

# Effect of Combined Core Training and Circuit Training Versus Circuit Training Alone on Explosive Power Among College Going Volleyball Players

Palapati Pooja Rajeswari<sup>1</sup>, A. Chaturvedi Pilladi<sup>2</sup>, Patchava Apparao<sup>3</sup>,  
Chintada Ganapathi Swamy<sup>4</sup>, Rayudu Geetha Mounika<sup>5</sup>

<sup>1</sup>MPT Sports, Department of Sports, GSL College of Physiotherapy, Dr. NTR University, Vijayawada, India.

<sup>2</sup>Professor, Vice Principal, Department of Sports, Swatantra Institute of Physiotherapy and Rehabilitation, Dr. NTR University, Vijayawada, India.

<sup>3</sup>Principal, Department of Orthopaedics, Swatantra Institute of Physiotherapy and Rehabilitation, Dr. NTR University, Vijayawada, India.

<sup>4</sup>Professor of Biostatistics, Department of Biostatistics, GSL Medical College, Dr. NTR University, Vijayawada, India.

<sup>5</sup>Professor, Department of Orthopaedics, GSL College of Physiotherapy, Dr. NTR University, Vijayawada, India.

Corresponding Author: Palapati Pooja Rajeswari

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## ABSTRACT

### BACKGROUND AND OBJECTIVE:

Volleyball is a team sport that imposes various demands on its players. In volleyball, performance depends on the ability of the player to generate the force rapidly; this is particularly prominent in the jumping, movements which gain most points in a game which is known as explosive power. Main objective of this study was to compare the effect of “combined core training and circuit training” and “circuit training alone” on explosive power among college going volleyball players.

**METHODS:** Quasi experimental study. In this study, 72 subjects were randomly allocated into two groups, each group containing 36 subjects. Group-A received ‘Combined core and circuit training’ and Group-B received ‘circuit training alone.’ Subjects received 3 sessions in a week for 8 weeks. The outcome measures were

measured in term of vertical jump test for explosive power. Independent t-test was used to compare the mean significance difference between continuous variables. Paired t-test was used to assess the statistical difference between pre-test and post-test scores.

**RESULTS:** Statistical analysis of the data revealed that Both groups demonstrated improvement in vertical jump performance after eight weeks of training. In Group A, the mean vertical jump height increased from  $37.22 \pm 5.41$  cm to  $54.81 \pm 5.65$  cm. Group B improved from  $36.86 \pm 5.25$  cm to  $41.22 \pm 6.79$  cm. The improvement observed in Group A ( $54.81 \pm 5.65$  cm) was greater than that in Group B ( $41.22 \pm 6.79$  cm), indicating superior enhancement of explosive power with combined core and circuit training.

**CONCLUSION:** Study concluded that after eight weeks of training both the groups showed significant improvement. Group-A, who received combined core and circuit

training showed better and effective results than group-B who received circuit training alone.

**Keywords:** core training, circuit training, vertical jump test, explosive power, college going volleyball players, sports.

## INTRODUCTION

Volleyball is a dynamic team sport that places multiple physical and technical demands on its players, shaped by specific game rules and structure. During both offensive and defensive plays, athletes frequently engage in bursts of high-intensity actions that are alternated with short recovery intervals.<sup>[1]</sup> It is categorized as an intermittent sport that predominantly involves anaerobic efforts, featuring rapid and forceful movements in both vertical and horizontal directions.<sup>[2]</sup> Given its fast-paced nature, volleyball requires players to constantly adapt to rapidly changing on-court conditions, which classifies it as an open-skill sport characterized by diverse, non-repetitive movement patterns.<sup>[3]</sup>

A player's success in volleyball is largely determined by the ability to produce force quickly and efficiently. This capacity is particularly vital in the execution of point-scoring skills such as spiking, blocking, and jump serving. All these techniques involve jumping, making vertical jump performance an essential indicator of explosive ability. Furthermore, movements like spiking and serving also demand upper-body explosive strength for forceful hits.<sup>[4]</sup> As volleyball involves frequent jumping and quick directional changes, developing optimal dynamic strength becomes essential for superior performance and competitive advantage.<sup>[5]</sup>

