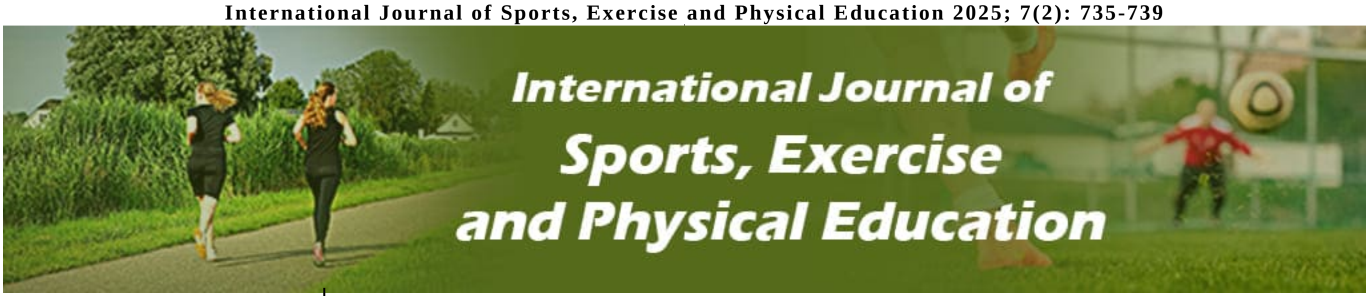

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Effects of strength training versus plyometric training on strength of lower limb in amateur cricketers between age group of 18 to 25 -A comparative study

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Abstract
The study aimed to compare the effects of plyometric and complex training on core strength, lower limb power, upper limb power, and overall athletic performance in male cricketers. A randomized controlled trial was conducted with participants assigned to either a plyometric training group or a complex training group for a period of eight weeks. Pre- and post-intervention assessments were performed to evaluate core stability, vertical jump height, sprint performance, and throwing velocity. Results indicated that both training modalities led to significant improvements in all measured outcomes; however, the plyometric training group showed greater enhancements in lower limb explosive power and vertical jump performance, while the complex training group demonstrated comparatively higher gains in upper limb power and core stability. The findings suggest that plyometric training is particularly effective for improving explosive lower body movements, whereas complex training offers broader benefits that include upper body strength and core stabilization. These results have practical implications for designing sport-specific conditioning programs for cricket players and other athletes requiring a combination of power, strength, and agility. Overall, targeted training interventions can optimize performance outcomes based on the specific demands of the sport and the athlete's performance goals.

Keywords: Plyometric training, complex training, core strength, lower limb power, athletic performance

Introduction

Cricket is a team sport involving various physical and technical demands [1] and is widely played throughout the country. Although traditionally regarded as relatively injury free, it is considered a sport with moderate injury risk. Due to its overall nature, the game places substantial load on the strength, physical fitness, and neuromuscular system of the player, requiring movements such as striding, sprinting, turning, and jumping [1]. Muscle strength is an important factor in enhancing the effectiveness of cricket-related activities [1]. Bowlers benefit from upper-body and leg strength to enhance their deliveries, batsmen rely on core and arm strength for powerful strokes and stability, fielders utilize upper-body strength for accurate throws, and wicket-keepers depend on forearm and wrist strength for catching and stumping. Lower-limb strength is essential for sprinting, rapid changes in direction, and repetitive jumping actions during play [1].

Plyometric training has gained considerable attention in recent years for its ability to improve strength and power output. Research indicates that plyometric stimuli can significantly increase vertical jump height and power without requiring heavy external resistance [2]. Strength training, meanwhile, is known to increase maximal force production but may not produce substantial gains in explosive power due to the presence of the "sticking point," a phase where muscle force and movement velocity are reduced, forming what is termed the sticking zone [2]. This reduction in force and speed can limit improvements in explosive performance. Plyometric training, on the other hand, uses the stretch-shortening cycle to convert elastic energy from eccentric contractions into concentric kinetic energy. While this mechanism effectively enhances explosive power, its low-load nature limits increase in maximal strength, and insufficient maximal force production can further restrict long-term power development. Additionally, the force-velocity curve indicates an inverse relationship between force and velocity, making simultaneous improvement in both qualities challenging.

Previous research presents conflicting findings. Studies by Hammami *et al*. (2019) and Zghal *et al*. (2019) showed that certain combined or complex training approaches improved jump ability, sprint performance, and maximal strength more effectively than plyometric training alone, whereas other studies found no significant differences between training methods in strength development [2]. While these findings highlight the diversity of training responses, most existing research focuses either on elite athletes or on power-related outcomes rather than pure strength measures. Lower-limb strength is crucial in cricket for actions like sprinting, bowling, and jumping, yet limited research specifically compares the effects of strength training and plyometric training on lower-limb strength in amateur cricketers. Most available studies involve professional players or emphasize power outcomes rather than pure strength. Given that amateur cricketers often face constraints in resources, time availability, and structured conditioning programs, determining which training method is more effective and practical for enhancing lower-limb strength becomes particularly important. This gap in the literature supports the need for a direct comparison of plyometric and strength training in this population.

