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# Impact of Plyometric Training on Performance Metrics in Female College Volleyball Players

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## ABSTRACT

The current research examined the effects of plyometric training on the different performance measures of the female college volleyball athletes. There was the use of a randomized pretest-posttest experimental design. Fifty-two female volleyball players aged between 17 21 years were recruited in Government Girls Colleges in Islamabad, Pakistan and randomly grouped into experimental group and control group, n = 26 and n = 26 respectively. They subjected the experimental group to eight weeks plyometric training besides the normal volleyball training, and the control group to standard volleyball training only. The variables such as performance, such as vertical jump, 20-m sprint, agility, and standing broad jump, were measured pre- and post-intervention. Repeated-measures ANOVA and paired-samples t-tests at $p < .05$ were used to analyze data. Significant Time × Group interaction effects were observed for vertical jump performance ($F = 76.57$, $p < .001$,

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$\eta^2$ = .605), sprint speed (F = 58.21, p < .001, $\eta^2$ = .538), agility (F = 66.73, p < .001, $\eta^2$ = .572), and standing broad jump performance (F = 73.29, p < .001, $\eta^2$ = .594). The results were that plyometric training had a significant effect on the physical performance of female college volleyball players in terms of plyometric training.

**Keywords:** Plyometric training, Volleyball, Agility, Sprint speed, & Explosive power

## INTRODUCTION

Volleyball is an intermittent high intensity sport, which involves repeated explosive movements in players involving jumping, sprinting, blocking, diving, and altering direction speedily whilst playing the match. These sport-specific loading exerts significant stress on lower-limb strength, agility, speed and neuromuscular coordination, especially with those female volleyball players at the collegiate level. These measurements of performance are believed to be essential to successful performance of offensive and defensive volleyball skills such as spiking, blocking and the efficiency of court movements (Raiola et al., 2025; Longakit et al., 2025).

Plyometric training has become one of the most popular conditioning methods of the improvement of explosive athletic performance. The training program is mainly grounded on the stretch-shortening cycle (SSC) whereby the muscles quickly switch to concentrate contraction, which leads to higher force generation and neuromuscular performance. Plyometric training may enhance muscular strength, reactive strength, request movement economy, and sport-specific sporting capabilities, because of repetitive practicing of explosive jumping and reactive movements (Prvulović et al., 2026).

Recent articles have continuously shown that plyometric training has great benefits on physical fitness and performance levels amongst volleyball players. Recently, Zhang et al. (2026) conducted a systematic review and meta-analysis that found plyometric training to have a significant effect on the vertical jump performance, factors contributing to sprinting, agility, muscular power, and overall athletic performance in adolescent team-sport athletes. Equally, Sylvester et al. (2024) found that an eight-week horizontal plyometric regimen enhanced stiffness and reactive performance in leg in post-peak-height-velocity female volleyball athletes.

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The explosive power of the lower parts of the body can be of great value in volleyball, as jumping skills directly influence the successful spiking and blocking actions. Research has pointed out that the use of plyometric exercises like box jumps, squat jumps, depth jumps, and bounding exercises elevates neuromuscular activity and increases the vertical jump height in volleyball players (Nurcahyati et al., 2026). Moreover, short-term plyometric exercises have also reported effects of boosting both sprint and agility speed, both of which are crucial in covering large areas of the court and transitioning to defense during competitive play (Longakit et al., 2025).

The plyometric based conditioning could especially be beneficial to the female volleyball athletes owing to physiological and biomechanical attributes of lower-limb strength and neuromuscular control. Past experiences indicate that adequately designed plyometric interventions can enhance not only the sports performance but, also, the movement mechanics and the other prevention of factors of injuries in female athletes (Sylvester et al., 2024). Moreover, both eccentric- and concentric-based plyometric training has been found to have positive effects on strength, speed, and muscle contractile properties in female athletes of explosive sports (Prvulović et al., 2026).

The other important factor is that volleyball requires both lower- and upper-body work to create the required power. Despite much focus on lower-body plyometrics, recent studies have also illustrated the importance of upper-body plymetric training in enhancing explosive arm movements in volleyball performance. T. K. et al. (2026) has shown that eight weeks of upper-body plyometric exercises were effective in enhancing handgrip strength, as well as upper-body explosive power among young female volleyball athletes. These results show that plyometric training has the potential to positively influence various aspects of volleyball specific athletic performance.