Modern competitive volleyball has evolved to include more frequent and powerful jumps, reflecting a shift toward faster gameplay and increased physical intensity.<sup>[6]</sup> This progression emphasizes the need for well-developed muscular strength, especially explosive power, which is

fundamental for achieving greater height and efficiency in jumping actions.<sup>[7]</sup>

The explosive power of the lower limbs forms a critical foundation of physical preparation for volleyball players, and it remains a primary focus for coaches across all age groups and performance levels. This quality enables players to perform sport-specific actions with precision and intensity during crucial game moments. Efficient movement execution also depends on the ability to generate maximum force in minimal time, highlighting the significance of explosive power.<sup>[8]</sup>

Explosive power associated with jumping is one of the key motor abilities that determine success in many sports, particularly in team-based disciplines. It reflects the neuromuscular system's capacity to rapidly generate high force output, allowing athletes to perform effectively within very short time frames.<sup>[9]</sup> In volleyball, vertical jump ability serves as a reliable indicator of lower-limb explosive power. Among several assessment techniques, the Sergeant Jump Test (Vertical Jump Test) is one of the most widely used, comparing the difference between an athlete's standing reach and maximum jump height.<sup>[10]</sup>

Core training is a fundamental component in developing both strength and power in the muscles that stabilize the spine and trunk. The global muscles such as the rectus abdominis, obliques, latissimus dorsi, and erector spinae provide external support, while the local muscles—including the transverse abdominis, multifidus, and pelvic floor offer deep stabilization.<sup>[11]</sup> Anatomically, the core encompasses all soft tissues with proximal attachments to the axial skeleton. The abdominal and trunk muscles are central to nearly all sports movements, as they regulate and transfer force between the upper and lower limbs.<sup>[12]</sup> The core muscles play a key role in maintaining central body stability, which is essential for posture control during movement. Additionally, they enhance proprioceptive ability and contribute to muscle endurance, speed, and coordination.

Continuous activation of the core muscles, particularly the transverse abdominis, provides stability and control of movement. Core endurance ensures spinal stability, especially during prolonged activity, which is crucial for maintaining proper biomechanics.<sup>[13]</sup>

However, there are limited studies examining the combined impact of core training on body composition and performance among team sport athletes. Core strength training remains an essential component in the fields of strength and conditioning, rehabilitation, and general fitness due to its effectiveness in improving performance and minimizing injury risk. Weakness or poor neuromuscular coordination in the core can impair energy transfer through the kinetic chain, reducing movement efficiency and predisposing athletes to overuse injuries.<sup>[14]</sup> Moreover, a stable core provides a foundation for the spine and trunk during complex upper-limb movements such as jumping, running, and throwing. A strong core allows efficient energy transfer between the lower and upper body, improving overall movement economy and power generation.<sup>[15]</sup>

Circuit training, on the other hand, is a structured resistance-based exercise method designed to improve multiple motor skills, including strength, endurance, and speed. It consists of a sequence of exercises targeting various muscle groups, such as those in the upper body, trunk, and lower limbs. These exercises can be performed using one's body weight or resistance tools and are arranged systematically to engage different muscle regions efficiently. This approach provides a comprehensive full-body workout while promoting overall conditioning and injury prevention.

