

Impact of Circuit, Resistance and Combined Training on Speed, Speed Endurance, Explosive Power and Muscular Endurance Among School Boys

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Abstract—The present study investigated the effects of circuit training, resistance training, and combined training on selected physical fitness variables among school boys. A total of 60 school boys aged 15–17 years from R.S. Government Higher Secondary School, Paramakudi, Tamil Nadu, were selected and randomly assigned into four equal groups: circuit training group, resistance training group, combined training group, and control group. The experimental groups underwent their respective training programmes for 12 weeks, while the control group continued routine activities without any special training intervention. The selected physical fitness variables were speed, speed endurance, explosive power, and muscular endurance. Speed was assessed using the 50 m dash, speed endurance through the 300 m run, explosive power through the standing broad jump, and muscular endurance through sit-ups. Pre-test and post-test data were collected before and after the intervention period. The data were analysed using analysis of covariance, and Scheffe's post hoc test was applied wherever significant differences were found. The results revealed significant improvements in all selected physical fitness variables among the experimental groups when compared with the control group. Among the three training methods, combined training produced the most favourable improvement in speed, speed endurance, explosive power, and muscular endurance. The findings suggest that integrating circuit training with resistance training provides a more comprehensive stimulus for improving physical fitness among school boys. Therefore, combined training may be recommended as an effective, practical, and school-friendly training approach for enhancing overall motor fitness and physical performance in adolescent boys.

Keywords: Circuit Training, Resistance Training, Combined Training, Physical Fitness, School Boys, Speed, Explosive Power, Muscular Endurance.

I. INTRODUCTION

Physical fitness during adolescence is an important foundation for health, sports performance, and lifelong participation in physical activity. School

boys between 15 and 17 years are in a critical stage of growth and neuromuscular development, where structured training can positively influence motor performance, muscular function, and movement efficiency. The World Health Organisation recommends that children and adolescents should participate in regular moderate-to-vigorous physical activity and include muscle- and bone-strengthening activities at least three days per week (Bull et al., 2020; World Health Organisation, 2024). These recommendations highlight the importance of planned exercise programmes in school settings, especially for improving physical fitness components such as speed, endurance, strength, power, and muscular endurance.

Among the different components of physical fitness, speed, speed endurance, explosive power, and muscular endurance are highly relevant for school boys because these qualities support both general fitness and sports performance. Speed is essential for performing rapid movements within a short duration, while speed endurance helps an individual sustain high-intensity movement despite fatigue. Explosive power reflects the ability to generate force quickly and is closely related to sprinting, jumping, and many sport-specific movements. Muscular endurance enables repeated muscular contractions over time and supports sustained performance during physical activity. In the present thesis, these four physical variables were selected as major outcome measures and assessed through standardised field tests, namely the 50 m dash, 300 m run, standing broad jump, and sit-ups.

Recent evidence suggests that supervised and structured exercise interventions can produce meaningful improvements in children and adolescents. Pinho et al. (2024), in a meta-analysis on physical fitness trainability, reported that structured

exercise can improve muscular strength, cardiorespiratory fitness, muscular power, and speed-related outcomes among children and adolescents. Similarly, León-Reyes et al. (2025) observed that strength training in school-age children can enhance physical and motor performance variables, supporting the inclusion of strength-based activities in educational and developmental settings. These findings indicate that well-planned training programmes can be useful not only for athletes but also for general school populations.

Circuit training is one of the practical methods used in schools and sports settings because it combines multiple exercises in a sequence, usually with limited rest between stations. This method can improve several fitness components within a single training session and can be easily modified according to age, ability, and training goal. Marinho et al. (2022) reported that high-intensity circuit training performed during school physical education classes produced significant improvements in muscular fitness performance among children. Therefore, circuit training may be considered an effective and time-efficient approach for improving physical fitness among school boys.

Resistance training has also gained strong scientific support for youth fitness development. Earlier concerns regarding resistance training for children and adolescents have been largely addressed through evidence showing that properly designed and supervised resistance training can improve health, fitness, and sports performance (Faigenbaum et al., 2009). More recent work by Faigenbaum et al. (2023) emphasised that youth resistance training can improve sprinting, jumping, throwing, agility, muscular strength, and movement skill performance when it is delivered with qualified instruction and progressive technique-based loading. Thus, resistance training is now considered an important component of youth physical development.