In addition, plyometric training surface and exercise mode could affect training outcomes. Yu et al. (2025) discovered that plyometric training that occurred on various materials; sand, land, and in water resulted in diverse changes in the jumping capacity, sprint and change-of-direction speed in volleyball players. This evidence indicates that the volleyball competitive physiological requirements should

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guide the uptake of plyometric programs design and structure.

Although there is mounting evidence supporting the application of plyometric training in volleyball there are a few gaps in the literature. Most of the earlier research concentrated on male athletes, young athletes or singular measures of performance whereas little has been done on the joint effect of plyometric training on numerous performance measures in female volleyball players in a college setting. Also, differences in training time, training regimens and population characteristics of participants complicate extrapolate results to other collegiate female volleyball groups.

Thus, the aim of the current research was to examine the influence of plyometric training on the chosen performance indicators in female college volleyball players. In particular, the research has considered the implications of a structured plyometric training program on such variables as explosive power, agility, speed, and athletic performance in volleyball. This research can yield practical information to instructors (coaches), strength and conditioning experts, and sports scientists on the efficacy of plyometric training to enhance performance in female collegiate volleyball players.

## RESEARCH METHODOLOGY

### Study Design and Setting

The current experiment used a randomized pretest/posttest controlled experimental research design to determine the effect of plyometric exercise on preferred performance measures in women in the college volleyball team. This research was carried out in the International Islamic University Islamabad. Standardized environmental and test conditions were used in all training sessions, pretesting and post testing procedures to reduce measurement bias, and external variability.

The eight weeks of intervention saw experimental group undergo an organized plyometric training program alongside their usual volleyball training program whereas the control group remained in the usual volleyball practice regime without any other form of plyometric training.

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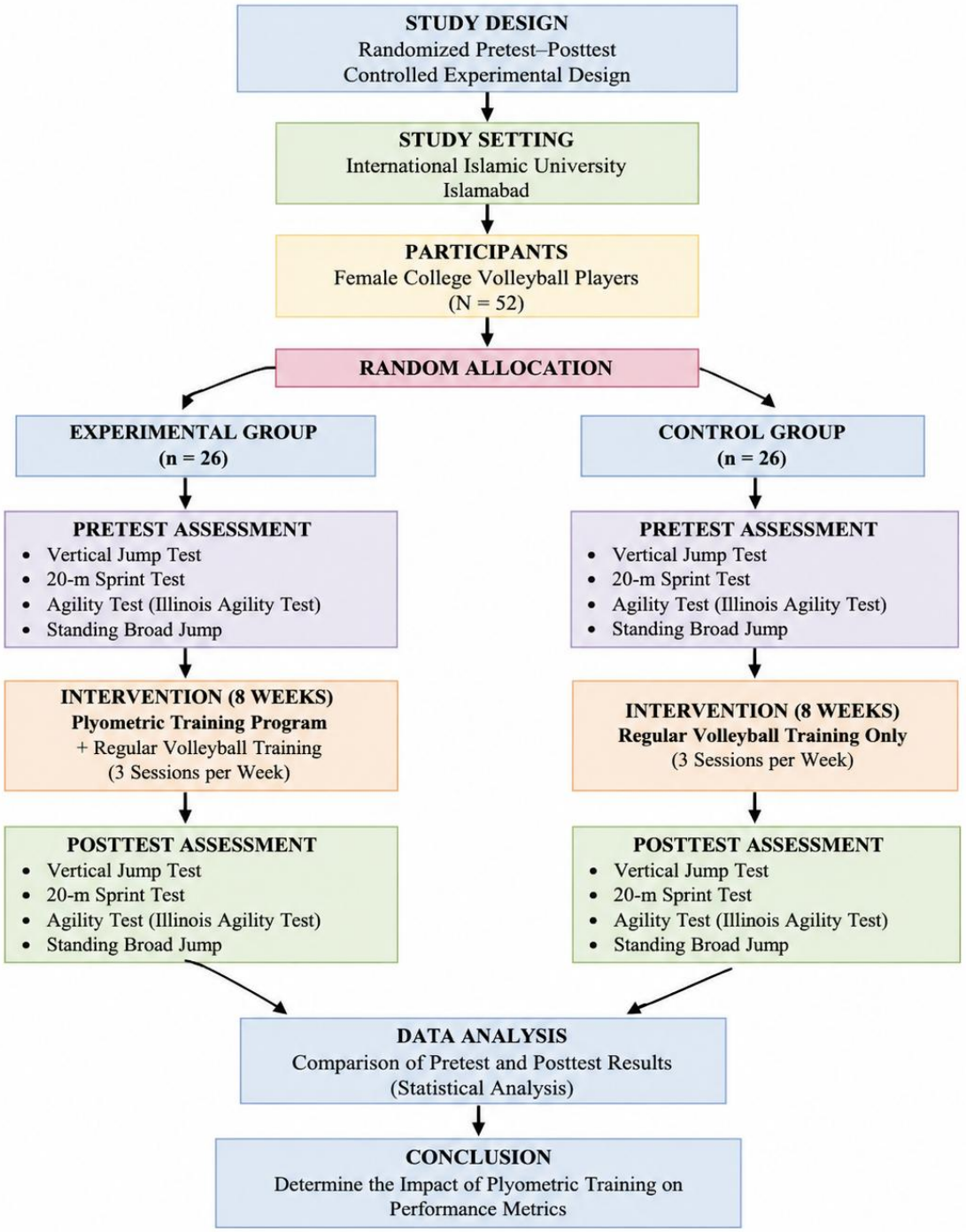


