RESEARCH JOURNAL ON PHYSICAL EDUCATION AND SPORTS (RJPES)
ISSN: 0975-4687 | Volume 19, Issue 2 (September 2025) | Peer-Reviewed
Journal No: RJPES-2026-1285

THE EFFECTS OF COMBINED COMPLEX AND CLOSED KINETIC CHAIN TRAINING VERSUS TRADITIONAL CONDITIONING ON COLLEGE STUDENTS' FITNESS PROFILES

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This study examined the impact of an 8-week combined program of Complex Training and Closed Kinetic Chain exercises, compared with traditional conditioning, on specific fitness parameters in college athletes. 30 male students aged 19 to 22 were randomly assigned to an Experimental Group (15) and a Control Group (15). The experimental group followed a structured training regimen involving heavy-to-light complex training with multi-joint closed-kinetic-chain exercises three times weekly, while the control group maintained usual conditioning routines. Performance was measured through standardized tests for speed (40 m sprint), muscular endurance (sit-ups), upper-body explosive power (medicine ball throw), flexibility (sit-and-reach), and lower-body explosive power (standing broad jump). Statistical analyses, including independent t-tests, ANCOVA, and effect size estimates, demonstrated significant gains in the experimental group across speed, muscular endurance, and explosive power, with large-to-very large effect sizes for the primary performance metrics. Flexibility, however, did not show notable differences between groups. The results indicate that combining Complex Training with Closed Kinetic Chain exercises enhances neuromuscular performance more effectively than conventional conditioning, especially for speed and power development in collegiate athletes. Keywords: Complex Training, Closed Kinetic Chain, Explosive Power, Strength and Conditioning.

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This study examined the impact of an 8-week combined program of Complex Training and Closed Kinetic Chain exercises, compared with traditional conditioning, on specific fitness parameters in college athletes. 30 male students aged 19 to 22 were randomly assigned to an Experimental Group (15) and a Control Group (15). The experimental group followed a structured training regimen involving heavy-to-light complex training with multi-joint closed-kinetic-chain exercises three times weekly, while the control group maintained usual conditioning routines. Performance was measured through standardized tests for speed (40 m sprint), muscular endurance (sit-ups), upper-body explosive power (medicine ball throw), flexibility (sit-and-reach), and lower-body explosive power (standing broad jump). Statistical analyses, including independent t-tests, ANCOVA, and effect size estimates, demonstrated significant gains in the experimental group across speed, muscular endurance, and explosive power, with large-to-very large effect sizes for the primary performance metrics. Flexibility, however, did not show notable differences between groups. The results indicate that combining Complex Training with Closed Kinetic Chain exercises enhances neuromuscular performance more effectively than conventional conditioning, especially for speed and power development in collegiate athletes.

Keywords: Complex Training, Closed Kinetic Chain, Explosive Power, Strength and Conditioning.

INTRODUCTION

Developing explosive power, movement speed, and efficient movement has become a central focus in modern athletic training, particularly in college sports. Coaches and sports scientists continually seek training techniques that enhance both strength and sport-specific movement skills. Traditional resistance training primarily aims to increase muscle strength, whereas modern, performance-oriented approaches incorporate velocity-based and neuromuscular methods that address the full force-velocity spectrum (Bompa & Buzzichelli, 2019; Suchomel, Nimphius, & Stone, 2016). In this framework, training strategies that integrate strength, power, stability, and coordination are increasingly valued in both research and practice. Notably, Complex Training and Closed Kinetic Chain exercises are widely recognized for their effectiveness in boosting athletic performance.

Complex Training blends high-load resistance exercises with similar plyometric or explosive movements in the same session (Docherty, Robbins, & Hodgson, 2004). For instance, heavy squats might be followed immediately by jump squats or depth jumps. The physiological basis of Complex Training is often linked to Post-Activation Performance Enhancement. This phenomenon occurs when a heavy muscle contraction temporarily boosts subsequent explosive actions. This effect is likely due to increased motor unit recruitment, better neuromuscular coordination, higher muscle temperature, and enhanced phosphorylation of myosin regulatory light chains (Tillin & Bishop, 2009; Blazevich & Babault, 2019). Research shows that Complex Training can significantly improve the rate of force development, sprinting speed, jumping ability, and overall power output in trained athletes (Seitz & Haff, 2016).