A combined training approach may provide additional benefits because it integrates the conditioning effect of circuit training with the strength and neuromuscular benefits of resistance training. Such an approach can target multiple fitness qualities simultaneously, including speed, muscular endurance, explosive power, and overall motor performance. Recent reviews suggest that combined and multicomponent training programmes may be

highly effective for improving physical and motor performance in young populations (León-Reyes et al., 2025; Pinho et al., 2024). This is particularly relevant in school settings, where training time is limited, and programmes must be practical, safe, and effective.

Although several studies have examined circuit training and resistance training separately, fewer studies have directly compared circuit training, resistance training, and combined training among school boys using multiple physical fitness variables. Therefore, the present study was designed to investigate the effect of circuit training, resistance training, and combined training on selected physical fitness variables among school boys. The selected variables were speed, speed endurance, explosive power, and muscular endurance. The findings of this study may help physical education teachers, coaches, and trainers identify suitable training methods for improving physical fitness among school-level boys.

II. METHODOLOGY

Study Design

The present study adopted a pre-test and post-test experimental design to examine the effects of three different training methods on selected physical fitness variables among school boys. The independent variables were circuit training, resistance training, and combined training, while the dependent variables were speed, speed endurance, explosive power, and muscular endurance. The study included three experimental groups and one control group. Pre-test scores were recorded before the training period, and post-test scores were recorded after the completion of the 12-week intervention.

Participants

The participants were selected from R.S. Government Higher Secondary School, Paramakudi, Tamil Nadu. Initially, 120 male students were screened, and finally, 60 schoolboys aged between 15 and 17 years were selected for the study. The selected participants were randomly divided into four equal groups consisting of 15 participants each. Group I underwent circuit training, Group II underwent resistance training, Group III underwent combined circuit and resistance training, and Group IV served as the control group.

Grouping of Participants

Group	Training Condition	Number of Participants
Group I	Circuit Training	15
Group II	Resistance Training	15
Group III	Combined Training	15
Group IV	Control Group	15

Selection of Variables

For the present article, only the physical fitness variables from the thesis were considered. The selected physical variables were speed, speed endurance, explosive power, and muscular endurance. These variables were chosen based on their relevance to school-level physical fitness and sports performance.

Criterion Measures

The following tests were used to assess the selected physical fitness variables:

Variable	Test Item	Unit of Measurement
Speed	50 m Dash	Seconds
Speed Endurance	300 m Run Test	Seconds
Explosive Power	Standing Broad Jump	Metres
Muscular Endurance	Sit-ups	Counts per minute

These tests were used as the criterion measures for evaluating the physical fitness performance of the participants before and after the training intervention.

Training Intervention

The training programme was conducted for a period of 12 weeks. The experimental groups underwent their respective training programmes on alternate days, while the control group did not participate in any special training programme other than their regular routine activities. The training sessions included warm-up, training activities, and cool-down.

The circuit training group performed selected body-weight and conditioning exercises such as press-ups, prone trunk extensions, reverse abdominal curls, sit-ups, V sit-ups, skipping, abdominal crunches, high bench step-up with jumps, high-knee sprints, and

jumping jacks. The programme progressed gradually in intensity across the training period.

The resistance training group performed selected resistance-based drills such as leg abduction, leg adduction, plank, side plank, short-arc squats, straight-leg raises, wall shin raises, heel step-downs, arm raises, and internal and external rotation exercises. The resistance training load was progressively increased during the intervention period.

The combined training group performed a combination of circuit training and resistance training exercises. This group included five circuit training exercises and five resistance training exercises arranged in a combined format. The combined training was performed on alternate days for 12 weeks, with progression adapted every four weeks.

Collection of Data

The data were collected before and after the 12-week training programme. The pre-test was conducted at the beginning of the experimental period, and the post-test was conducted after the completion of the training intervention. All measurements were recorded carefully in their respective units. The same testing procedures were followed during both pre-test and post-test to maintain consistency.

Reliability of Tests

The reliability of the test scores was established through the test-retest method. The intra-class correlation coefficients reported for the physical fitness variables showed acceptable reliability: speed = 0.89, speed endurance = 0.92, explosive power = 0.88, and muscular endurance = 0.96. These values indicate that the selected tests were reliable for assessing the physical fitness variables used in the study.

Statistical Analysis

The collected data were statistically analysed using analysis of covariance (ANCOVA) to determine the significant differences among the adjusted post-test means of the groups. When the obtained F-ratio was found to be significant, Scheffe's post hoc test was applied to identify the specific paired mean differences. The level of significance was fixed at 0.05.