The method has gained popularity among athletes and fitness enthusiasts alike because it integrates cardiovascular exercise with resistance and strength training. During a typical circuit, individuals perform a series of 6–10 exercises, completing a set number of repetitions or performing for a specific duration before transitioning to the next

activity with minimal rest. This continuous sequence not only enhances muscular endurance but also elevates cardiovascular capacity. Depending on fitness level, participants may complete one or several circuits, providing a well-rounded training stimulus for multiple muscle groups.<sup>[16]</sup>

Recent studies suggest that circuit training contributes to improved leg explosive power by inducing both muscular and neuromuscular adaptations. When high-resistance or plyometric movements are incorporated, they stimulate structural modifications in muscle fibres that enhance force generation. Simultaneously, neural adaptations promote better motor unit recruitment and firing efficiency, resulting in faster and stronger muscle contractions key elements for developing explosive strength.<sup>[17]</sup>

Therefore, the purpose of this study is to investigate the effect of core training combined with circuit training on improving explosive power in volleyball players

## MATERIALS & METHODS

This is a quasi-experimental study design approved by the Ethical Committee of GSL Medical College and General Hospital. The study was conducted for period of 1 year, from July 1<sup>st</sup> 2024 to June 30<sup>th</sup> 2025 at Sports arena of physiotherapy college campus. 96 subjects were screened between the age group of 18 years and above, and according to inclusion and exclusion criteria 72 subjects were selected who were randomly allocated through systematic random sampling into two groups, each group containing 36 subjects. Informed consent will be obtained from the participants, and demographic data will be recorded. Group-A received Combined core and circuit training, and Group-B received circuit training alone. Subjects received 3 sessions in a week for 8 weeks. The vertical jump test was used for explosive power to evaluate both the groups before and after the intervention.

**Inclusion criteria:** Age – 18 years and above, male and female subjects were included, the subjects had to be physically active in playing volleyball for minimum 3 months, college going subjects who had average vertical jump scoring that is, for males is  $\leq 30 - 50$  cm and females is  $\leq 20 - 40$  cm were included in the study, no previous experience with core training exercises, subjects who voluntarily gave consent to participate in the study.

**Exclusion criteria:** Taking any personal training or gym, subjects with musculoskeletal injuries, cardiovascular problems, neurological deficits, recent surgeries.

### Outcome Measures

Pre-test and post-test measures were taken by using vertical jump test. All the subjects underwent a protocol treatment of 3 days per week for 8 weeks duration.

**VERTICAL JUMP TEST** (sergeant jump test): Vertical jumping ability is one of the key indicators of explosive power in volleyball. The Vertical Jump Test is widely used to assess lower-limb power by

measuring how high an individual can jump from a standing position.

Before testing, a few practice attempts were allowed to ensure familiarity with the movement. The participant's standing reach height was first measured by marking the fingertips with a highlighter, fully extending one arm overhead, and touching the wall. The subject then lowered the arms and, without any pause or step, dropped into a squat movement before exploding upward into a vertical jump. At the peak of the jump, the participant touched the wall again, leaving a second highlighter mark at the highest point reached. The difference between the standing reach mark and the highest mark was recorded as the vertical jump height. Each subject was given three attempts, and the best score (maximum height reached) was recorded for analysis.<sup>[18]</sup>

### INTERVENTION

#### GROUP A: COMBINED CORE TRAINING AND CIRCUIT TRAINING:

A structured training regimen aimed at enhancing explosive power was implemented by blending core training exercises with a multi-station circuit format.



**FIG. 1: GROUP – A COMBINED CORE TRAINING AND CIRCUIT TRAINING**

**A. Push Ups, B. Superman Exercises, C. Flutter Kicks, D. V Sit Ups, E. Lying Hip Raises, F. Step Ups, G. Tuck Jump, H. Leg Raises, I. Plank, J. Jumping Jacks.**

Exercises included were skipping, push up's, jumping jacks, step up's, v sit up's, shuttle run, squat jump, sprint, box jump, tuck jump, plank, sit up's, leg raise, side bend, superman exercises, Russian twists, flutter kicks and lying hip raises (fig. 1) and performed with a duration of 30 seconds per exercise, rest of 10 seconds between the exercises, completed for 3 circuits, with 3 minutes rest between each circuit. The training was conducted 3 times weekly for duration of 8 weeks, with each session beginning with a 5-minute dynamic mobility warm-up. The treatment duration was 48 min per session, 3 days a week for 8 weeks. Subjects were given proper instruction, and the exercises were performed under the supervision. [19,20]