Closed Kinetic Chain exercises are also vital in functional athletic conditioning. In these exercises, the distal part of the limb remains fixed against a surface or resistance, as in squats, lunges, push-ups, and step-ups. These movements promote coordinated multi-joint patterns, improve proprioceptive feedback, and encourage co-contraction of agonist and antagonist muscles, which enhances joint stability and neuromuscular control (Escamilla et al., 2012). Closed Kinetic Chain exercises also lead to better core stability, balance, and functional force transfer—all essential for moving effectively in sports and preventing injuries (Kisner & Colby, 2017). Since many sports actions take place in weight-bearing positions, these exercises closely mirror the physical demands of competitive performance.

While previous research has examined the benefits of Complex Training and Closed Kinetic Chain exercises separately, few studies have explored combining these methods in a single conditioning program. Combining Complex Training with Closed Kinetic Chain exercises could provide a stronger stimulus by increasing neuromuscular power while improving movement stability. The neural activation from Post-Activation Performance Enhancement might work well with the structural and proprioceptive benefits of Closed Kinetic Chain exercises, resulting in better athletic performance. This integrated approach could be especially beneficial for college athletes who need a balance of strength, speed, coordination, and effective movement to succeed.

This study aimed to compare the effects of an integrated training program of Complex Training and Closed Kinetic Chain exercises against traditional conditioning exercises on physical and physiological performance measures in college athletes. It focused on changes in speed, explosive power, flexibility, and core endurance after an eight-week training program. The hypothesis was that athletes participating in the combined training would show significantly larger improvements in performance measures than those using standard training methods.

METHODOLOGY

This study employed a randomized pre-test-post-test experimental design to compare an 8-week Complex Training program with Closed Kinetic Chain exercises against traditional conditioning in college athletes. Thirty male athletes were divided into experimental and control groups, and performance was assessed using standardized fitness tests before and after the intervention to measure training effects.

Experimental Approach to the Problem

This study used a randomized parallel-group design with pre- and post tests to assess the effects of specific athletic training interventions on physiological and motor performance. It compared an integrated Complex Training and Closed Kinetic Chain program against a traditional conditioning routine over eight weeks. The independent variable was the type of training, while the repeated measures included pre-test and post-test assessments.

The dependent variables consisted of specific anthropometric traits and fitness components linked to athletic performance. These included body height, body weight, and five standardized motor tests: the 40-meter sprint for speed and acceleration, the sit-up test for muscular endurance, the medicine ball throw for upper-body explosive power, the sit-and-reach test for flexibility, and the standing broad jump for lower-body explosive strength and reactive power. The study aimed to assess whether the combined intervention would yield greater improvements in athletic performance than traditional training methods.

Participants

30 healthy male college athletes voluntarily participated in this study. All were actively involved in collegiate sports and had at least one year of structured resistance training before the study began. To ensure safety and uniformity in training, participants were screened based on specific inclusion criteria. Athletes with any recent neuromuscular disorders, metabolic diseases, or musculoskeletal injuries in the six months before the baseline assessment were excluded.

After screening, participants were randomly assigned to two equal groups: an Experimental Combination Group (n = 15) that underwent the integrated Complex Training and Closed Kinetic Chain exercise program, and a Control Group (n = 15) that followed a traditional conditioning routine. Before data collection, all participants received a detailed explanation of the study's objectives, procedures, potential risks, and benefits. Written informed consent was obtained from each participant before baseline testing began.

