

The effect of upper body plyometric training program on young women volleyball players in their usual training program

-  **Jithin Das T K** . Department of Physical Education and Sports Sciences. Faculty of Science and Humanities. SRM Institute of Science and Technology. Kattankulathur, Tamil Nadu, India.
-  **Sigamani Jayasingh Albert Chandrasekar**. Department of Physical Education and Sports Sciences. Faculty of Science and Humanities. SRM Institute of Science and Technology. Kattankulathur, Tamil Nadu, India.
-  **Ganesh R.** Department of Physical Education and Sports Sciences. Faculty of Science and Humanities. SRM Institute of Science and Technology. Kattankulathur, Tamil Nadu, India.
-  **Fuad Sharaf V C.** Department of Physical Education. WMO Arts and Science College. Muttill, Kerala, India.
-  **Sooryajith K V.** Department of Physical Education and Sports Sciences. Faculty of Science and Humanities. SRM Institute of Science and Technology. Kattankulathur, Tamil Nadu, India.
-  **Thamaraiselvi Saravanakumar.** Department of Yoga. Faculty of Science and Humanities. SRM Institute of Science and Technology. Kattankulathur, Tamil Nadu, India.

ABSTRACT

The study was to find out the effect of upper body plyometric training program on young women volleyball player's hand grip strength and upper body explosive power in their usual training program. For this study, twenty-four female volleyball players were selected as the participants and they randomly allocated to either experimental group or control group. The experimental group had 8 weeks of training program along with their usual training and control group had not special training. Training effects were analysed by independent t-tests. The significance level was set at .05. Notable improvements in HG and UBES were recorded in post values of between the experimental and control group. [HG: $t(11) = -4.020, p < .001$], [UBES: $t(11) = -3.213, p = .004$]. Conversely no significant improvements in HG and UBES were recorded in pre values of between the experimental and control group. [HG: $t(11) = -0.954, p = .350$], [UBES: $t(11) = 0.439, p = .665$] in performance of both variables. The study concluded that upper body plyometric training program can effective modality for enhancing hand grip strength and upper body explosive power on young women volleyball players.

Keywords: Performance analysis, Upper body plyometric training, Hand grip strength, Upper body explosive strength, Volleyball players.

Cite this article as:

T K, J. D., Chandrasekar, S. J. A., R, G., V C, F. S., K V, S., & Saravanakumar, T. (2026). The effect of upper body plyometric training program on young women volleyball players in their usual training program. *Journal of Human Sport and Exercise*, 21(2), 544-552. <https://doi.org/10.55860/sq75hp32>



Corresponding author. Department of Physical Education and Sports Sciences. Faculty of Science and Humanities. SRM Institute of Science and Technology. Kattankulathur, Tamil Nadu, India.

E-mail: jithindastk@gmail.com

Submitted for publication December 19, 2025.

Accepted for publication January 21, 2026.

Published February 21, 2026.

[Journal of Human Sport and Exercise](https://doi.org/10.55860/sq75hp32). ISSN 1988-5202.

©Asociación Española de Análisis del Rendimiento Deportivo. Alicante. Spain.

doi: <https://doi.org/10.55860/sq75hp32>

INTRODUCTION

The sport of volleyball involves a great deal of physical activity, such that the players must possess physical fitness to shine in the game (Kasur et al., 2015; Marques et al., 2009; Sheppard et al., 2009). Rapid, forceful actions like serving, spiking, blocking, and setting require the shoulders, arms, and hands to be heavily involved as players are expected to perform them most of the time (Marques, et al. 2009). Continuous and repetitive movements constitute the characteristics of the game, thus exerting considerable pressure on different muscle groups (Chelly et al., 2009). To fulfil such requirements, athletes have to produce the maximum force repeatedly with physical efficiency during the match. With the competitiveness and speed at which the game is played, particularly in youth and elite levels, physical fitness becomes the utmost priority (Sheppard et al., 2009). In this regard, the upper body strength and explosive power have become a crucial factor in successful performance in attacking and defensive behaviours. In addition to it, a physically fit athlete can maintain strenuous activity without premature exhaustion, which gives any participant a tremendous competitive advantage (Gabbett, 2016). With the ever-growing competitive standards, there is a greater rise in demand for players who are technically competent and also have better physical relatedness. Volleyball requires greater upper body strength, explosiveness, and gripping strength due to the physical exertion requirements of the sport, especially in athletes in the developmental stage (Marques et al., 2008).