### GROUP B: CIRCUIT TRAINING GROUP:

The subjects in the group-B will receive circuit training alone. The following combination of 8 different exercises like skipping, push-ups, jumping jack, step ups, sit ups, shuttle run, squat jump, box jump, tuck jump, (fig. 2) and sprint in 3 sessions a week for 8 weeks. Before starting of each session, the subjects will do a warm-up of 10 minutes which include running and stretching exercises. The treatment duration will be given 35 minutes per session, 3 days a week for 8 weeks. Subjects will be given proper instruction, and the exercise will be performed under supervision. [21,22]

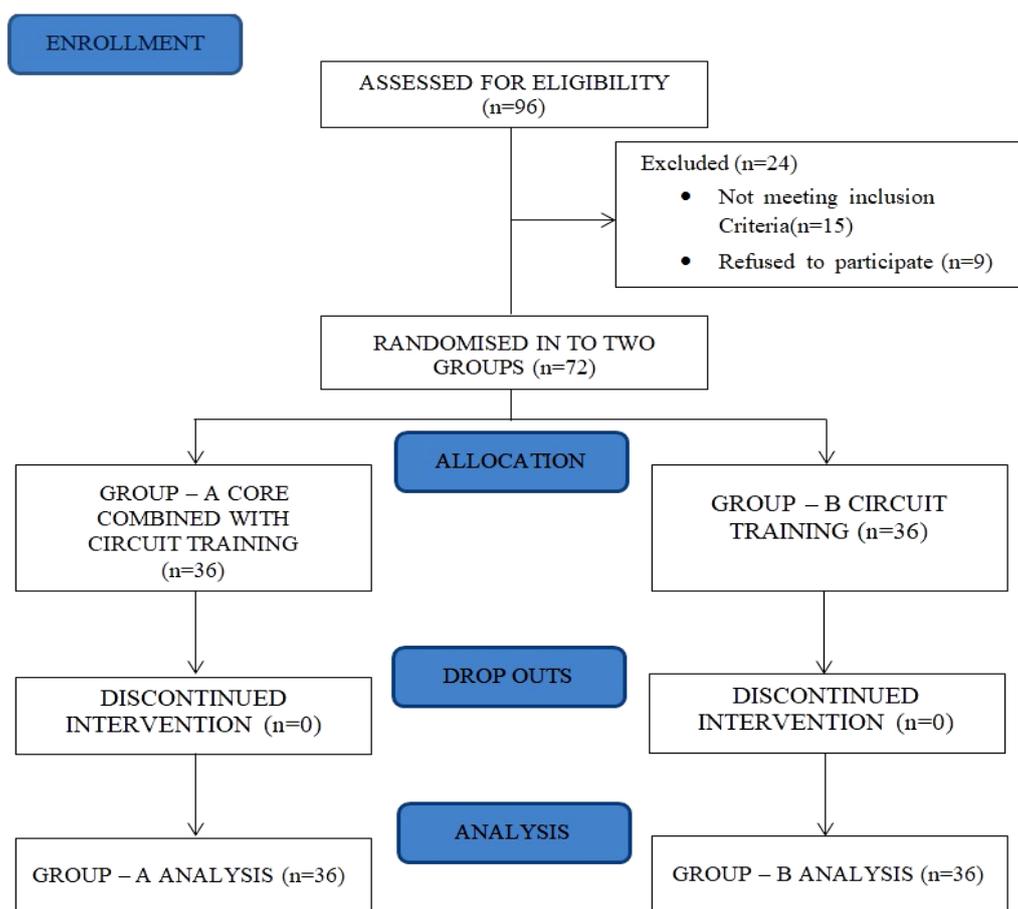


FIG. 3: CONSORT FLOW CHART OF STUDY PARTICIPANTS FROM ENROLLMENT TO ANALYSIS

### Statistical Analysis

Statistical analysis was done by using SPSS software version 20.0 and Microsoft excel

2019. All Descriptive data was presented in the form of mean  $\pm$  standard deviation and mean difference percentages were

calculated and presented. Within the groups paired student “t” test was performed to assess the statistical difference within the group on vertical jump test from pre- test and post- test values. Between the groups independent student “t” test was performed to assess the statistically significant difference mean value between the groups on vertical jump test. Data was tabulated and graphically represented. For all statistical analysis,  $p < 0.05$  was considered as statistically significant.

