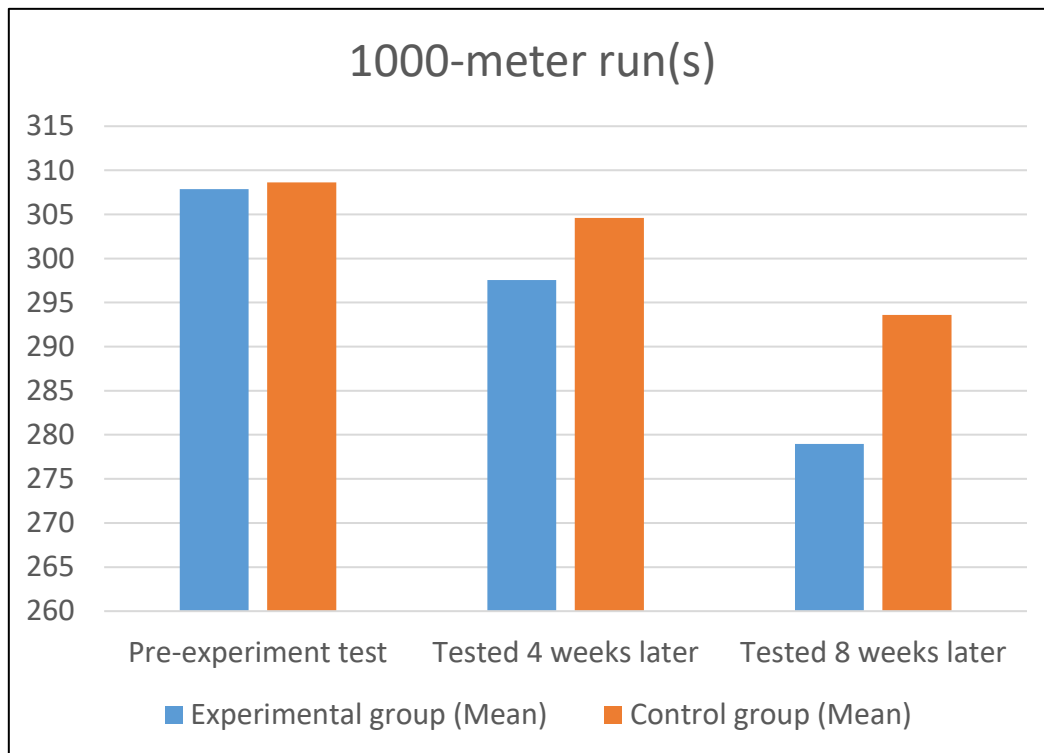


**Figure 3:** Trends in Physical Performance Indicators for Experimental and Control Groups Over the Training Period in the 1000-Meter Run

Changes in physical fitness metrics in the experimental and control groups over an 8-week training period. Performance was evaluated before training, and at 4 and 8 weeks post-training. In the 50-meter sprint and 1000-meter run charts, a decrease in time indicates an improvement in speed and aerobic endurance, respectively. In the standing long jump chart, an increase in distance indicates an improvement in muscle power. As shown in the figure, the experimental group outperformed the control group in terms of physical fitness data after 4 and 8 weeks.

**Table 2:** One-Way ANOVA Was Performed on the 50-Meter Sprint, Standing Long Jump, and 1000-Meter Run in The Experimental and Control Groups Before the Experiment, After 4 Weeks of the Experiment, and After 8 Weeks of the Experiment

| Group              | Test Project       | Source of Variation | SS                    | DF              | MS                 | F       | p     |
|--------------------|--------------------|---------------------|-----------------------|-----------------|--------------------|---------|-------|
| Experimental group | 50-meter sprint    | Time Error          | 3.717<br>0.804        | 1.305<br>37.837 | 2.849<br>0.021     | 134.023 | <.001 |
|                    | Standing long jump | Time Error          | 11082.156<br>1323.844 | 1.552<br>44.997 | 7142.344<br>29.421 | 242.765 | <.001 |
|                    | 1000-meter run     | Time Error          | 12872.600<br>780.733  | 1.321<br>38.307 | 9745.180<br>20.381 | 478.147 | <.001 |