*Figure 1. Design of the Study*

**Participants and Sampling**

Women volleyball players in colleges who were between 17 and 21 years were enrolled in the research. The Government Girls Colleges of Islamabad were approached via their physical education teachers and sports coordinators to play at

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the Colleges. To start with, 58 volleyball players received contacts but only 52 players met the inclusion criteria and volunteered to take part in the study.

The participants were selected based on the following criteria:

(a) were 17–21-year-old female volleyball players;

(b) had not less than one year experience in volleyball playing;

(c) regularly participated in college-level volleyball training and competitions; and

(d) were in good physical health to undergo high intensity physical training.

The participants were not allowed in case they:

(a) had any musculoskeletal injury or neurological disorder;

(b) were physically impaired by medical conditions;

(c) had just attended some other organized strength or plyometric training program; or

(d) attended less than 85% of the sessions of the intervention.

Simple randomization was employed in assigning the participants to Experimental Group (EG; n = 26) and Control Group (CG; n = 26).

G*Power version 3.1.9.7 was used to determine the size of the sample. Repeated-measures analysis of variance was performed (ANOVA) within-between interaction with an a priori power analysis. Such analysis has been conducted in terms of an effect size of 0.25 (medium effect), alpha of 0.05, statistical power of 0.80, two groups, and two measurement occasions (pretest and posttest). In order to determine the necessary sample size, there were 44 participants. To account drops out and missing data, the sample size was oversized by about 15 to give the final sample of 52 respondents. All the inferential statistical analyses had a 95% CI in the study.

Informed consent was taken in writing before data collection among all the participants. The purpose, procedures, benefits, as well as the potential risks of the study were explained to the participants. All the information gathered during the research was kept confidential, and the participants were free to participate voluntarily.