Testing Protocols

All physical and performance variables were measured during two identical evaluation phases at Week 0 (pre-test) and Week 9 (post-test). To ensure reliability and minimize fatigue effects, assessments were conducted over three consecutive days under consistent environmental conditions between 07:00 AM and 10:00 AM. Anthropometric measurements included body height, recorded with a wall-mounted stadiometer, and body weight, measured with a calibrated digital scale, to the nearest 0.1 cm and 0.1 kg. Speed and acceleration were evaluated with a 40-meter sprint test, in which participants completed three maximal trials from a standing start, and the best result was used for analysis. Core muscular endurance was assessed with a 60-second sit-up test, and the highest number of correct repetitions was recorded. Upper-body explosive power was measured with a seated 2 kg medicine ball chest throw, and the furthest distance among three attempts was recorded in meters. Flexibility of the lower back and hamstrings was assessed using the sit-and-reach test, and the best score from three trials was recorded in centimeters. Lower-body explosive power was assessed with the standing broad jump, in which participants performed three maximum horizontal jumps, and the longest distance was used for analysis.

Table 1. *Description of Testing Variables and Measurement Procedures*

Variable	Test Used	Unit of Measurement	Performance Component
Height	Stadiometer Measurement	Centimeters (cm)	Anthropometric Variable
Weight	Digital Weighing Scale	Kilograms (kg)	Anthropometric Variable
Speed & Acceleration	40-Meter Sprint Test	Seconds (sec)	Speed Performance
Muscular Endurance	60-Second Sit-Up Test	Number of Repetitions	Core Endurance
Upper Body Explosive Power	Medicine Ball Throw (2 kg)	Meters (m)	Explosive Strength
Flexibility	Sit-and-Reach Test	Centimeters (cm)	Flexibility
Lower Body Explosive Power	Standing Broad Jump	Meters (m)	Explosive Power

Table 1 outlines the variables, tests, and units used to assess participants' anthropometric and performance characteristics. Height and weight were measured using standard instruments. At the same time, speed, endurance, explosive power, and flexibility were assessed using validated field tests, including the 40-meter sprint, sit-ups, medicine ball throw, sit-and-reach, and standing broad jump. Overall, these measures provide a simple and reliable profile of the athletes' physical fitness.

Training Interventions

The experimental cohort completed an 8-week intervention meeting three times per week on alternating days (Mondays, Wednesdays, and Fridays) for approximately 60–75 minutes per session. Each session began with a 10-minute dynamic mobility warmup and concluded with a 5-minute structural static cool-down.

The core protocol combined high-load structural compound movements with explosive closed-kinetic-chain variations. For example, a lower-body sequence paired a heavy back squat (3–5 reps at 80–85% 1RM) with an explosive plyometric jump variation (5–6 reps of depth jumps or explosive bodyweight squats) to leverage Post-Activation Performance Enhancement mechanisms. Upper-body sequences paired heavy bench-press loads with explosive plyometric push-ups. The control group performed standard physical conditioning routines, including calisthenics, moderate-intensity aerobic running, and generalized low-resistance circuit variations, maintaining the same total weekly training volume and duration but without the structured heavy-to-light complex pairs.

ANALYSIS AND RESULTS

The data collected in this study were analyzed to examine differences between the experimental and control groups from pre-test to post-test. Descriptive statistics, such as the mean and standard deviation, were used to summarize performance variables, while inferential tests were used to determine the significance of changes following the intervention. The analysis focused on identifying improvements in anthropometric and physical fitness components resulting from the training program.

Table 2. *Independent Samples t-Test of (Post–Pre) Differences Between Combination Training and Control Groups for Selected Performance Variables*

Dependent Performance Variable	Combination Pre	Combination Post	Control Pre	Control Post	Mean Difference	*t*-value	df	*p*-value
40M Sprint (s)	6.11	6.04	5.99	6.03	-0.108	-4.016	24.96	0.0004*
Sit-Ups (reps)	45.00	46.13	45.07	44.87	+1.333	2.082	26.55	0.0471*
Medicine Ball Throw (m)	4.59	4.67	4.65	4.65	+0.075	2.561	27.94	0.0181*
Sit & Reach (cm)	32.27	32.53	34.73	34.73	+0.267	0.636	27.35	0.5317
Standing Broad Jump (m)	2.22	2.30	2.20	2.21	+0.069	4.956	26.24	0.0001*

*Significant at $p < 0.05$

Table 2 shows that the experimental group (Combination Training) demonstrated greater improvements across most performance variables than the control group. Significant differences were observed in 40 m sprint, sit-ups, medicine ball throw, and standing broad jump ($p < 0.05$), indicating superior gains in speed, muscular endurance, upper-body power, and lower-body explosive strength following the intervention. However, flexibility (sit-and-reach) did not differ significantly between groups.

