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Effect Of 12 Weeks Plyometric And Strength Training On Explosive And Spiking Speed Skill Of U-17 Volleyball Project Players

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Abstract

This study aimed to examine the effect of plyometric and strength training intervention on explosive and spike speed skill of U-17male volleyball trainees. A total of 68 project players participated in the study and randomly allocated into four groups. The first group participated in plyometric training, second and third groups took part in strength and combined training respectively. The fourth group (control group) had participated only in the usual volleyball training program. The presented variables were the Spike jump, Block jump height in centimeter, standing broad jump distance in meter and spike speed in radar. In addition, to strength and plyometric training 24 Bure site players took part in spike skill training. The outcomes showed a significant difference between the four groups (Pre vs. Post) and the combined group scored the most prominent result of all other groups. Also plyometric and strength training significantly improved spiking speed, in EG at ($p<0.05$). But, no significant differences were found in all of variables in CG ($p>0.05$). Thus, it is concluded that a 12-week PT and ST intervention with the range of exercise intensity from 60% to 90% can positively impacts explosive power of the lower legs, and boosts the vertical jumping abilities.

Keywords: Explosive power; plyometric training; Strength training; Spike speed.

1. Introduction

Volleyball is a group of sports that has gained its' place in every competitive stage, depend on very speedy and explosive actions, such as jumping, hitting, diving and blocking Marques (2009). (Conditioning_for_Volleyball.9.pdf), stated that the percentages of attack and block jumps performed according to the location played in the court were 33 and 67 % for location 2(right side outside hitter), 29 and 71 % for Number 3 (middle blocker), and 59 and 41 for number 4.The left high ball hitter considers more in attack jumps than blocking since the position 2 attacker is the one that helps often the position 3 blocker, participates mostly in block jumps, (Conditioning_for_Volleyball.9.pdf). According to Marques (2009), there are differences in anthropometric, muscular strength and power characteristics of volleyball athletes according to the position they are playing. Volleyball needs anaerobic conditioning due to the

short and explosive movements and high power outputs, games may last a long period of time but the game plays are not continuous with numerous breaks through the game Scates (2003).

Precise volleyball exercises are essential to raise the body efforts and development. Plyometric training is a quick, powerful movement involving an eccentric contraction, followed immediately by an explosive concentric contraction Foqhaa (2021). The use of free weights and of upper and lower body ballistic training is important in developing strength and power Gadeken (1999).The new offense and defense roles brought about a need for an intensive study of volleyball abilities, especially the ability of the leg muscles to produce explosive type strength, which in volleyball terminology is referred to as the vertical jump. Due to the specific growth and development of young volleyball players, any vertical jump training must be approached with caution. Considering the fact that the height of volleyball players cannot be changed during the course of training, the height within reach during a spike or block (the vertical jump) can be increased by sport training. The specific training for the increase of explosive type strength is referred to as "plyometric training" and the training method is called the "plyometric method".
Plyometrics is a speed -strength training, a combination of strength and speed"(, Sáez-Sáez de Villarreal, González-Badillo, Izquierdo, L Ow, M Oderate (2008). One of the major requirements for using the plyometric training method is basic strength training. Young volleyball players do not require a high basic strength level. Strength is the capacity to overcome resistance or to take action against resistance (http://library1.nida.ac.th/termpaper6/sd/2554/19755.pdf). Once we have stabilized the basic strength, the next problem is the eccentric strength of the leg muscles. Without the adequate eccentric muscle strength, a high speed shift from the eccentric to the concentric mode proves to be ineffective. If the amortization phase lasts a long time, and if the movements are slow, the shift from eccentric to concentric muscle movement, the eccentric strength levels will not be adequate, and the training itself should be reduced in volume and intensity Pushparajan (2010).
The spike's success depends on numerous factors, such as the path of the set, opponent positioning, the physical and technical skills of the attacker, etc. From the perspective of technique execution (i.e. biomechanical analysis), the three basic aspects that affect the efficiency of the spike's basic technique are Gutiérrez, Ureña, Soto (1994): a) hit height, b) speed of the ball, and c) direction. The spike is generally monitored in training and/or competition due to its importance in a set's outcome. This monitoring attempts to serve as an evaluation of and guide for the training process that is being done and to quantify the work done by the players Sands, Stone (2005).

In volleyball, the use of radar and throwing machines are commonly used. Radar offers information about ball speed (e.g. spikes or serves). Machines let a high number of repetitions in practice at different speeds. The use of radar and throwing machines is also common in volleyball sport, and in fact, radar is used to monitor spike speed in competition and training. (E.g. Menayo, Fuentes, Moreno, Clemente, García-Calvo (2008); Moras et al. (2008).

The fundamental goal of this experimental research is to investigate the effectiveness of the plyometric and strength exercises in the development of explosive type strength (vertical jumping) and spike speed skill for U-17 project volleyball trainees, or more precisely, to combine the technical-tactical training with the plyometric and strength training method. One of the primary training goals for any volleyball player

or coach is to increase the vertical jump height and have explosive power of the athletes [9]. Incorporating strength and plyometrics training into a training program could become a helpful tool in increasing the explosive power of those volleyball players. Coaches, Athletic Trainers, and Strength conditioning coaches know about plyometrics and that doing strength and plyometric exercises can help increase the explosive power and spike skill of an athlete, but not many know how to safely and effectively add them into their off season training programs Baechle, Earle, (2008). Performance differences among Amhara youth male volleyball project trainees /athletes/ are not readily available, therefore strength and conditioning specialists/PE teachers/, and coaches may have difficulty in developing programs to improve volleyball performance, especially during their years of competition.