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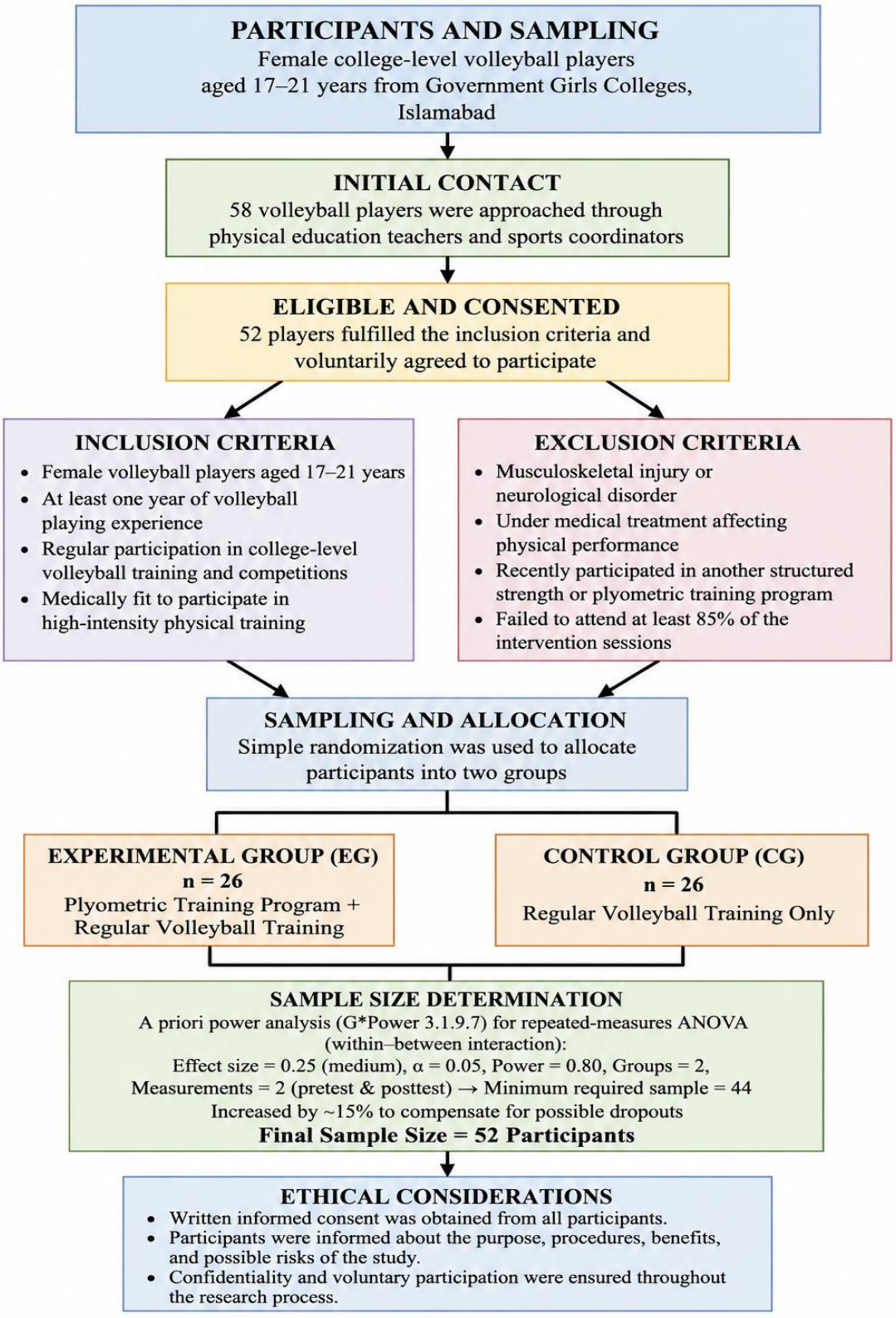


*Figure 2. Flowchart of Participants and Sampling*

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**Intervention and Assessment**

The experimental group underwent an eight-week plyometric training program that had three sessions in non-consecutive days. One training session was between 45 and 60 minutes and was led by qualified physical education and sports science professionals.

The plyometric training program comprised of progressive lower-body explosive exercises such as squat jumps, tuck jumps, box jumps, lateral jumps, bounding exercises, split jumps, and depth jumps. The level of training was increased gradually during the intervention period and volume, in order to provide progressive overload with a reduced risk of injury. In every session, there was a common warm-up and cool-down.

The control group just resumed their normal volleyball training sessions without any involvement in any extra plyometric training.

Before the intervention period, the performance was tested and the performance after the intervention period was tested under the same testing conditions. The performance variables, which were measured, are as follows:

**Table 1:** ***Performance Variables, Assessment Tests, and Units of Measurement***

| S.No | Variable | Test Used | Unit of Measurement |
|---|---|---|---|
| 1 | Vertical Jump Performance | Sargent Vertical Jump Test | Centimeters (cm) |
| 2 | Speed | 20-Meter Sprint Test | Seconds (s) |
| 3 | Agility | Illinois Agility Test | Seconds (s) |
| 4 | Lower Body Muscular Power | Standing Broad Jump Test | Centimeters (cm) |

Familiarization trials were conducted on participants prior to official testing to minimize the learning effect and enhance measurement reliability. All testing was done by trained assessors and through standardized testing procedures.