III. RESULTS

The data obtained from the four groups were analysed using analysis of covariance (ANCOVA). When the adjusted post-test means were significant, Scheffe's post hoc test was used to identify the paired

mean differences. The level of significance was fixed at 0.05. In this article, the results are presented only for the selected physical fitness variables: speed, speed endurance, explosive power, and muscular endurance.

Table 1: Pre-test, post-test and adjusted post-test means of selected physical fitness variables

Variable	Group	Pre-test Mean ± SD	Post-test Mean ± SD	Adjusted Post-test Mean
Speed	Circuit Training	7.7207 ± 0.31269	7.3507 ± 0.32043	7.374
	Resistance Training	7.7293 ± 0.47308	7.4200 ± 0.41290	7.436
	Combined Training	7.7273 ± 0.43856	7.3073 ± 0.36056	7.325
	Control Group	7.8213 ± 0.19849	7.8293 ± 0.21506	7.8293
Speed Endurance	Circuit Training	63.40 ± 5.2071	53.667 ± 3.132	53.468
	Resistance Training	63.33 ± 4.9086	54.000 ± 3.316	53.835
	Combined Training	63.20 ± 4.6629	52.600 ± 1.9566	52.501
	Control Group	62.066 ± 5.25719	62.4667 ± 5.22175	62.929
Explosive Power	Circuit Training	2.124 ± 0.09912	2.3387 ± 0.14618	2.346
	Resistance Training	2.1487 ± 0.09125	2.4487 ± 0.22226	2.430
	Combined Training	2.1287 ± 0.01882	2.4873 ± 0.20991	2.489
	Control Group	2.1213 ± 0.01759	2.1080 ± 0.07523	2.118
Muscular Endurance	Circuit Training	25.1333 ± 1.8464	30.860 ± 2.722	30.729
	Resistance Training	25.000 ± 1.96396	31.333 ± 2.225	31.288
	Combined Training	25.0667 ± 1.4864	32.133 ± 2.1995	32.042
	Control Group	24.533 ± 1.8847	24.000 ± 1.4638	24.174

Note: For speed and speed endurance, lower values indicate better performance because the scores are measured in seconds. For explosive power and muscular endurance, higher values indicate better performance.

Table 2: ANCOVA summary for selected physical fitness variables

Variable	Pre-test F-ratio	Post-test F-ratio	Adjusted Post-test F-ratio	Result
Speed	0.249	7.66*	26.646*	Significant
Speed Endurance	0.235	24.052*	50.614*	Significant
Explosive Power	0.327	14.476*	17.233*	Significant
Muscular Endurance	0.34	43.83*	56.23*	Significant

*Significant at 0.05 level.

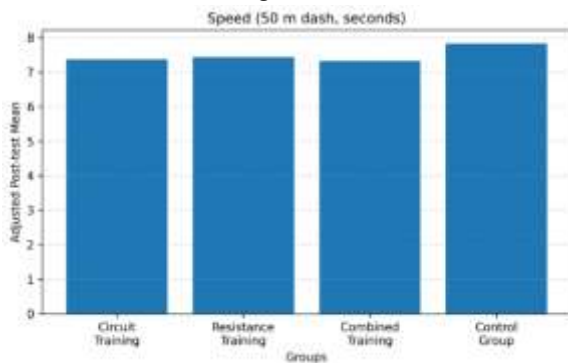
The ANCOVA results showed that there was no significant difference among the groups at the pre-test level, indicating that the groups were nearly equal before the training intervention. However, the post-test and adjusted post-test F-ratios were significant for all four physical fitness variables. This shows that the training interventions produced significant changes in speed, speed endurance, explosive power, and muscular endurance among school boys.

training group, 7.325 for the combined training group, and 7.8293 for the control group. Since speed was measured in seconds, the lower mean value indicates better performance. The combined training group showed the best improvement in speed, followed by the circuit training group and resistance training group. The adjusted post-test F-ratio of 26.646 was significant at the 0.05 level, indicating a significant difference among the groups.