## RESULT

The results of the study were analysed in terms of vertical jump test. The consort flowchart of the study showed the study organization in terms of subject’s enrollment, screening, allocation, and analysis following intervention as shown in figure 3.

The study compared the effect of combined “core training and circuit training” and “circuit training alone” on explosive power among college going volleyball players. A total of 96 subjects were screened for eligibility among them 72 students were recruited under the inclusion and the exclusion of the study. Each participant was randomly assigned to one of two groups, each consisting of 36 players, after completing baseline assessments. Training was conducted three times a week for eight weeks. At the end of the intervention, all 72 participants, 36 in Group A and 36 in Group B completed the training. At a significance level set at  $p \leq 0.05$ , both the groups demonstrated statistically significant improvements in vertical jump test scores with group A being more effective than group B.

**TABLE 1: COMPARISON OF MEAN SCORES OF VERTICAL JUMP TEST (EXPLOSIVE POWER) BETWEEN THE GROUPS: [PRE – TEST]**

VERTICAL JUMP TEST	MEAN	STANDARD DEVIATION	P VALUE	INFERENCES	
PRE TEST	GROUP A	37.22	5.41	0.7446	INSIGNIFICANT
	GROUP B	36.86	5.24		

**RESULTS:** The above table 1 indicate that the PRE-TEST mean scores of the VERTICAL JUMP TEST between the two groups were found to be statistically insignificant ( $p < 0.05$ ). Group A had a PRE -

TEST mean score of 37.22, while Group B had a PRE-TEST mean score of 36.86 indicating an insignificant difference of PRE-TEST values between groups A and B.

**TABLE 2: COMPARISON OF MEAN SCORES OF VERTICAL JUMP TEST (EXPLOSIVE POWER) BETWEEN THE GROUPS: [POST – TEST]**

VERTICAL JUMP TEST	MEAN	STANDARD DEVIATION	P VALUE	INFERENCES	
POST TEST	GROUP A	54.80	5.64	0.001	HIGHLY SIGNIFICANT
	GROUP B	41.22	6.79		

**RESULTS:** The above table 2 indicate that the POST-TEST mean scores of the VERTICAL JUMP TEST between the two groups were found to be statistically highly significant ( $p < 0.05$ ). Group A had a POST-TEST mean score of 54.80, while Group B had a POST-TEST mean score of 41.22 indicating statistically significant difference of POST-TEST values between groups A and B.

## DISCUSSION

The main purpose of this study was to evaluate the effect of combined core training and circuit training versus circuit training alone on explosive power among college going volleyball players. In this study, subjects were assessed for vertical jump test pre and posttest respectively. Seventy-two subjects were divided into two groups and group – A (n=36) received

combined core training and circuit training and group – B (n=36) received circuit training alone, who then underwent eight – week exercise training program for 3 sessions a week. Assessment was done before and after eight – weeks of training program.

By the end of the eight weeks training program, the subjects of Group – A who received combined core training and circuit training had significantly improved results in vertical jump performance which showed changes in outcome measures vertical jump test Composite mean score ( $p < 0.001$ ). Group – B who received circuit training alone also showed significant results in vertical jump test composite score ( $p < 0.001$ ).

However, the participants in Group A, who received the combined core and circuit training, showed a greater improvement in vertical jump height when compared to Group B. This indicates that while circuit training alone has benefits in enhancing explosive performance, the inclusion of targeted core training provides an added advantage by contributing to stability, force transfer, and overall power generation. The statistical analysis confirmed that the differences between the two groups were significant, with Group A is more than Group B.