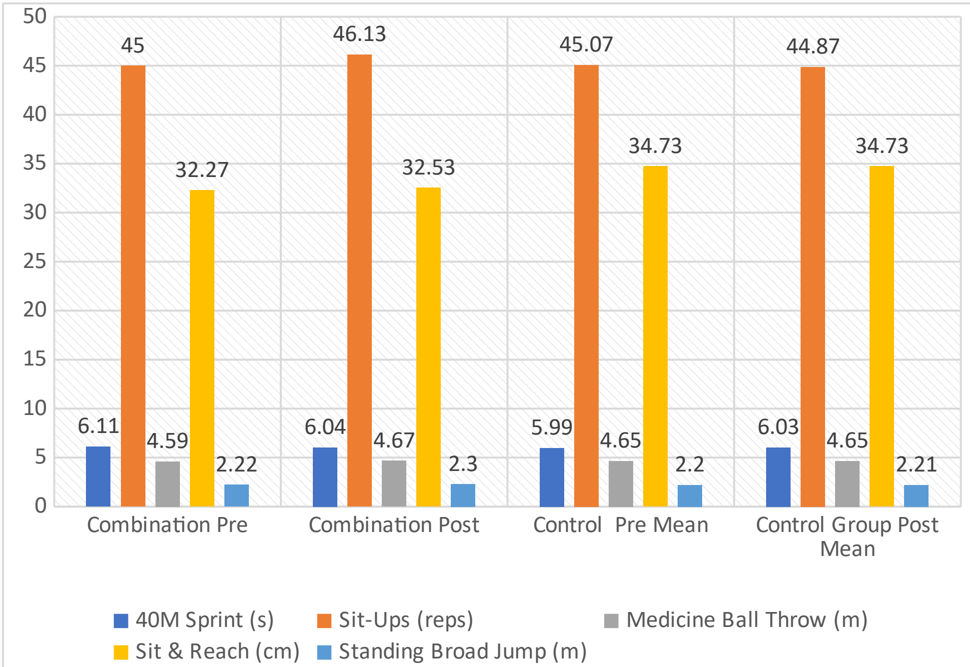

Figure 1. *Post- and Pre- Between-Group Comparison of Combination Training and Control Groups for Selected Performance Variables*

Table 3 *ANCOVA Summary for Adjusted Post-Test Scores Between Combination and Control Groups*

Variable	Combination Adjusted Post Mean	Control Adjusted Post Mean	Mean Difference	F-value	*p*-value
40M Sprint (s)	6.04	6.03	-0.108	16.13	0.0004*
Sit-Ups (reps)	46.13	44.87	+1.333	4.33	0.0471*
Medicine Ball Throw (m)	4.67	4.65	+0.075	6.56	0.0181*
Sit & Reach (cm)	32.53	34.73	+0.267	0.40	0.5317
Standing Broad Jump (m)	2.30	2.21	+0.069	24.56	0.0001*

*Significant at $p < 0.05$

Table 3 presents the ANCOVA results of adjusted post-test scores between the Combination Training and Control groups. The findings reveal that the experimental group showed significantly better performance in 40 m sprint, sit-ups, medicine ball throw, and standing broad jump ($p < 0.05$), indicating that the training intervention had a strong positive effect on speed, endurance, and explosive power even after adjusting for baseline differences. However, no significant difference was observed in flexibility (sit-and-reach), suggesting that both training methods had similar effects on this variable.