Based on these considerations, the present study aims to compare the effects of strength training and plyometric training on lower-limb strength in amateur cricketers aged 18 to 25 years. The study seeks to evaluate baseline lower-limb strength before intervention, to examine the effects of a structured strength training program, and to assess the impact of a structured plyometric training program on lower-limb strength in this age group. Furthermore, it aims to determine which of the two training methods produces more significant improvements in lower-limb strength among amateur cricketers, thereby providing evidence to guide practical and effective

Materials and Methods

This study was designed as a comparative study using convenient sampling. The study population consisted of amateur male cricketers aged 18 to 25 years. The study was conducted in cricket clubs in Pune over a duration of six months with a total sample size of 40 participants. Ethical approval was obtained from the ethical committee of TMV's Indutai Tilak College of Physiotherapy, Department of Physiotherapy, Pune. All participants provided written informed consent after the study aim, methodology, and procedures were explained to them. Their confidentiality and identity were assured throughout the study.

The materials used in this study included pens, paper, consent forms, a Bosu ball, a height scale, a plyo-box, a barbell, disc weights, a leg press machine, and a weighing machine. The primary outcome measure was lower limb strength, which was assessed using the One-Repetition Maximum (1RM) tests. These included the barbell squat and leg press, both of which evaluate maximal lower body strength critical for cricket-specific activities such as batting, bowling, sprinting, and fielding.

The inclusion criteria comprised amateur male cricketers aged 18 to 25 years who practiced regularly, whereas the exclusion criteria were female cricketers, professional male cricketers, cricketers below 18 years, and participants with a major musculoskeletal injury in the past three months.

Cricketers from Pune city were recruited as study participants. Each participant's lower limb strength was evaluated using the One-Repetition Maximum (1RM) leg press exercise. The procedure was explained thoroughly before the evaluation session. For the leg press test, participants performed one repetition with the maximum weight they could lift safely. Following baseline assessment, participants were randomly divided into two groups of 20 players each. Group A underwent a structured strength training program, while Group B underwent a structured plyometric training program. Both groups performed their respective protocols under supervision for six weeks, after which post-intervention 1RM testing of the leg press was conducted to evaluate improvements in lower limb strength.

Strength Training Protocol; Each strength training session began with a 10 to 15-minute warm-up, including dynamic stretching exercises such as leg swings, hip circles, walking lunges, high knees, and butt kicks. Muscle activation exercises, including glute bridges, bodyweight squats, and lunges, were performed to activate the glutes, quadriceps, and hamstrings.

The resistance training exercises included barbell back squats, deadlifts (conventional or Romanian), Bulgarian split squats, walking lunges, leg press, step-ups with dumbbells or barbell, hip thrusts, calf raises, and glute bridges. Each exercise was performed with proper technique, emphasizing both strength and stability in the quads, hamstrings, glutes, calves, and hip muscles. The benefits of these exercises included improved lower body strength, explosive power, sprinting ability, posture during batting and bowling, and overall cricket-specific performance.

Barbell back squats were performed by standing with feet shoulder-width apart with a barbell on the upper back, lowering until thighs were parallel to the ground, and pushing through the heels to return to the starting position. Deadlifts focused on hamstrings, glutes, lower back, and calves, with conventional or Romanian variations depending on knee bend. Bulgarian split squats, walking lunges, and step-ups strengthened the lower limbs unilaterally, improving balance and stability. Hip thrusts and glute bridges targeted glutes and hamstrings for explosive power, while calf raises developed calves for sprinting and jumping performance.

Each strength training session concluded with a cool-down of 5 to 10 minutes, including static stretching of the quads, hamstrings, calves, hip flexors, and glutes, along with foam rolling. Participants were instructed to start with bodyweight exercises if beginners and gradually increase resistance over time, performing the sessions 2 to 3 times per week with at least 48 hours of recovery between sessions.

Plyometric Training Protocol: The plyometric training sessions also began with a 10 to 15-minute warm-up, consisting of dynamic stretching such as leg swings, high knees, butt kicks, walking lunges, and hip circles. Activation drills included glute bridges, bodyweight squats, and ankle hops.

