



Effects of circuit training and Indian traditional games on muscular strength and muscular endurance among school students: An experimental study

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Abstract

This study compared the effects of circuit training and Indian traditional games on muscular strength and muscular endurance among school students. Sixty students were randomly assigned to a Circuit Training Group (CTG, $n = 20$), Indian Traditional Games Group (ITGG, $n = 20$), or Control Group (CG, $n = 20$). The experimental groups participated in 12-week programmes, three sessions per week. Muscular strength was assessed using the Pull-up and Flexed Arm Hang Tests, while muscular endurance was measured using the One-Minute Sit-up Test. ANCOVA was used to examine post-test differences at $p < .05$. The results showed that the CTG achieved the greatest improvements in both muscular strength and muscular endurance, followed by the ITGG, while the CG showed comparatively less improvement. The findings suggest that circuit training is highly effective, while Indian traditional games can also be a useful and enjoyable approach for improving muscular fitness among school students.

Keywords: Circuit training, Indian traditional games, muscular strength, muscular endurance, school students

Introduction

Physical fitness is an essential component of children's health and overall development, with muscular strength and muscular endurance playing a crucial role in improving functional performance, physical activity participation, and long-term well-being. Schools provide an appropriate environment for implementing structured physical activity programmes that promote these fitness components. Circuit training is a widely accepted training method because it combines multiple exercises to enhance muscular fitness efficiently, whereas Indian traditional games offer enjoyable, culturally relevant, and physically demanding activities that encourage active participation among students.

Although both circuit training and Indian traditional games have been reported to improve physical fitness, limited research has directly compared their effects on muscular strength and muscular endurance among school students. Therefore, the present study aimed to compare the effectiveness of a 12-week circuit training programme and an Indian traditional games programme on these two fitness components. It was hypothesized that both interventions would improve muscular strength and muscular endurance compared with the control group, with circuit training producing greater improvements.

Objectives of the Study

- To determine the effect of a circuit training programme on muscular strength and muscular endurance among school students.
- To determine the effect of an Indian traditional games programme on muscular strength and muscular endurance among school students.
- To compare the effects of circuit training and Indian traditional games on muscular strength and muscular endurance among school students.

Research Hypotheses

- A 12-week circuit training programme will significantly improve muscular strength among school students compared with the control group.
- A 12-week Indian traditional games programme will significantly improve muscular strength among school students compared with the control group.
- There will be a significant difference between the effects of circuit training and Indian traditional games on muscular strength among school students.
- A 12-week circuit training programme will significantly improve muscular endurance among school students compared with the control group.
- A 12-week Indian traditional games programme will significantly improve muscular endurance among school students compared with the control group.
- There will be a significant difference between the effects of circuit training and Indian traditional games on muscular endurance among school students.

Materials and Methods

1. Research Design

The present study employed a true experimental pre-test–post-test control group design to examine the effects of circuit training and Indian traditional games on muscular strength and muscular endurance among school students. Participants were randomly assigned to one of three groups: Circuit Training Group (CTG), Indian Traditional Games Group (ITGG), and Control Group (CG).

2. Participants

A total of 60 school students aged 12–14 years were selected using a random sampling technique from Vadodara, Gujarat. The participants were randomly allocated into three equal groups ($n = 20$ each): CTG, ITGG, and CG.

3. Intervention Programme

The intervention lasted 12 weeks, with training sessions conducted three days per week. The Circuit Training Group participated in a structured circuit training programme consisting of progressive exercise stations designed to improve muscular fitness. The Indian Traditional Games Group participated in selected traditional games, including Kho Kho, Kabaddi, Langdi, and Satoliya, organized to provide moderate-to-vigorous physical activity. The Control Group continued their regular school routine without participating in the intervention programme.

4. Variables of the Study

Independent Variable

The training intervention with three levels:

- Circuit Training Programme (CTG)
- Indian Traditional Games Programme (ITGG)
- Control Group (CG)

Dependent Variables

- Muscular Strength

- Muscular Endurance

5. Criteria of Measurement

Muscular Strength

Muscular strength was assessed using the Pull-up Test for boys and the Flexed Arm Hang Test for girls, following the standardized procedures recommended by the AAHPERD Youth Physical Fitness Test. The Pull-up Test measured the maximum number of correctly executed pull-ups without rest, while the Flexed Arm Hang Test measured the duration (in seconds) for which participants maintained the chin above the horizontal bar. Higher scores indicated greater upper-body muscular strength.

Muscular Endurance

Muscular endurance was assessed using the One-Minute Sit-up Test. Participants performed the maximum number of correctly executed sit-ups within 60 seconds according to standardized testing procedures. The total number of correctly completed sit-ups was recorded, with higher scores indicating better abdominal muscular endurance.