Volleyball is a game that involves coordinated muscle movements, especially among the arms, shoulders, chest, and forearms, so that athletes can coordinate forceful strikes with balls that cause repeated contacts, but remain in control and precise (Chou et al., 2025). On the other side, a strong grip is essential in managing the ball in receiving, setting, and spiking, and in the overall effort in striking and blocking (Camacho-Villa et al., 2024). Increased grip capabilities also help to avoid injuries related to the wrist and forearms and contribute to stability in the joints. Grip strength is unlikely to be a main emphasis of a volleyball conditioning program, even though it is important (Wiliński et al., 2022).

Compared to their traditional strength training protocols that mostly focus on enhancing the overall muscular strength, the traditional strength training may be unsuitable to meet the sport-specific explosive demands of volleyball. The more dynamic plyometric training or upper-body plyometric training (UBPT) aims to increase neuromuscular efficiency and power production and reactive strength by facilitating stretch-shortening cycles (SSC) (Garcia-Carrillo et al., 2023). Uniting the upper body plyometric training can also indirectly reflect on the better grip strength, as it targets the forearm muscles that focus on producing the same explosive pushing and throwing. In addition, plyometric exercises above the waist not only improve the power production capacity but also lead to better proprioception, joint stability, and movement economy in play (Wang & Xu, 2025).

Although the benefits of the plyometric training on lower-body performance of players in volleyball were reported in the past, little is known of the isolated effects of upper-body plyometric training on specifically named measures of hand grip strength and explosive power in upper-body performance. The results could help facilitate the implementation of sport-specific conditioning and educate coaches and trainers about the strategies enhancing volleyball performance optimization. However, there is few studies have examined the plyometric training affects grip strength and overall upper body explosive power in the field of volleyball. Addressing this gap could provide valuable insight into the performance enhancement. Therefore, the purpose of this study to find out the effect of upper body plyometric training program on young women volleyball player's hand grip strength and upper body explosive power in their usual training program. The findings may provide valuable insights into the effectiveness of UBES on these variables to inform coaches,

strength and conditioning professionals, and athletes about the need to maximize performance with the help of holistic methods of training.

MATERIALS AND METHODS

Participants

Twenty four female volleyball players from SRM Institute of Science and Technology, Kattankulathur, Chennai were selected as the participants for the study. The investigator informed benefits and risk of the study. Injured or illness players not selected for the study and all the participants had 5 years volleyball training background. Informed consent was collected from all the participants. They were randomly allocated to either experimental group or control group with 12 participants each group.

Experimental design and procedure

This study was a longitudinal training experiment; the experimental group had 8 weeks of upper body plyometric training program along with their usual training and control group had not special training. Pre and post testing completed before and after training program.

Training program

The participants had two training sessions per week, and duration was 90 minutes. The participants in experimental group completed the upper body plyometric exercises. All the participants have got detailed instruction about how to perform exercise properly before starting the training program.

Table 1. Training program of 8 weeks upper body plyometric training.

Week	Warm Up	Exercises	Sets	Reps	Rest(Min)	Warm Down
1-2	Dynamic	Medicine ball chest pass	3	10	1	
3-4	stretching,	Plyometric pus-up	3	15	1	Limbering
5-6	Rotatory	Two hand over head throw	4	10	1	down
	movements,	Two hand side to side throw				exercises,
7-8	Mobility	Single arm throw	4	15	1	static
	exercises	Power drop				stretching

The training program starts with 10 minutes of warm up period which includes dynamic stretching, rotatory movements, and mobility exercises. After the warming up session, the participants were a performed plyometric exercise which includes six exercises and after finishing starts with warm down exercises. Detailed training schedule presented in the Table 1.