Statistical Analyses

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IBM SPSS Statistics were used to analyze the data. Mean and standard deviation (Mean + SD) of the study variables were computed by calculating descriptive statistics.

The skew and kurtosis values were used to check the normality of the data distribution, which was analyzed by the ShapiroWilk test. Independent samples t-tests were used to determine the baseline equality between the control group and the experimental group.

A two-way repeated-measures ANOVA was used to analyze the influences of plyometric training on performance variables to test the effects of time, group, and joint time x group effects. Post hoc comparisons adjusted with Bonferonni were made when they had significant interaction.

To obtain the degree of intervention effects, partial eta squared (eta 2 p ) was used to calculate effects. The statistical significance threshold to be considered was $p < .05$ with a 95% confidence interval being kept in all analyses.

**Results**

**Table 1:** ***Demographic Characteristics of Female College Volleyball Players (N = 52)***

| **Variable** | **Experimental Group (n = 26)** | **Control Group (n = 26)** | **Total (N = 52)** |
|---|---|---|---|
| Age (years) | 19.12 ± 1.31 | 18.96 ± 1.42 | 19.04 ± 1.36 |
| Height (cm) | 163.81 ± 5.44 | 164.27 ± 5.71 | 164.04 ± 5.54 |
| Weight (kg) | 56.83 ± 6.12 | 57.15 ± 5.98 | 56.99 ± 6.01 |
| Playing Experience (years) | 3.11 ± 1.08 | 3.27 ± 1.14 | 3.19 ± 1.10 |

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**Table 2:** ***Baseline Comparison of Performance Variables Between Experimental and Control Groups***

| Variable | Experimental Group Mean ± SD | Control Group Mean ± SD | t | p | Cohen's d |
|---|---|---|---|---|---|
| Vertical Jump (cm) | 33.46 ± 3.81 | 33.12 ± 3.69 | 0.33 | .744 | 0.09 |
| 20-m Sprint (s) | 3.91 ± 0.19 | 3.94 ± 0.22 | -0.53 | .599 | 0.14 |
| Illinois Agility Test (s) | 18.64 ± 0.82 | 18.71 ± 0.79 | -0.31 | .756 | 0.08 |
| Standing Broad Jump (cm) | 164.77 ± 10.54 | 163.81 ± 11.12 | 0.32 | .752 | 0.09 |

**Table 3:** ***Descriptive Statistics for Pretest and Posttest Performance Variables***

| Variable | Group | Pretest Mean ± SD | Posttest Mean ± SD |
|---|---|---|---|
| Vertical Jump (cm) | Experimental Group | 33.46 ± 3.81 | 39.15 ± 3.94 |
| | Control Group | 33.12 ± 3.69 | 33.58 ± 3.77 |
| 20-m Sprint (s) | Experimental Group | 3.91 ± 0.19 | 3.61 ± 0.17 |
| | Control Group | 3.94 ± 0.22 | 3.91 ± 0.21 |
| Illinois Agility Test (s) | Experimental Group | 18.64 ± 0.82 | 17.39 ± 0.71 |
| | Control Group | 18.71 ± 0.79 | 18.58 ± 0.77 |
| Standing Broad Jump (cm) | Experimental Group | 164.77 ± 10.54 | 178.65 ± 11.28 |
| | Control Group | 163.81 ± 11.12 | 165.04 ± 10.87 |

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**Table 4:** ***Repeated-Measures ANOVA for Performance Variables***

| Variable | Source | F | p | Partial $\eta^2$ |
|---|---|---|---|---|
| Vertical Jump | Time | 82.41 | < .001 | .622 |
| | Group | 14.28 | < .001 | .222 |
| | Time × Group | 76.57 | < .001 | .605 |
| 20-m Sprint | Time | 64.39 | < .001 | .563 |
| | Group | 9.74 | .003 | .163 |
| | Time × Group | 58.21 | < .001 | .538 |
| Illinois Agility Test | Time | 71.12 | < .001 | .587 |
| | Group | 11.45 | .001 | .186 |
| | Time × Group | 66.73 | < .001 | .572 |
| Standing Broad Jump | Time | 79.64 | < .001 | .614 |
| | Group | 13.18 | < .001 | .209 |
| | Time × Group | 73.29 | < .001 | .594 |