By strengthening the core, individuals can improve balance and trunk stability, which allows them to move more efficiently during dynamic activities. For athletes, this means they can transfer the force generated by the legs more effectively through the body, often resulting in higher jumps and better overall performance. The greater post-test improvement seen in Group A supports this concept, a well-stabilized trunk minimizes energy loss during explosive movements, allowing more of the force to contribute directly to upward propulsion. Rodríguez-Perea explained through a meta-analysis that core strengthening produces small to moderate improvements in jump performance, along with clear advantages in balance and endurance. This evidence

supports why combining core training with circuit training produced better results than circuit training alone.<sup>[23]</sup>

One major reason core strengthening enhances performance is because it promotes stability through the spine and pelvis, which helps the body transfer force more effectively between the upper and lower limbs. When the deep trunk muscles are strong and well-coordinated, the hips and lower back remain firm during powerful actions like jumping. As a result, the leg muscles, especially the hip extensors and calves can generate force more efficiently.

Yu reported in a meta-analysis that athletes who performed regular core training showed improved muscle coordination and timing, leading to greater speed and power during movement. This supports the findings of the present study, where participants in the combined training group (core plus circuit) achieved a greater increase in vertical jump height compared with those who trained with circuit exercises alone.<sup>[24]</sup>

Another important mechanism through which core exercises assist athletes is by enhancing balance and posture, both of which are crucial for rapid, forceful movements like jumping. Gao Y, Yang Y, Xian C, Wang Z et al. reported that including core activities in functional training improved athletes' postural control and coordination during explosive movements.<sup>[25]</sup>

Circuit training primarily works through the stretch–shortening cycle (SSC) — a natural muscle mechanism that allows tendons and muscles to store elastic energy during a rapid lengthening phase (eccentric) and release it during a shortening phase (concentric). This efficient energy use helps the athlete to produce more force quickly, improving performance in explosive activities such as jumping.

With repeated circuit-based exercises, the muscle–tendon units adapt to store and release energy more efficiently, resulting in higher jump performance. Sylvester found that circuit training improved leg stiffness and SSC efficiency in female volleyball

players, which in turn led to significant increases in jump height. This aligns with the post-test gains observed in Group B, where plyometric elements in the circuit likely contributed to improved explosive power. However, while SSC adaptations enhance force output, they do not necessarily improve the trunk stability needed for efficient force transfer through the kinetic chain. As a result, the gains in Group B were notable but smaller than those of Group A.<sup>[26]</sup>

Iranpour demonstrated that combining plyometric exercises with resistance training enhances strength, agility, and explosive power in volleyball players. These results indicate that circuit training alone is still beneficial for improving performance, as reflected by the progress in Group B.<sup>[27]</sup>

One of the major benefits of combining circuit and core training is that it strengthens both the proximal and distal parts of the kinetic chain. Deng N, Soh KG, Zaremohzzabieh Z, Abdullah B, Salleh KM, Huang D et al. showed that multi-segment training produces better overall athletic performance compared to single-segment training.<sup>[28]</sup> Similarly, Rodríguez-Perea emphasized that core training improves proximal stability, allowing better force transfer throughout the body. Together, these effects explain why the group that performed combined training achieved significantly higher improvements in jump height.<sup>[23]</sup>

Another key observation from this study is that integrating core exercises with circuit routines produced better overall outcomes than circuit exercises alone. This combined approach likely worked because core training enhanced stability and coordination, while circuit training developed muscular strength, endurance, and power. Yu also noted in their meta-analysis that athletes who followed programs including core exercises displayed greater explosive power than those who trained using traditional methods.<sup>[24]</sup>

Belli G, Marini S, Toselli S et al. found that participants who engaged in trunk-focused

circuit programs showed greater improvements in strength and functional ability compared to those without a core emphasis. This supports the idea that the dual approach circuit for limb power and core for stability creates a more complete training effect. This explains why Group A showed a much higher increase in jump height compared to Group B.<sup>[29]</sup>