Results on Speed

The adjusted post-test means for speed were 7.374 for the circuit training group, 7.436 for the resistance

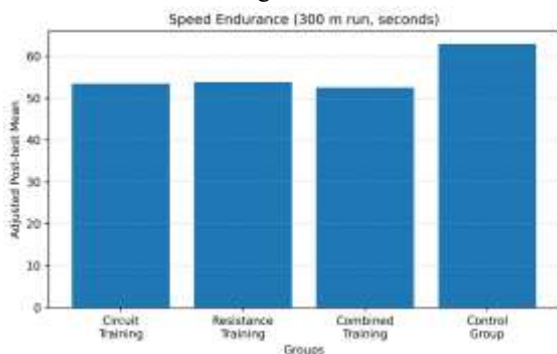
Figure 1:



Results on Speed Endurance

The adjusted post-test means for speed endurance were 53.468 for the circuit training group, 53.835 for the resistance training group, 52.501 for the combined training group, and 62.929 for the control group. Since speed endurance was measured in seconds, the lower score reflects better performance. The combined training group recorded the best performance, followed by the circuit training group and the resistance training group. The adjusted post-test F-ratio of 50.614 was significant at the 0.05 level, showing a significant difference among the groups.

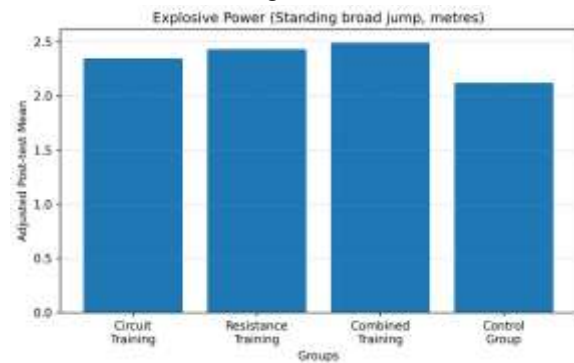
Figure 2:



Results on Explosive Power

The adjusted post-test means for explosive power were 2.346 m for the circuit training group, 2.430 m for the resistance training group, 2.489 m for the combined training group, and 2.118 m for the control group. Since explosive power was measured through standing broad jump distance, a higher value indicates better performance. The combined training group showed the highest improvement in explosive power. The adjusted post-test F-ratio of 17.233 was significant at the 0.05 level, indicating a significant difference among the groups.

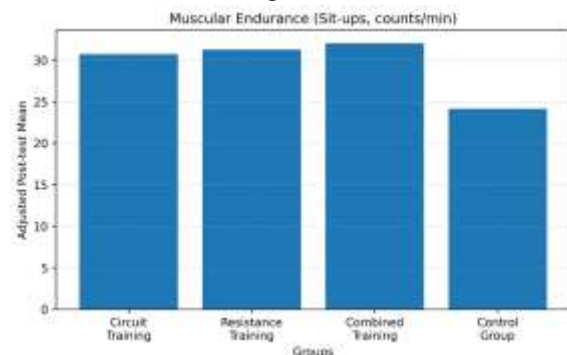
Figure 3:



Results on Muscular Endurance

The adjusted post-test means for muscular endurance were 30.729 for the circuit training group, 31.288 for the resistance training group, 32.042 for the combined training group, and 24.174 for the control group. Since muscular endurance was measured by sit-ups per minute, a higher value indicates better performance. The combined training group showed the highest adjusted post-test mean, followed by the resistance training group and circuit training group. The adjusted post-test F-ratio of 56.23 was significant at the 0.05 level, showing a significant difference among the groups.

Figure 4:



The findings clearly indicate that circuit training, resistance training, and combined training significantly improved the selected physical fitness variables among school boys when compared with the control group. Among the three training interventions, combined training produced the most favourable adjusted post-test means in speed, speed endurance, explosive power, and muscular endurance. Therefore, combined training may be considered more effective for improving overall physical fitness among school boys.

IV. DISCUSSION

The purpose of the present study was to examine the effect of circuit training, resistance training, and combined training on selected physical fitness variables among school boys. The findings revealed that all three experimental training groups showed significant improvement in speed, speed endurance, explosive power, and muscular endurance when compared with the control group. However, the combined training group produced the most favourable improvement across the selected physical variables. This suggests that integrating circuit-based conditioning with resistance-based exercises may provide a broader and more effective training stimulus for adolescent school boys than using either method alone. The thesis data showed that the selected physical variables were speed, speed endurance, explosive power, and muscular endurance, measured through the 50 m dash, 300 m run, standing broad jump, and sit-ups test respectively.

The significant improvement in speed may be due to better neuromuscular coordination, improved stride efficiency, enhanced lower-limb strength, and repeated exposure to fast movement patterns during the training period. Speed development in adolescents is strongly influenced by the nervous system's ability to recruit motor units rapidly and coordinate body segments efficiently. In the present study, the combined training group recorded the best adjusted post-test mean for speed, indicating that the combination of resistance exercises and circuit-based activities may have improved both force production and movement quickness. This finding is consistent with Faigenbaum et al. (2009), who stated that properly designed resistance training can improve motor skill performance and sports performance in youth. It is also supported by Pinho et al. (2024), who reported that supervised and structured exercise programmes can improve muscular strength, muscular power, and speed-related fitness outcomes in children and adolescents.