| Group         | Test Project       | Source of Variation | SS       | DF     | MS       | F       | p     |
|---------------|--------------------|---------------------|----------|--------|----------|---------|-------|
| Control group | 50-meter sprint    | Time                | 1.158    | 1.101  | 1.052    | 59.143  | <.001 |
|               |                    | Error               | 0.568    | 31.919 | 0.018    |         |       |
|               | Standing long jump | Time                | 5439.489 | 1.224  | 4445.603 | 179.152 | <.001 |
|               |                    | Error               | 880.511  | 35.483 | 24.815   |         |       |
|               | 1000-meter run     | Time                | 3632.689 | 1.517  | 2393.932 | 22.584  | <.001 |
|               |                    | Error               | 4664.644 | 44.006 | 106.000  |         |       |

\*P≤ 0.05

Table 2 shows that both the experimental and control groups exhibited highly significant time effects ( $P < .001$ ) in the 50-meter sprint, standing long jump, and 1000-meter run. This indicates that the physical fitness levels of both groups improved over time, but the F-values for each indicator were larger in the experimental group, suggesting that the circuit training intervention was more effective in improving students' performance in the 50-meter sprint, standing long jump, and 1000-meter run.

**Table 3:** Comparison Of 50-Meter Sprint, Standing Long Jump, and 1000-Meter Run Performances at Different Stages in The Experimental Group Control Group (T1: Pre-Experiment Test. T2: Tested After 4 Weeks of Experiment. T3: Tested After 8 Weeks of Experiment)

| Group              | Test Project       | I vs J   | IJ        | SE    | P(Bonferroni) |
|--------------------|--------------------|----------|-----------|-------|---------------|
| Experimental group | 50-meter sprint    | T1 vs T2 | 0.259*    | 0.027 | <.001         |
|                    |                    | T2 vs T3 | 0.239*    | 0.022 | <.001         |
|                    |                    | T1 vs T3 | 0.498*    | 0.040 | <.001         |
|                    | Standing long jump | T1 vs T2 | - 11.733* | 0.967 | <.001         |
|                    |                    | T2 vs T3 | - 15.367* | 1.149 | <.001         |
|                    |                    | T1 vs T3 | - 27.100* | 1.519 | <.001         |
|                    | 1000-meter run     | T1 vs T2 | 10.300*   | 0.673 | <.001         |
|                    |                    | T2 vs T3 | 18.600*   | 0.846 | <.001         |
|                    |                    | T1 vs T3 | 28.900*   | 1.234 | <.001         |
| Control group      | 50-meter sprint    | T1 vs T2 | 0.131*    | 0.008 | <.001         |
|                    |                    | T2 vs T3 | 0.147*    | 0.032 | <.001         |
|                    |                    | T1 vs T3 | 0.278*    | 0.030 | <.001         |
|                    | Standing long jump | T1 vs T2 | -7.700*   | 0.523 | <.001         |
|                    |                    | T2 vs T3 | -11.233*  | 1.049 | <.001         |
|                    |                    | T1 vs T3 | -18.933*  | 1.289 | <.001         |
|                    | 1000-meter run     | T1 vs T2 | 4.033     | 1.697 | 0.073         |
|                    |                    | T2 vs T3 | 11.000*   | 2.260 | <.001         |
|                    |                    | T1 vs T3 | 15.033*   | 2.846 | <.001         |

\*P≤ 0.05

Table 3 shows that the experimental group using the circuit training method demonstrated sustained and highly significant improvement in all physical fitness indicators. In the 50-meter and 1000-meter races: the mean difference (I-J) was positive in both the T1-T2 and T2-T3 phases, with  $p < .001$ , indicating significant improvements in students' speed and cardiorespiratory. In the standing long jump: this indicator showed a large positive increase (a negative mean difference indicates performance improvement, e.g., the T1 vs T3 difference was -27.100 cm), and the  $p$  values for all phase comparisons were  $< .001$ , indicating that circuit training had an excellent effect on enhancing muscle power.