Fogliata A, Silvestri F, Marcelli L et al. further demonstrated that trunk-centered control exercises improve explosive power by enhancing coordination between body segments. These findings support the conclusion that while circuit training improves limb power, core training enhances trunk control, and together they produce a greater overall vertical force.<sup>[30]</sup>

Huang WY, Wu CE, Huang H et al. reported that plyometric-only programs typically improve vertical jump height by 3–10 cm, whereas combined methods, like the one used in this study, can lead to much greater gains up to around 17 cm. This highlights the synergistic action between the proximal (core) and distal (legs) segments of the body. Together, they enable athletes to generate and transfer power more efficiently throughout the kinetic chain, explaining the superior results in Group A.<sup>[31]</sup>

Combined training not only contributes to performance enhancement but also offers a protective role in injury prevention. Sylvester emphasized that while plyometric exercises are valuable for increasing muscle and tendon stiffness, they may also cause overuse or fatigue if the athlete lacks sufficient core stabilization. The quick and forceful stretch–shortening actions involved in these drills generate large impact forces that must be properly absorbed and transferred through the kinetic chain.<sup>[26]</sup>

Yu reported that incorporating core training helps limit unnecessary trunk movement and improves neuromuscular control, allowing the proximal segments to remain stable during high-speed lower-limb activities.<sup>[24]</sup> When core exercises are integrated with circuit and plyometric

training, the body can more effectively produce and distribute force, which helps reduce the stress placed on joints and surrounding soft tissues. This balanced approach enhances jump performance while simultaneously lowering the chance of injuries.

In volleyball, skill performance depends on the smooth coordination of power generation, core stability, and technical execution. Keoliya observed that the most effective training programs are those that address all these components together improving technique, building muscular strength, and enhancing trunk control.<sup>[32]</sup>

The findings of the present study align with this view, demonstrating that explosive jump ability improved significantly when core stability training was combined with plyometric circuit exercises. This outcome reflects the practical value of strengthening both proximal (core) and distal (lower limb) segments, ensuring that athletes can perform explosively while minimizing the likelihood of injury in real match situations.

Pre- and post-test results indicate that both circuit training alone and circuit training combined with core training improved vertical jump performance in volleyball players. However, Group A, which received combined core and circuit training, demonstrated the greatest improvement in power output compared with the control group.

Therefore, based on these results, strength, and conditioning trainers along with volleyball coaches in universities are advised to incorporate core training together with circuit training as part of the regular practice sessions. Using such combined programs as a supplement to standard training can assist college volleyball players in developing their explosive lower-limb power, thus enabling them to perform better in spiking, blocking, and fast movements on the court which are among the important skills.

However, the study has its limitations: The study was conducted on a limited sample size of college-level volleyball players,

which restricts generalizability to other age groups, competitive levels, or sports. The intervention period was relatively short. Blinding of assessors and players was not highlighted, which could introduce observer and performance bias and an absence of Long-term Follow-up. Additionally, it is recommended that future studies should include larger and diverse populations, to improve generalizability, longer-duration interventions, and follow-up assessments to evaluate the sustainability of training benefits and additional performance measures such as speed, balance, and injury prevention should be incorporated to gain a more comprehensive understanding of training effects.

## CONCLUSION

In conclusion, the present study concluded that an eight-week program of combined core training and circuit training as well as circuit training alone produced statistically significant improvements in vertical jump performance among college-level volleyball players. However, superior gains in explosive power were observed in Group A, which received the combined core and circuit training, indicating that the addition of core exercises provides a greater enhancement in vertical jump height compared to circuit training alone. These findings emphasize the importance of incorporating structured core and circuit training into training protocols.

## Declaration by Authors

**Ethical Approval:** The research work has been approved by the Institutional Ethics Committee.

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**Conflict of Interest:** The authors declare no conflict of interest.

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