Table 1: Criteria of Measurement

Variable	Test	Unit of Measurement
Muscular Strength	Pull-up Test (Boys) / Flexed Arm Hang Test (Girls)	Number of repetitions / Seconds
Muscular Endurance	One-Minute Sit-up Test	Number of repetitions

6. Data Collection Procedure

Baseline data were collected through pre-test assessments of muscular strength and muscular endurance before the intervention. Participants were then assigned to the Circuit Training Group, Indian Traditional Games Group, or Control Group. The intervention programmes were conducted for 12 weeks (three sessions per week), after which post-test assessments were administered using the

same standardized procedures. The collected data were coded and analysed using descriptive statistics and ANCOVA to determine the effectiveness of the intervention programmes.

Results

Muscular Strength

Table 2: Descriptive Statistics for Muscular Strength

Group	N	Pre-test Mean	Pre-test SD	Post-test Mean	Post-test SD	Mean Improvement
Circuit Training Group (CTG)	20	13.05	6.85	14.50	6.83	+1.45
Indian Traditional Games Group (ITGG)	20	10.75	6.72	11.20	6.65	+0.45
Control Group (CG)	20	12.65	6.12	12.65	6.12	0.00

Note: Values are expressed as mean $\pm$ standard deviation (SD). Higher scores indicate better muscular strength

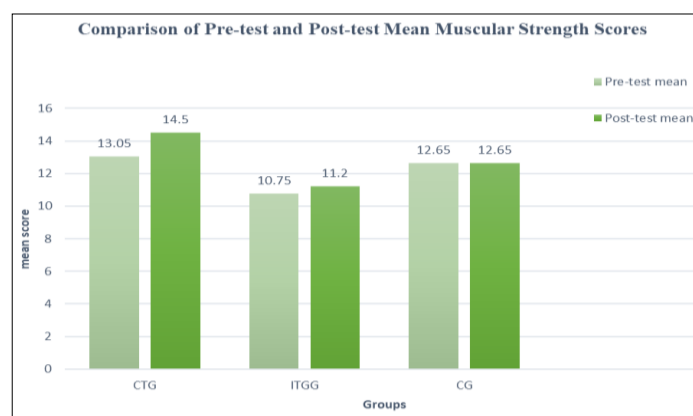


Fig 1: Comparison of Pre-test and Post-test Mean Muscular Strength Scores

Table 3: Analysis of Covariance (ANCOVA) for Muscular Strength

Source of Variation	Sum of Squares	df	Mean Square	F	p-value
Between Groups	22.126	2	11.063	63.18	< .001
Within Groups (Error)	9.806	56	0.175	—	—

Note: ANCOVA was performed using pre-test muscular strength scores as the covariate. Statistical significance was set at $p < .05$

Table 1 presents the descriptive statistics for muscular strength among the Circuit Training Group (CTG), Indian Traditional Games Group (ITGG), and Control Group (CG). The CTG demonstrated the greatest improvement, with the mean score increasing from 13.05 ± 6.85 at pre-test to 14.50 ± 6.83 at post-test (mean improvement = 1.45). The ITGG showed a moderate increase from 10.75 ± 6.72 to 11.20 ± 6.65 (mean improvement = 0.45), whereas the CG exhibited no change (12.65 ± 6.12 at both pre-test and post-test).

The ANCOVA results (Table 2) revealed a statistically significant difference among the three groups after controlling for pre-test scores ($F = 63.18, p < .001$). These findings indicate that the intervention programmes significantly influenced muscular strength, with the Circuit Training Group demonstrating superior performance compared with the other groups.

Muscular Endurance

Table 4: Descriptive Statistics for Muscular Endurance

Group	N	Pre-test Mean	Pre-test SD	Post-test Mean	Post-test SD	Mean Improvement
Circuit Training Group (CTG)	20	23.55	3.24	26.65	3.44	+3.10
Indian Traditional Games Group (ITGG)	20	22.60	3.98	24.15	4.03	+1.55
Control Group (CG)	20	22.50	3.56	22.50	3.56	0.00

Note: Values are expressed as mean $\pm$ standard deviation (SD). Higher scores indicate better muscular endurance

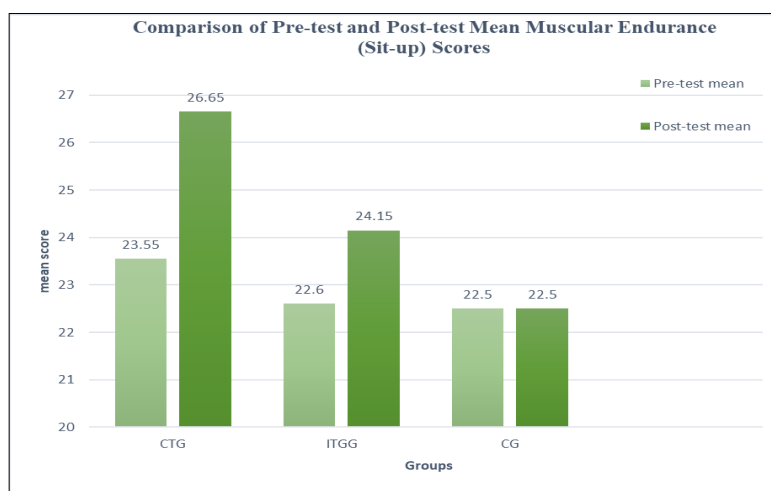


Fig 2: Comparison of Pre-test and Post-test Mean Muscular Endurance (Sit-up) Scores