Criterion measures

Pre and post tests were conducted before and after an eight week training program. Hand grip strength (HG) and upper body explosive strength (UBES) were measured by hand grip dynamometer and Medicine ball throw test (Genç, & Dağlıoğlu, 2021; Kim et al., 2022; Turgut et al., 2019).

Statistical analysis

In this study, several statistical methods were employed to analyse the data. The Shapiro-Wilk test indicated that the data were normally distributed ($p > .05$); therefore, parametric tests were employed in this study. After confirming normality Independent t test were used to assess the effect within the group. The significance level was set at .05 level. SPSS software was used for analysis.

RESULTS

The baseline characteristics of the experimental group and control group including age, height, and weight were compared before the training (Table 2). The results indicated no statistical difference ($p > .05$) in baseline characteristics. These results demonstrate that the two groups were similar at the baseline, meaning that the difference that takes place thereafter can be ascribed to the training program and not to the existing differences.

Table 2. Results of independent t test for identifying Base line group difference of experimental and control group on selected variables.

Group	Mean \pm SD		p-Value
	EG	CG	
Age	20.583 \pm 1.50	21.083 \pm 1.832	.473
Hieght	171.25 \pm 10.61	168.917 \pm 9.08	.569
Weight	61.083 \pm 7.16	59.083 \pm 6.748	.489

Note. EG = Experimental group, CG = Control group, Data are presented as Mean \pm SD, Level of significance = .05.

Table 3. Independent t test between pre values of experimental and control groups.

Variables	Mean \pm SD		Mean difference	95% CI for mean differences		t	p-Value	Effect size d
	EG Pre	CG Pre		Lower	Upper			
UBES	3.304 \pm 0.564	3.096 \pm 0.504	-0.208	-0.661	0.244	-0.954	.350	-0.390
HG	29.442 \pm 4.927	30.150 \pm 2.638	0.708	-2.638	4.054	0.439	.665	0.179

Note. Note: HG = Hand grip strength, UBES = Upper body explosive strength, EG = Experimental group, CG = Control group, Level of significance = .05.

The Table 3 compares the pre-test performance of the Experimental Group (EG) and Control Group (CG) on two variables: Upper Body Explosive Strength (UBES) and Hand Grip Strength (HG). It shows that there were no significant differences in both UBES (p -value of .350 $>$.05) and HG (p -value of .665 $>$.05) between the experimental and control group during Baseline, confirming that both groups were comparable before the intervention.

Table 4 presents the post-test comparison between the Experimental Group (EG) and Control Group (CG) for Upper Body Explosive Strength (UBES) and Hand Grip Strength (HG).

Table 4. Independent t test for post values between EG and CG.

Variables	Mean \pm SD		Mean difference	95% CI for mean differences		t	p-Value	Cohen's d
	EG Post	CG Post		Lower	Upper			
UBES	3.975 \pm 0.580	3.104 \pm 0.476	-0.871	-1.320	-0.422	-4.020	<.001	-1.641
HG	34.133 \pm 3.257	30.250 \pm 2.630	-3.883	-6.390	-1.377	-3.213	.004	-1.312

Note. HG = Hand grip strength, UBES = Upper body explosive strength, EG = Experimental group, CG = Control group, Level of significance = .05.

For UBES, the EG (3.975 \pm 0.580 m) showed a considerably higher mean score compared to the CG (3.104 \pm 0.476 m). The mean difference was -0.871 , with a 95% confidence interval ranging from -1.320 to -0.422 , which does not include zero. The t-value (-4.020) with a p -value $<$.001 indicates a highly significant difference in favour of the experimental group. The effect size (Cohen's $d = -1.641$) suggests a very large effect, highlighting a strong impact of the intervention on UBES.

For HG, the EG (34.133 ± 3.257 kg) also recorded higher mean values compared to the CG (30.250 ± 2.630 kg). The mean difference was -3.883 , with a 95% confidence interval between -6.390 and -1.377 . The t -value (-3.213) with a p -value of $.004$ ($<.01$) shows a statistically significant difference favouring the experimental group. The effect size (Cohen's $d = -1.312$) indicates a large effect, confirming a meaningful improvement in hand grip strength for the EG compared to the CG.