The control group also showed improvement in physical fitness under traditional physical training, but its rate of improvement and stability were slightly inferior to the experimental group. In the 50-meter sprint and standing long jump, the control group showed significant differences in both the T1-T2 and T2-T3 phases ( $p < .001$ ). However, in the 1000-meter endurance event, the control group did not show significant progress in the first 4 weeks of the experiment (T1 vs T2) ( $p = 0.073 > .05$ ) and only showed significant progress after 8 weeks of the experiment (T1 vs T3).

## Discussion

This study evaluated the impact of an 8-week circuit training intervention on physical fitness in grade 6 boys. Both circuit training and traditional physical training significantly improved fitness ( $P < 0.05$ ). However, circuit training demonstrated superior efficiency, particularly regarding muscle power and cardiorespiratory endurance.

The rapid progression in the 1000-meter run within 4 weeks in the experimental group-contrasting with the control group-suggests that circuit training induces faster cardiovascular adaptations. This aligns with Kosaka et al. (2025), who noted that high-intensity circuit formats facilitate more efficient aerobic threshold stimulation. Physiologically, this likely reflects enhanced mitochondrial biogenesis and capillary density resulting from sustained metabolic stress, which are less pronounced in traditional lower-intensity physical education sessions.

Regarding muscle power, the superior standing long jump performance in the experimental group ( $P < 0.05$ ) highlights specific neuromuscular adaptations. Unlike traditional physical training, the circuit training format demands rapid transitions between explosive movements, improving motor unit recruitment efficiency and the rate of force development (RFD). As Mayorga-Vega et al. (2013) and Yunus et al. (2024) suggest, this "threshold of stimulus" is critical for adolescents; our findings imply that for 6th-grade students, training intensity acts as the primary determinant for fitness optimization, effectively overcoming the adaptation plateaus often observed in traditional PE.

These findings suggest that circuit training is an optimal strategy for school-based physical education, as it maximizes fitness outcomes within the limited time available in the school curriculum.

### Limitations and Future Research Directions

This study has several limitations. First, the small sample ( $n=60$ ) from a single school limits generalizability. Second, the 8-week duration provides only short-term evidence, leaving long-term sustainability unverified. Finally, potential confounders-such as extracurricular activities and nutrition-were not strictly controlled. Future research should utilize larger, multi-site samples and longitudinal designs to assess long-term efficacy. Additionally, integrating physiological markers and qualitative measures would further elucidate the mechanisms through which circuit training enhances physical fitness in youth.

## Conclusion

In conclusion, both circuit and traditional physical training are effective methods for enhancing the physical fitness of grade 6 boys over an 8-week period. However, circuit training proves to be more efficient, particularly regarding the development of muscle power and cardiorespiratory endurance. Given its ability to yield significant improvements in a shorter timeframe, circuit training serves as an optimized and practical strategy for physical education in primary schools. Future research should consider extending the intervention duration to examine long-term adherence and the sustainability of these physical gains.

## Suggestion

Promoting the circuit training method to optimize classroom efficiency: Given the immediate advantages of circuit training in improving cardiorespiratory and explosive power, it is recommended that physical education teachers give priority to this method in the early stages of physical training or when class time is limited to achieve efficient transformation of physical fitness.

Implement progressive load monitoring: To avoid students experiencing physiological adaptation that leads to stagnation in improvement during the later stages, the difficulty and intensity of practice sites should be dynamically adjusted based on test feedback, following the principle of gradual progression to maintain continuous stimulation during training.

Balancing fun and scientific rigor: Considering the psychological characteristics of upper elementary school students, diverse equipment and competition formats should be incorporated into circuit training to enhance students' willingness to participate and their initiative in training by increasing the fun factor of the exercises.

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