**Table 5:** ***Within-Group Pretest and Posttest Comparisons***

| Variable | Group | Mean Difference | t | p | Cohen's d |
|---|---|---|---|---|---|
| Vertical Jump (cm) | Experimental Group | 5.69 | 10.82 | < .001 | 1.92 |
| | Control Group | 0.46 | 1.09 | .286 | 0.18 |
| 20-m Sprint (s) | Experimental Group | -0.30 | -9.37 | < .001 | 1.71 |
| | Control Group | -0.03 | -0.88 | .387 | 0.16 |
| Illinois Agility Test (s) | Experimental Group | -1.25 | -11.46 | < .001 | 2.01 |
| | Control Group | -0.13 | -1.17 | .253 | 0.21 |
| Standing Broad Jump | Experimental | 13.88 | 9.94 | < .001 | 1.79 |

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| Variable | Group | Mean Difference | t | p | Cohen's d |
|---|---|---|---|---|---|
| (cm) | Group | | | | |
| | Control Group | 1.23 | 1.02 | .317 | 0.17 |

The results indicated that all the performance variables selected were significantly improved in the experimental group after the eight-week plyometric training intervention. There were significant Time-Group interaction effects on vertical jump performance, sprint speed, agility, and standing broad jump performance ($p < .001$). Conversely, the control group experienced low and insignificant changes in most of the performance variables. The results of these studies imply that plyometric training was useful in increasing explosive strength, velocity, agility and muscle lower-body performance among female college volleyball players.

**Discussion**

The current research examined the effect of an eight-week plyometric exercise program on the measure of performance of a selected group of performance measures in female college volleyball players. The results showed that there were great improvements in the performance of vertical jump, sprint speed, agility as well as lower-body muscular power in the experimental group in comparison with the control group. The findings suggest that well organized plyometric training can be considered as an effective conditioning technique to improve physical performance related to volleyball in female college players.

Among the biggest results of the study, there was a significant increase in vertical jump performance after the plyometric intervention. In volleyball, there is repetitive explosive jumping involved in blockage and attack activities and the power of the lower limbs is a crucial factor contributing to the performance of competitiveness. The improvements that are observed could be explained by the changes in better use of stretch-shortening cycle, better motor unit recruitment, and better neuromuscular coordination which lead to repetitive explosive exercises. Ramirez-Campillo et al. (2020) found similar results and showed significant improvements in jump performance in young female athletes due to plyometric training based on neuromuscular adaptations and increased reactive strength

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capacity. Similarly, Slimani et al. (2019) have concluded that plyometric training is very useful in enhancing explosive performance and jump-related skills among team-sport athletes.

The outcomes also indicated that there were significant gains in sprint speed of those participants that underwent the plyometric training program. Volleyball sprint performance is imperative as during rallies athletes must carry out rapid accelerations and short-distance movements. The enhancement of the sprint performance as was seen in the current study, could be linked to the greater production of lower-limb force, a greater musculotendinous rigidity, as well as the effective velocity of force development. These findings have been supported by previous evidence. Moran et al. (2021) announced that plyometric exercises had a significant effect on sprinting speed as they enhanced lower-body explosive strength and efficiency of movement in adolescent athletes. Moreover, Loturco et al. (2021) have found that explosive strength training plays a role in accelerating faster and enhancing sprint mechanics on a court during volleyball and other court-based sports.

The other significant finding of the research was that there was great improvement in the agility performance of female volleyball players. Agility is a performance aspect that is essential to volleyball since players must be able to change directions fast, balanced and controlled. The difference in Illinois Agility Test time is that the plyometric intervention was beneficial regarding dynamic stability, neuromuscular responsiveness, and coordination during multidirectional patterns of movement. The results are in accordance with the study of Chaabene et al. (2019), which indicated that change-of-direction speed and movement control in female athletes are positively affected through plyometric training. In a similar way, Pereira et al. (2021) reported that explosive multidirectional exercises enhance the performance of agility and capacity of reactive movement among volleyball players.