The independent t -test results reveal that the experimental group showed significantly greater improvements than the control group in both upper body explosive strength and hand grip strength, with large effect sizes. This indicates that the intervention was highly effective.

DISCUSSION

The study was found out the effect of upper body plyometric training program on young women volleyball player's hand grip strength and upper body explosive power in their usual training program. The findings of the study indicate that upper body plyometric training program significantly improved both hand grip strength and upper body explosive power compared to the control group after the intervention. These observations emphasize the effectiveness of upper body plyometric training in improving hand grip strength and upper body explosive power.

The results of the present study are in line with earlier observations; plyometric training has always proven to be an effective tool in improving sport-specific physical qualities in various sports (Ramirez-Campillo et al., 2022). Our study results are consistent with the previous studies, for instance, experiments with handball players (Yanti et al., 2024), ball badminton players (Sawant, 2023), and volleyball players (Pereira et al., 2015) have shown that not only upper body performance, such as throwing strength but also lower body performance, such as vertical jump and extremity power were significantly enhanced through plyometric exercises. Even a short-term intervention on a 4-week upper extremity program involving wheelchair athletes (PASHA et al., 2024) resulted in enhanced trunk balance and fitness. And longer intervention, such as a 12-week program in soccer players (Siby et al., 2025) resulted in overall improvements in agility, speed, explosive power, leg and core strength. All of these studies cumulatively prove that plyometric training improves explosive and functional capacitive tasks related to competitive sport.

Plyometric training has become one of the most effective modalities in terms of the simultaneous acquisition of game-specific abilities, as well as various physical qualities in a wide range of sports (Zhou et al., 2024). Plyometric training in the upper body of volleyball players during a sports season has been shown to dramatically enhance the speed of a spike (Valadés Cerrato et al., 2018) and another study affirmed that plyometric training in the upper body also enhances the performance-relevant skills in serving among female volleyball players (Uzor et al., 2023), showing a direct transfer of plyometric training into a performance-relevant technique. In addition to skill improvement, plyometrics also addresses the various aspects of athletic capacity: a 10-week intervention in young handball female athletes led to significant gains in handgrip strength, back extensor strength, medicine ball throw, sprint performance, change of direction and vertical jump ability (Hammami et al., 2020). This and similar findings explore that plyometric training is not only specific to the refinement of game-specific actions crucial to the success of sports, such as volleyball, but also produces wide-ranging multidimensional benefits among athletes across different competitive environments.

Plyometric training is effective in improving physical capacities as well as game-specific performance in a variety of sports (Ramirez-Campillo et al., 2023). Our study results are reliable with previous studies, as an

example, plyometric training of upper limbs among young male tennis players resulted in significant improvements of muscle strength, power, and serve velocity (Wang & Xu, 2025), whereas a combination of ten exercises of throwers with plyometric weight training resulted in significant increases of throwing distance, as well as the strength of the hand grip in shot put athletes (Ramkumar et al., 2024). In the same line of thought, upper-body plyometric exercise produced significant gains in maximal strength, medicine ball throw, sport-specific throwing performance, and the volume of upper-limb muscle among youth and young adults (Garcia-Carrillo et al., 2023). These results are further supported by laboratory data, which indicates that manipulating the mass of medicine balls during plyometric throwing exercises is effective in increasing the release momentum of the ball and upper-limb power output, thus providing a valid biomechanical explanation of safe load progression (Riemann et al., 2019). Taken together, these results not only develops the essential physical qualities but also transfer directly to game-specific skills, so that plyometric training acts as a dual role as a physical conditioner and technical performance enhancer.