Table 5: Analysis of Covariance (ANCOVA) for Muscular Endurance

Source of Variation	Sum of Squares (SS)	df	Mean Square (MS)	F-ratio	p-value
Between Groups	94.152	2	47.076	127.38	< .001
Within Groups (Error)	20.696	56	0.370	—	—

Note: Analysis of covariance (ANCOVA) was performed to compare the post-test muscular endurance scores among the Circuit Training Group (CTG), Indian Traditional Games Group (ITGG), and Control Group (CG) while controlling for pre-test muscular endurance scores. The analysis revealed a statistically significant group effect ($F(2, 56) = 127.38, p < .001$), indicating significant differences in adjusted post-test muscular endurance among the three groups. Statistical significance was established at $p < .05$

Table 3 presents the descriptive statistics for muscular endurance. The CTG recorded the highest improvement, with the mean sit-up score increasing from 23.55 ± 3.24 to 26.65 ± 3.44 (mean improvement = 3.10). The ITGG improved from 22.60 ± 3.98 to 24.15 ± 4.03 (mean improvement = 1.55), while the CG showed no change (22.50 ± 3.56 at both assessments).

The ANCOVA results (Table 4) indicated a statistically significant difference among the three groups after adjusting for baseline performance ($F = 127.38, p < .001$). The findings suggest that the intervention programmes significantly improved muscular endurance, with the Circuit Training Group achieving the greatest improvement.

Discussion

The present study examined the effects of circuit training and Indian traditional games on muscular strength and muscular endurance among school students. The findings demonstrated that both intervention programmes improved muscular fitness compared with the control group; however,

the Circuit Training Group (CTG) achieved significantly greater improvements than the Indian Traditional Games Group (ITGG). The ANCOVA results confirmed statistically significant differences among the groups for both muscular strength ($F = 63.18, p < .001$) and muscular endurance ($F = 127.38, p < .001$), indicating that the observed improvements were attributable to the intervention programmes rather than baseline differences.

The superior improvement in muscular strength observed in the CTG may be attributed to the structured and progressive nature of circuit training. The programme incorporated body-weight and resistance exercises that progressively overloaded the muscles, stimulating neuromuscular adaptations and enhancing force-generating capacity. In contrast, although Indian traditional games involve movements such as running, chasing, jumping, and pulling, these activities are primarily game-oriented and do not provide the same systematic overload required for maximizing muscular strength development. Nevertheless, the significant improvement observed in the ITGG suggests

that traditional games can contribute positively to muscular fitness while simultaneously promoting enjoyment and active participation among school students.

Similarly, the CTG demonstrated the greatest improvement in muscular endurance, followed by the ITGG, whereas the Control Group showed no meaningful change. Circuit training involves repeated performance of multiple exercise stations with minimal recovery, thereby increasing muscular endurance through enhanced local muscular efficiency and resistance to fatigue. Indian traditional games also improved muscular endurance because participants performed repeated functional movements throughout the games; however, the intensity and progression of these activities were less structured than those of the circuit training programme. These findings suggest that although both interventions are effective, circuit training provides a more targeted stimulus for improving muscular endurance.

Overall, the findings of the present study indicate that circuit training is a more effective intervention for enhancing muscular strength and muscular endurance among school students. At the same time, Indian traditional games remain a valuable approach for school physical education because they improve muscular fitness while preserving cultural relevance, increasing student engagement, and encouraging regular participation in physical activity. Incorporating both approaches within school physical education programmes may therefore provide a balanced strategy for improving students' physical fitness and promoting lifelong participation in physical activity.

Conclusion

The present study concludes that both circuit training and Indian traditional games significantly improve muscular strength and muscular endurance among school students. However, circuit training was more effective than Indian traditional games in enhancing both fitness components. These findings support the integration of structured circuit training into school physical education programmes while also recognizing the educational and cultural value of Indian traditional games as an enjoyable and effective form of physical activity.

Practical Implications

- Circuit training can be implemented as an effective strategy for improving muscular strength and muscular endurance in school physical education.
- Indian traditional games provide a low-cost, enjoyable, and culturally relevant method for enhancing muscular fitness and increasing student participation.
- Integrating circuit training with Indian traditional games may help schools improve students' physical fitness while promoting engagement, teamwork, and lifelong physical activity.

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