The current study also showed significant increases in standing broad jump performances that showed to be due to increased lower-body muscular power. Plyometric exercises are those exercises that engage repeated eccentric/ concentric movement of muscles, which activates muscle-tendon stiffness and force-generating

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capacity adaptations. These physiological adjustments have also led to better horizontal and vertical force production, which have positive links with the volleyball-specific athletic tasks. The results are in line with the existing literature indicating that plyometric sessions are associated with beneficial effects in enhancing lower-extremity power and athletic performance in female athletes who have participated in sports like plyometric training (Markovic and Mikulic, 2020).

The improvements observed may as well be linked to the progressive design of the intervention program due to its magnitude. The progressive nature of the training intensity and the complexity of exercise probably facilitated the constant kind of neuromuscular adaptation but also reduced the risk of excessive fatigue and injury. Past research underscore the importance of progressive overload, as well as exercise specificity in maximizing the effectiveness of plyometric training programs within athletic populations (Cormie et al., 2021). Sport-specific explosive training seems especially effective in volleyball as the movements required in this sport are closely similar to the reactionary and jumping kicks when playing or competing.

A noteworthy finding of the existing research was that the control group showed slight and statistically insignificant gains in most performance variables. This observation may indicate that intensive volleyball training might not result in significant explosive power, sprinting speed, and agility improvements in a brief period of training. Conversely, structured plyometric exercise added to the exercises produced a higher neuromuscular stimulus that could be used to produce meaningful alterations in the performance. Sanchez-Sixto et al. (2021) made similar conclusions but observed supplementing plyometric conditioning with sports practice alone can significantly improve athletic performance.

The results of the current research can be applied to practitioners in volleyball, strength and conditioning and physical education. Structured plyometric exercises can serve as part of volleyball conditioning programs, potentially leading to enhanced athletic performance, specifically with regards to explosive and movement-related activities. Furthermore, the favorable results of female college athletes demonstrate that the plyometric training may be easily and safely used in the field of collegiate sport under the condition of observing proper supervision and

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development principles.

Important findings like these, however, must be considered in the light of some limitations. The research was constituted of participants within a small geographical region, and restricted to female volleyball players in college, which might not be relevant to other population groups of athletes. Also, the intervention period was not long enough and such physiological variables as the type of muscle activation or biomechanical variations were not examined. The future research ought to focus on long-term plyometric interventions, diversify samples, and explore biomechanical and physiological adaptations related to volleyball-specific performance improvement.

**Conclusion**

The results of the current study showed that the eight weeks plyometric training program had a significant positive effect on the VTB performance, sprint speed, agility and lower-body muscular power in female college volleyball players. Plyometric training than traditional volleyball practice alone showed more favorable results on physical performance related to volleyball. So, plyometric exercises might be implied as the suitable type of training to improve the athletic activity of female college volleyball players.

**Limitations and Future Directions**

The current investigation was only inclusive of female volleyball athletes of the Few Government Girls Colleges in the city of Islamabad, which personalizes the conclusions to other groups and level of competitiveness. Also, only eight weeks of intervention were considered; consequently, long-term consequences of plyometric training on volleyball performance were not studied. It is suggested that future research incorporates larger and more heterogeneous samples in other regions and classes of the competition. In addition, future studies are required to study the physiological and biomechanical consequences of plyometric training in the long term by extending the duration of intervention and developing other sophisticated methods of measuring performance.

**Research Implications**

The results of the current research add to the accumulating body of literature about

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the efficiency of plyometric training to enhance volleyball-specific performance in female athletes. The research gives a practical test that organized plyometric training has the capacity to considerably boost explosive force, pace, agility, and lower body muscle capability in college volleyball athletes. Such results can be used by coaches, physical educators, and strength and conditioning experts to create evidence-based training programs among female volleyball players.

The research paper also notes how sport specific neuromuscular training should be applied in the context of collegiate sports which can help in maximizing athletic performance. Besides, the results give a basis on future experimental studies on the relationship of varying plyometric training intensity, durations and training surfaces with volleyball performance and injury prevention.

**Conflict of Interest**

The authors assert that there are no conflicts of interest when it comes to publication of this study.

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