Meta-analytical data support the use of plyometric training in the development of overall physical qualities and sport-specific abilities with a high level of evidence. A meta-analysis of 11 studies with 302 respondents reported great enhancements in countermovement and squat jumps, change-of-direction, sprint ability, throwing skills, jumping throw, penalty throw, repeated sprint ability, upper-limb peak power and bilateral handgrip strength in handball players (Hang et al., 2025). To add to this, a meta-analysis of 15 moderate-to-high-quality studies that included 523 athletes aged 12-22.4 years in total and used a combination of upper- and lower-limb plyometric interventions, confirmed that such interventions produced significant muscle-power, sprint-speed, strength, agility, and flexibility improvements (Deng et al., 2022). In addition to performance enhancement, plyometric exercise has also been identified as a vital rehabilitation device, which mediates recovery with return to sport by enhancing the stretch-shortening cycle, neuromuscular coordination, and explosive power (Davies et al., 2015). Combined, these meta-analytical results support strong evidence that plyometric training, when done systematically, not only enhances physical fitness parameters but also reinstates sport-specific preparedness, minimizes risks of injury, and necessitates safe and confident re-entry into competitive play. Thus, in this study indicates the favourable effect of upper body plyometric training on hand grip strength and upper body explosive power. So, our study suggests that upper body plyometric training is an effective and practical intervention for enhancing grip strength and upper body explosive power. UBPT an attractive for coaches, strength and conditioning professionals, and athletes to force- enhance volleyball skills like blocking, spiking, serving, and passing which depend on both grip and upper-body speed. Grip strength and upper body explosive power improvements may also help to better joint stability and less fatigue from repeated and quick movements, which could reduce the risk of overuse injuries.

The study showed positive outcomes, but there has few limitations. The size of the sample was small, that can limit the generalizability of results. Moreover, the present study concentrated on variables such as hand grip strength and upper body explosive power, future research could employ more variables and new method of measurements. It is recommended that future research should suggested to use longer training periods, compare with other training modalities, and investigating physical and performance variables.

CONCLUSIONS

Results of the presented study suggest that upper body plyometric training program can effective modality for enhancing hand grip strength and upper body explosive power. essential for volleyball, like rapid and continuous limb movement and force production. The findings add to the literature by showing evidence of benefit on performance that due to the plyometric training in women athletes.

AUTHOR CONTRIBUTIONS

Conceptualization, JD and SJAC; methodology, JD SJAC, and GR; investigation, JD, FS, SKV; resource, JD, GR, FS; data curation, JD and TS; writing, JD, GR; writing review and editing, JD, SKV; supervision, JD AND SJAC.

SUPPORTING AGENCIES

No funding agencies were reported by the authors.

DISCLOSURE STATEMENT

No potential conflict of interest was reported by the authors.

ACKNOWLEDGEMENTS

We would like to thank all the subjects for their engagement and effort in helping us in this very important research.

REFERENCES

- Camacho-Villa, M. A., Hurtado-Alcoser, J., Jerez, A. S., Saavedra, J. C., Paredes Prada, E. T., Merchán, J. A., Millan-Domingo, F., Silva-Polanía, C., & De la Rosa, A. (2024). Handgrip Strength and Upper Limb Anthropometric Characteristics among Latin American Female Volleyball Players. *Journal of Functional Morphology and Kinesiology*, 9(3), 168. <https://doi.org/10.3390/jfmk9030168>
- Chelly, M. S., Fathloun, M., Cherif, N., Ben Amar, M., Tabka, Z., & Van Praagh, E. (2009). Effects of a back squat training program on leg power, jump, and sprint performances in junior soccer players. *Journal of strength and conditioning research*, 23(8), 2241-2249. <https://doi.org/10.1519/JSC.0b013e3181b86c40>
- Chou, K. Y., Wu, W. L., Chiu, C. W., Cheng, S. C., & Chang, H. Y. (2025). Adaptation Characteristics in the Range of Motion of the Shoulder Among Young Male Volleyball Players. *Journal of functional morphology and kinesiology*, 10(1), 67. <https://doi.org/10.3390/jfmk10010067>
- Davies, G., Riemann, B. L., & Manske, R. (2015). Current concepts of plyometric exercise. *International journal of sports physical therapy*, 10(6), 760-786.
- Deng, N., Soh, K. G., Zaremohzabieh, Z., Abdullah, B., Salleh, K. M., & Huang, D. (2022). Effects of Combined Upper and Lower Limb Plyometric Training Interventions on Physical Fitness in Athletes: A Systematic Review with Meta-Analysis. *International journal of environmental research and public health*, 20(1), 482. <https://doi.org/10.3390/ijerph20010482>
- Gabbett T. J. (2016). The training-injury prevention paradox: should athletes be training smarter and harder?. *British journal of sports medicine*, 50(5), 273-280. <https://doi.org/10.1136/bjsports-2015-095788>
- Garcia-Carrillo, E., Ramirez-Campillo, R., Thapa, R. K., Afonso, J., Granacher, U., & Izquierdo, M. (2023). Effects of Upper-Body Plyometric Training on Physical Fitness in Healthy Youth and Young Adult Participants: A Systematic Review with Meta-Analysis. *Sports medicine - open*, 9(1), 93. <https://doi.org/10.1186/s40798-023-00631-2>
- Genç, F. A., & Dağlıoğlu, Ö. (2021). Effect of plyometric training program on athletic performance in young taekwondo athletes. *European Journal of Physical Education and Sport Science*, 7(5). <https://doi.org/10.46827/ejpe.v7i5.4089>