The improvement observed in speed endurance may be explained by the repeated performance of dynamic exercises with limited rest intervals, especially in the circuit and combined training groups. Speed endurance requires the ability to maintain high-

intensity movement despite fatigue. Circuit training may have contributed to this adaptation by exposing the participants to continuous movement demands, while resistance training may have supported better muscular force and fatigue tolerance. Marinho et al. (2022) observed that high-intensity circuit training performed during school physical education classes improved muscular fitness performance in children, which supports the present finding. In the current study, the combined training group showed the lowest adjusted mean in the 300 m run, indicating better speed endurance performance because lower time reflects better performance.

The significant improvement in explosive power may be attributed to enhanced lower-limb strength, improved rate of force development, and better coordination between strength and speed components. Explosive power is essential for jumping, sprinting, and many sport-specific movements. The standing broad jump performance was highest in the combined training group, followed by the resistance training group and circuit training group. This pattern indicates that resistance-based exercises may have played an important role in improving force production, while circuit training may have added movement efficiency and dynamic conditioning. Granacher et al. (2016) reported that resistance training improves muscular fitness and athletic performance in youth athletes, while Luo et al. (2025) found that strength and plyometric-type training methods are effective for improving jump and sprint performance in adolescent athletes. The present findings are in line with this evidence, as combined training produced the greatest improvement in explosive power.

Muscular endurance also improved significantly among the experimental groups. The improvement in sit-up performance may be due to repeated trunk and abdominal muscle activation during the training programme. Circuit training usually involves repeated body-weight movements, whereas resistance training improves muscular strength and contraction efficiency. When these two methods are combined, they may increase the ability of muscles to perform repeated contractions for a longer duration. The combined training group recorded the highest adjusted post-test mean for muscular endurance, suggesting that combined training was more effective in improving repeated muscular effort. León-Reyes et al. (2025) reported that strength training improves

physical and motor performance variables in school-age children, while Pinho et al. (2024) also confirmed that structured exercise programmes improve muscular fitness in children and adolescents.

The superiority of combined training in the present study may be explained through the principle of multi-component adaptation. Circuit training primarily improves movement continuity, general conditioning, coordination, and fatigue resistance, while resistance training improves strength, force production, and muscular control. When both are integrated into a single programme, the participants receive both metabolic and neuromuscular benefits. This type of combined stimulus is especially suitable for school boys because adolescent fitness development requires balanced improvement in strength, speed, power, endurance, and coordination. Cui et al. (2026) also reported that concurrent training can improve lower-body explosive power and aerobic capacity in children and adolescents without producing a negative interference effect when training frequency is appropriate.

The findings also highlight the practical value of structured training in school settings. Since the participants were schoolboys aged 15–17 years and the intervention was conducted for 12 weeks, the results suggest that properly planned training programmes can produce meaningful improvements within a school-based population. The control group showed comparatively lower improvement, indicating that regular routine activities alone may not be sufficient to produce the same level of physical fitness development. This supports the view that school physical education programmes should include systematic and progressive exercise methods rather than relying only on general activity. Pinho et al. (2024) emphasised that structured and supervised physical exercise can be applied in school physical education, sports training, and health promotion contexts to improve physical fitness among children and adolescents.

Overall, the results of the present study indicate that circuit training, resistance training, and combined training were effective in improving selected physical fitness variables among school boys. However, combined training produced the most consistent improvement in speed, speed endurance, explosive power, and muscular endurance. Therefore, a combined programme of circuit and resistance

training may be recommended for physical education teachers, coaches, and trainers who aim to improve overall physical fitness among school boys.

V. CONCLUSION

The present study concluded that circuit training, resistance training, and combined training significantly improved selected physical fitness variables among school boys. Among the three methods, combined training produced the greatest improvement in speed, speed endurance, explosive power, and muscular endurance, indicating its superior effectiveness for overall physical fitness development. Therefore, a well-planned combination of circuit and resistance training can be recommended as a practical and effective training approach for school boys. Future studies may be conducted with larger samples, female students, different age groups, and sport-specific populations. Further research may also examine long-term training effects, different training durations, and additional variables such as agility, balance, coordination, body composition, and psychological performance.

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