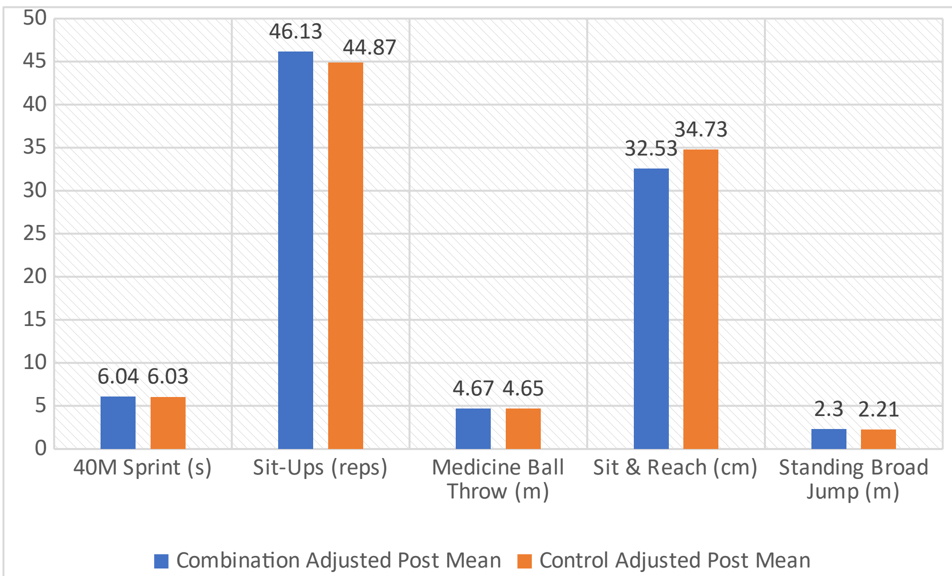

Figure 2: *Adjusted Post-Test Scores Between Combination and Control Groups*

Table 4 *Effect Size Analysis (Cohen's d) for Performance Variables*

Variable	Cohen's *d*	Effect Magnitude
40M Sprint (s)	1.47	Large
Sit-Ups (reps)	0.76	Moderate
Medicine Ball Throw (m)	0.94	Large
Sit & Reach (cm)	0.23	Small
Standing Broad Jump (m)	1.81	Very Large

Table 4 presents the effect size analysis using Cohen's d to determine the magnitude of training effects across performance variables. The results indicate a very large effect for the standing broad jump and large effects for the 40 m sprint and medicine ball throw, showing great improvements in speed and explosive power due to the training intervention. Sit-ups demonstrated a moderate effect, while sit-and-reach showed only a small effect, indicating minimal change in flexibility.