- Hang, F., Zhong, Y., Zhu, L., & Feng, S. (2025). Meta-analysis of the effects of plyometric training on athletic performance in handball athletes. *Scientific Reports*, 15(1), 29298. <https://doi.org/10.3390/app11031309>
- Hammami, M., Gaamouri, N., Suzuki, K., Shephard, R. J., & Chelly, M. S. (2020). Effects of Upper and Lower Limb Plyometric Training Program on Components of Physical Performance in Young Female Handball Players. *Frontiers in physiology*, 11, 1028. <https://doi.org/10.3389/fphys.2020.01028>
- Kausar, A., Mudassir, S., Badaam, K. M., Shete, A. N., & Khan, S. (2015). Cardiorespiratory Fitness of University Volleyball Players and Sedentary Young People in Marathwada Region of Maharashtra Province in India. *Journal of clinical and diagnostic research: JCDR*, 9(7), CC20-CC21. <https://doi.org/10.7860/JCDR/2015/14361.6246>
- Kim, S., Rhi, S. Y., Kim, J., & Chung, J. S. (2022). Plyometric training effects on physical fitness and muscle damage in high school baseball players. *Physical activity and nutrition*, 26(1), 1-7. <https://doi.org/10.20463/pan.2022.0001>
- Marques, M. C., Tillaar, R.v, Vescovi, J. D., & González-Badillo, J. J. (2008). Changes in strength and power performance in elite senior female professional volleyball players during the in-season: a case study. *Journal of strength and conditioning research*, 22(4), 1147-1155. <https://doi.org/10.1519/JSC.0b013e31816a42d0>
- Marques, M. C., van den Tillaar, R., Gabbett, T. J., Reis, V. M., & González-Badillo, J. J. (2009). Physical fitness qualities of professional volleyball players: determination of positional differences. *Journal of strength and conditioning research*, 23(4), 1106-1111. <https://doi.org/10.1519/JSC.0b013e31819b78c4>
- Pasha, M., Chivate, D., & Motimath, B. (2024). Effect of upper body plyometric training on fitness and trunk balance in wheelchair athletes-an experimental study. *Trends in Sport Sciences*, 31(4). <https://doi.org/10.23829/TSS.2024.31.4-7>
- Pereira, A., Costa, A. M., Santos, P., Figueiredo, T., & João, P. V. (2015). Training strategy of explosive strength in young female volleyball players. *Medicina (Kaunas, Lithuania)*, 51(2), 126-131. <https://doi.org/10.1016/j.medic.2015.03.004>
- Ramirez-Campillo, R., García-Hermoso, A., Moran, J., Chaabene, H., Negra, Y., & Scanlan, A. T. (2022). The effects of plyometric jump training on physical fitness attributes in basketball players: A meta-analysis. *Journal of sport and health science*, 11(6), 656-670. <https://doi.org/10.1016/j.jshs.2020.12.005>
- Ramirez-Campillo, R., Sortwell, A., Moran, J., Afonso, J., Clemente, F. M., Lloyd, R. S., Oliver, J. L., Pedley, J., & Granacher, U. (2023). Plyometric-Jump Training Effects on Physical Fitness and Sport-Specific Performance According to Maturity: A Systematic Review with Meta-analysis. *Sports medicine - open*, 9(1), 23. <https://doi.org/10.1186/s40798-023-00568-6>
- Ramkumar, S., Muthukumar, M., & Dharani, J. (2024). Effect of thrower's ten exercise along with plyometric weight training on throwing distance and hand grip strength among shot put players. <https://doi.org/10.22271/kheljournal.2024.v11.i5f.3544>
- Riemann, B. L., Hipko, N., Johnson, W., Murphy, T., & Davies, G. J. (2019). Effects of medicine ball mass on the intensity of 90°/90° plyometric throwing exercise. *Physical therapy in sport : official journal of the Association of Chartered Physiotherapists in Sports Medicine*, 40, 238-243. <https://doi.org/10.1016/j.ptsp.2019.10.002>
- Sawant, P. C. (2023). Effect of plyometric exercises on physical fitness preparation of elite ball badminton player. *International Journal of Research Pedagogy and Technology in Education and Movement Sciences*, 12(02), 188-192.
- Sheppard, J. M., Gabbett, T. J., & Stanganelli, L. C. (2009). An analysis of playing positions in elite men's volleyball: considerations for competition demands and physiologic characteristics. *Journal of*