The plyometric exercise circuit included squat jumps, box jumps, lateral bounds, depth jumps, broad jumps, single-leg box jumps, tuck jumps, and ankle hops. Each exercise was performed for 3 to 4 sets with 30 to 60 seconds of rest between sets. The focus was on explosive power, control, and proper landing techniques to prevent injury. For example, squat jumps emphasized vertical explosive power, box jumps developed leg strength and coordination, lateral bounds improved lateral agility and stability, depth jumps enhanced reactive strength, broad jumps increased horizontal power, and single-leg box jumps improved unilateral strength and stability. Tuck jumps and ankle hops targeted vertical jumping power and ankle stability.

The plyometric training sessions concluded with a cool-down of 5 to 10 minutes, including static stretching of the lower limb muscles and foam rolling to aid recovery.

Both interventions were supervised, and participants' pre-intervention and post-intervention lower limb strength were recorded using the 1RM leg press to compare the effectiveness of the training programs.

Results

A total of 40 participants were selected for the study based on the age group and inclusion criteria. All participants were amateur cricketers aged between 18 and 25 years, with a mean age of 22.39 years. Only cricketers who practiced daily were included to ensure consistent baseline physical activity. Participants were randomly divided into two groups of 20 each. Pre-intervention testing of lower-limb strength was conducted for all participants, after which the respective intervention programs were administered over a six-week period. Post-intervention testing was then performed to evaluate changes in lower-limb strength.

Descriptive statistics were calculated to examine age, pre-intervention, and post-intervention lower-limb strength values. The mean pre-intervention lower-limb strength of all participants was 234.52, which increased to 254.42 post-intervention, indicating overall gains across both groups.

Within-group analyses using paired-sample t-tests revealed significant improvements in both groups. In Group A, which underwent strength training, the paired t-test showed a statistically significant increase in lower-limb strength (t = 11.219, df = 19, $p<0.001$) with a mean difference of 28.3±2.52 and a very large effect size (Cohen's d = 2.51). Normality testing confirmed that the data were normally distributed. Similarly, Group B, which underwent plyometric training, also demonstrated a significant increase in lower-limb strength (t = 7.25, df = 19, $p<0.001$) with a mean difference of 11.5±1.59 and a large effect size (Cohen's d = 1.62). Data normality was confirmed for this group as well.

A between-group comparison of mean gain scores using an independent-sample t-test indicated a statistically significant difference (t = 5.63, df = 38, $p<0.001$). The strength-training group showed a greater mean gain in lower-limb strength (28.3±11.32) compared with the plyometric-training group (11.5±7.09), demonstrating the superior effectiveness of strength training. Normality tests confirmed that the gain scores were normally distributed.

Overall, the results indicate that both strength and plyometric training significantly improved lower-limb strength in cricketers aged 18-25 years, but strength training produced markedly greater improvements. These findings support the rejection of the null hypothesis and confirm the alternative hypothesis that strength training yields significantly greater gains in lower-limb strength compared with conventional plyometric training in this population.

Table 1: Overall Descriptive Statistics of the participants (N=40)

Variable	N	Mean	Median	SD
Age	40	22.32 ±1.96	21.96	±1.96
Pre intervention strength	40	234.52 ±45.68	45.68	±45.68
Post intervention strength	40	254.42 ±46.02	260	±46.02

Table 2: Frequency Distribution of Participants by Group

Group	N	% of total	Cumulative %
Group A-strength training	20	50%	50%
Group B plyometric training	20	50%	100%

Table 3: Paired Sample t-Test for Group a (Strength Training)

Variables compared	Mean difference	SE difference	95% CI (lower -upper)	t	DF	P value
Pre vs post Strength	-28.30	2.52	-33.5 - -23.0	-11.219	19	< 0.001

Table 4: Paired sample t Test for group B (plyometric training)

Variables Compared	Mean difference	SE difference	95% CI (lower-upper)	t	DF	P value
Pre vs post intervention strength	-11.50	1.59	-14.8 - -8.18	-7.25	19	<0.001

Table 5: Comparison of mean gain score between groups (Independent t- test)

Group	N	Mean gain (post-pre)	SD	SE	t	DF
Strength(A)	20	28.3± 11.32	± 11.32	2.52		
plyometric(B)	20	11.5±7.09	±7.09	1.59	5.63	38

Discussion

The aim of the study was to determine the effects of plyometric versus strength training on lower-limb strength in cricketers aged 18 to 25 years. This study evaluated and compared the effects of a six-week strength training protocol against a plyometric training protocol on lower-limb strength, as measured by the one-repetition maximum (1RM) leg press test. Forty amateur male cricketers practicing daily were randomly divided into two groups of twenty each, one assigned to strength training and the other to plyometric training. Pre- and post-intervention 1RM tests were conducted to assess changes in maximal lower-limb strength.