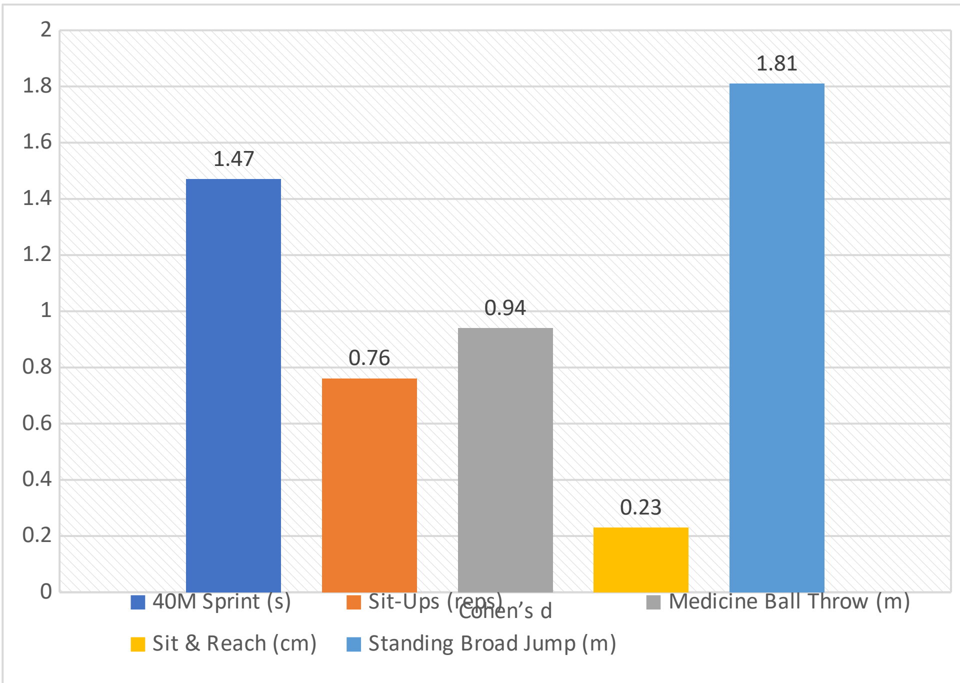

Figure 3: *Effect Size (Cohen's d) for Performance Variables*

DISCUSSION ON FINDINGS

The results of this study strongly confirm the primary hypothesis: an 8-week training program that combines Complex Training with Closed Kinetic Chain (CKC) exercises leads to superior fitness gains compared to traditional conditioning. Notably, significant improvements were seen in lower-body explosive power, upper-body strength, and sprint performance, highlighting the benefits of combining high-load resistance exercises with explosive movements. These outcomes align with earlier research by Seitz and Haff (2016), who found that complex training effectively enhances sprinting and jumping capabilities by improving neuromuscular efficiency and the rate of force development.

The gains in Standing Broad Jump (+0.076 m) and 40 m Sprint (−0.068 s) are linked to Post-Activation Performance Enhancement (PAPE). This involves alternating heavy resistance exercises with plyometric actions to boost neuromuscular readiness. As explained by Tillin and Bishop (2009) and supported by Blazevich and Babault (2019), heavy loading increases myosin light-chain phosphorylation and enhances actin–myosin sensitivity. These changes improve cross-bridge cycling and motor unit recruitment. This neural “priming” effect enables athletes to engage higher-threshold motor units during explosive activities, leading to increased power output.

Additionally, Boullosa et al. (2020) and Cormier et al. (2020) demonstrate that combining heavy resistance training with plyometric exercises results in greater horizontal force production than using each method alone, reinforcing the current findings.

Including Closed Kinetic Chain (CKC) exercises further boosts performance by enhancing joint stability, proprioception, and core control. Unlike open-chain movements, CKC exercises involve multi-joint coordination under load, increasing axial compression and stimulating mechanoreceptors that enhance neuromuscular feedback. As noted by Escamilla et al. (2012) and Kisner and Colby (2017), these movements improve co-contraction patterns and functional stability, which are crucial for effective athletic performance.

The improvement in core endurance (Sit-Ups +1.133 reps) is probably due to the ongoing activation of trunk stabilizers during CKC-based training. This increased core stability likely enhanced force transfer between the lower and upper body, which may have led to better performance in tasks like the medicine ball throw.

The Sit & Reach results did not show a significant change ($p = 0.5317$), suggesting that neither training method effectively impacted muscle–tendon length adaptations. This supports Behm et al. (2016), who found that resistance and plyometric exercises mainly improve neural drive and muscle stiffness instead of flexibility. As a result, enhancing joint range of motion usually needs specific stretching or mobility exercises. Overall, the results confirm that the combined Complex Training and CKC approach provides a more comprehensive and effective stimulus to enhance speed, strength, and explosive power than traditional conditioning, making it a valuable strategy for collegiate athletic development.

CONCLUSIONS

1. The 8-week combined Complex Training and Closed Kinetic Chain (CKC) program significantly improved selected physical fitness variables in college athletes.
2. The experimental group showed greater improvements in speed, muscular endurance, and explosive power compared to the traditional conditioning group.
3. Significant gains were observed in 40 m sprint, sit-ups, medicine ball throw, and standing broad jump performance.
4. Flexibility (sit-and-reach) did not show meaningful improvement, indicating limited effect of the training on range of motion.
5. The integration of heavy resistance and plyometric training enhanced neuromuscular efficiency and rate of force development.
6. Closed Kinetic Chain exercises contributed to better core stability and functional force transfer.
7. Overall, combined training was more effective than traditional conditioning for improving athletic performance in collegiate athletes.
8. The findings support the use of integrated strength and power training methods in sports conditioning programs.

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