- strength and conditioning research, 23(6), 1858-1866. <https://doi.org/10.1519/JSC.0b013e3181b45c6a>
- Siby, D., Rajkumar, N. C. J., Salvi, N. M., Karmakar, D., Valappil, I. N. K., Orhan, B. E., ... & Astuti, Y. (2025). Does three sessions of 12-week plyometric training per week improve physical fitness parameters in professional male soccer players? A randomized controlled trial. *Fizjoterapia Polska*, (1). <https://doi.org/10.56984/8ZG007DDZ6Q>
- Turgut, E., Cinar-Medeni, O., Colakoglu, F. F., & Baltaci, G. (2019). "Ballistic Six" Upper-Extremity Plyometric Training for the Pediatric Volleyball Players. *Journal of strength and conditioning research*, 33(5), 1305-1310. <https://doi.org/10.1519/JSC.0000000000002060>
- Uzor, T. N., Iwuoha, E. D., Ujuagu, N. A., & Offodile, H. N. (2023). The effects of upper body plyometric training on serving skill of female university volleyball players. *Athena: Physical Education and Sports Journal*, 1(2), 68-76. <https://doi.org/10.56773/athena.v1i2.13>
- Valadés Cerrato, D., Palao, J. M., Femia, P., & Ureña, A. (2018). Effect of eight weeks of upper-body plyometric training during the competitive season on professional female volleyball players. *The Journal of sports medicine and physical fitness*, 58(10), 1423-1431. <https://doi.org/10.23736/S0022-4707.17.07527-2>
- Wang, J., & Xu, Q. (2025). Single-session upper limb plyometric training is as effective as two sessions for improving muscle strength, power, and serve velocity in male youth tennis players: a randomized parallel controlled study. *Frontiers in psychology*, 16, 1539739. <https://doi.org/10.3389/fpsyg.2025.1539739>
- Wiliński, W., Struzik, A., Rokita, A., Krejci, M., & Wieczorek, M. (2022). Hand Grip Strength Vs. Locomotor Efficiency in Sitting Volleyball Players. *Journal of human kinetics*, 82, 275-282. <https://doi.org/10.2478/hukin-2022-0081>
- Yanti, N., Susanto, N., Putra Sastaman, B., Suryadi, D., Suganda, M. A., Kuswoyo, D. D., & Nasrulloh, A. (2024). Application of plyometric training in handball games: How effective is it on throwing power and speed? *Journal of Physical Education and Sport*, 24(5), 1183-1190. <https://doi.org/10.7752/jpes.2024.05136>
- Zhou, J. Y., Wang, X., Hao, L., Ran, X. W., & Wei, W. (2024). Meta-analysis of the effect of plyometric training on the athletic performance of youth basketball players. *Frontiers in physiology*, 15, 1427291. <https://doi.org/10.3389/fphys.2024.1427291>



This work is licensed under a [Attribution-NonCommercial-ShareAlike 4.0 International](https://creativecommons.org/licenses/by-nc-sa/4.0/) (CC BY-NC-SA 4.0 DEED).