The results clearly indicate that both training methods produced statistically significant improvements in lower-limb strength within their respective groups. For the strength training group, there was a highly significant improvement in 1RM (t = -11.219, $p<0.001$) with a large mean difference (28.3±2.52) and a very large effect size (Cohen's d = 2.51). These findings are consistent with established resistance training principles. Traditional strength training, involving exercises such as barbell squats, deadlifts, and leg press, provides mechanical overload that promotes muscle hypertrophy and neural adaptations, including increased motor unit recruitment, synchronization, and reduced antagonist co-activation. Since the 1RM leg press directly measures maximal strength, the substantial gains observed are in line with the specificity of training principle.

Similarly, the plyometric training group showed a statistically significant increase in lower-limb strength ($t = -7.25$, $p<0.001$) with a mean difference of 11.5±1.59 and a large effect size (Cohen's $d = 1.62$). Plyometric exercises, while primarily designed to enhance explosive strength through the stretch-shortening cycle, also improved maximal strength. The high-intensity, short-duration ground contact of exercises such as squat jumps, box jumps, and depth jumps generates significant force production, which can translate into strength gains, particularly in amateur athletes with lower initial training age. Neural adaptations from plyometric training enhance the muscles' ability to generate force quickly, providing a secondary benefit to maximal strength.

The between-group comparison revealed a statistically significant difference in mean gain scores ($t = 5.63$, $p < 0.001$), with the strength training group showing greater improvement (28.3±11.32) than the plyometric group (11.5±7.09), confirming the superior effect of strength training for maximal lower-limb strength. This outcome reflects the specificity of training and the outcome measure. Strength training targets high-force, low-velocity movements similar to the 1RM leg press, while plyometrics emphasize high-velocity, low-load movements. As training gains are maximized when the stimulus closely matches the test condition, the superior results in the 1RM test for the strength training group were expected.

These findings align with existing literature supporting the efficacy of heavy resistance training for maximal strength development. Eihara *et al*. reported that heavy resistance training is generally superior to plyometric training for improving outcomes involving maximal force production, as greater maximal strength provides a foundation for enhanced power [2]. Conversely, studies incorporating complex training, which combines plyometrics and weight training, have shown greater improvements in both strength and power than either method alone [2]. This highlights that while plyometric training alone can improve explosive power, maximal strength gains are more effectively achieved through resistance training.

Comparisons with cricket-specific research further contextualize the findings. Ali *et al*., in a study comparing plyometric and complex training in cricketers, concluded that effects on core strength and power were similar between groups, emphasizing that plyometric training is highly effective for power-related outcomes [1]. Bugti *et al*. reported that plyometric training improved endurance and explosive strength but had less impact on maximal strength [3]. The present study supports these findings, showing that plyometric training improves strength but is less effective than resistance training for maximal strength development as measured by the 1RM test.

The physiological mechanisms underlying these differences are consistent with established principles of strength and conditioning. Strength training induces muscle hypertrophy through mechanical tension and promotes neural adaptations such as increased firing frequency, motor unit synchronization, and reduced inhibition, all contributing to higher maximal force production. Plyometric training enhances the efficiency of the stretch-shortening cycle, increases rate of force development, and improves muscle-tendon stiffness, which predominantly benefits power and explosiveness rather than absolute strength.

From a practical perspective, these findings have important implications for amateur cricketers aged 18-25. Maximal lower-limb strength underpins critical cricket-specific actions such as powerful batting strokes, fast bowling strides, quick sprinting between wickets, and explosive jumps for catching. Prioritizing resistance training in the pre-season can establish a maximal strength foundation, which can later be converted into explosive power through plyometric or combined training. While strength training proved superior for the 1RM outcome, integrating plyometric exercises remains essential to develop sport-specific explosiveness.

Limitations of this study include the reliance on the 1RM leg press as the sole measure of lower-limb performance, which does not capture improvements in explosive power, sprinting, or sport-specific movements. The short six-week intervention and focus on amateur athletes may limit generalizability to professional cricketers with higher baseline strength. Future studies should explore longer-term training interventions, include power-based performance measures, and examine the effects of complex training combining strength and plyometric exercises.

Conclusion

The present study demonstrates that strength training is more effective than plyometric training in enhancing lower-limb strength among amateur cricketers aged 18 to 25 years. These findings highlight that structured strength training protocols can produce substantial improvements in muscular strength, which is critical for performance enhancement and injury prevention in cricket.

Based on these results, it is recommended that coaches and trainers prioritize strength-based exercises when designing lower-body conditioning programs for amateur cricketers. At the same time, plyometric training remains valuable for developing other performance components such as power, agility, and neuromuscular coordination and can be incorporated as a complementary training modality.

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