The lack of information available to U-17 male volleyball project trainees' /athletes/ across skills and competition level makes comparison of performance indicators among athletes impossible. Having these specific values available would create a baseline performance measure that would better equip strength and conditioning specialists /PE teachers/, and coaches to create programs that would address deficits in player performance.

Objective of the Study

The study was carried out to:

-Examine the effect of strength and plyometric training on explosive power development of U17 volleyball players

-To evaluate the effect of twelve weeks plyometric and strength training on spike speed.

Research Hypothesis

-It was hypothesized that both plyometric and strength training interventions can improve explosive power significantly.

-Twelve weeks plyometric and strength training would have significant effect on spiking speed in under17 volleyball project players.

However, the combined training of plyometric plus strength training can by far improve explosive power than plyometric or strength training alone.

2. Methods

The research design was experimental (randomized pre-test post-test control group) design. The Statistical Package for Social Sciences (SPSS) version 26 Software for data processing was used to organize and analyze the data.

Descriptive and inferential statistics was employed for analysis of quantitative data collected through experimental tests. The tests score on each sub scale was added and in order to see the expected mean difference. Univariate Analysis of variance was employed to determine whether difference existed among groups in the changes in each variable from the base line to the post test. In addition the paired t-test was used to compare the pre training and post training data for 24 Bure site players. The level of significance was set at 0.05. There for the data was analyzed and compared with the help of statistical procedure in which arithmetic Mean Standard deviation and T-test.

All the trainees are older than 15 and less than17years of age; they were all members of a publicly owned project trainees; they trained volleyball for a period of 3 months ; they were registered as U-17 volleyball project trainees /players/ in the 2021 season; all were having four training sessions a week during the preliminary period, and the sessions lasted from 90 to 120 minutes; they were tested at the start and at the end of the experiment; all the volleyball players were physically healthy and the data on the injured players was not used in the statistical analyses.
All the participants provided their written informed consent. This study was approved by the Human Research Ethics Committee of Bahir Dar University, Reference number S.A/6286/2021.

By means of the randomization, the trainees were divided into 4 groups, experimental PGs (18) STGs (14), Combined (24), and Control (12), volleyball players. From the total population of 85project players, the study used of a sample of 68 players as research participants. This was determined by using Taro Yamane formula (1967) cited in in (C, Survey, 1991), Data Gathering procedures.
Independent variables: physical and technical exercises delivered for selected training groups.
Dependent variables: Performance of athletes in terms of explosive power strength and spike output. The process of developing and of establishing the state of the explosive power at the initial and final measuring carried out with the use of 3 measuring test items which cover the area of explosive type strength and spike speed. The validity of Spike jump, & Block jump was proven by Pushparajan (2010), while the spike speed test was measured using. Stalker **Radar Pro II.** These test items labeled in the following manner:

The block jump (BJ)
The spike jump (SJ)
The spike speed test

3. Results
Posttest training and base line motor performance skills scores in four groups are presented in the following tables.

Table 1: Dependent Variable: Spike jump post

	Sum of Squares	Df	Mean Square	F	Sig.	Partial Eta Squared
Contrast	.803	3	268	69.316	.000	.770
Error	.240	62	004			

The F tests the effect of Type of training given. This test is based on the linearly independent pair wise comparisons among the estimated marginal means.

The statistics on table (1) indicates measure of the linear relationship b/n different training methods and performance of players. The three training methods and achievement of subjects are statistically

significant. The F spastic (3, 63) =12.824, P-value <0.001, $nP^{2=}$0.379. This shows that for increment of every specific training, there is an improvement of performance of players.

As the dependent variable indicates the block jump score for the **PG** is 2.591± 0.120m, while the **ST+PG** attains 2.733±0.086. The strength group executes 2.457 ± 0.114m. Likewise, **CG** gains 2.618± 0.146. The combined group had higher means score than all of the groups.

Table 2: Dependent Variable: Block jump post

	Sum of Squares	Df	Mean Square	F	Sig.	Partial Eta Squared
Contrast	.500	3	167	62.890	.000	.750
Error	.167	63	.003			

The F tests the effect of Type of training given. This test is based on the linearly independent pair wise comparisons among the estimated marginal means

The F tests the effect of Type of training given. This test is based on the linearly independent pair wise comparisons among the estimated marginal means.
The above able 2 shows the repeated measures training factors and performance of young players. The F statistic (3, 63) =62.890, P-value <0.001 $nP^{2=}$0.750 associated with performance level of Players.

This enables us to reject the null hypothesis that there is no relationship b/n the training factors and performance of subjects. Therefore, we can come to the conclusion that, as he time of training factors increases the performance of players also increases.

Radar test

Spike speed in volleyball is directly measured through the radar test. Radar testing has been shown to be a valid and reliable measure of upper-body explosive power. Palao, Valades, (2012), acknowledged Validity of the radar test as a monitoring spike speed protocol for volleyball players.

Testing setup

For the radar tests, the net height was 2.24m and the target zone should be placed 5 m from the players. This distance allows players to spike the ball with maximal power toward the target zone. If the players were positioned closer, the spike angle would not be realistic. It would be too vertical and would change the kinetic chain of the spike. If the players were positioned farther, the precision would not allow players to apply all their strength.

The target zone should be set at 1m x 1.5 m. The ball has to go directly toward the target zone to ensure proper measurement. If radar is used as the measurement system, it should be protected by a metallic frame (net), and it should be orientated toward the zone where the ball is contacted.

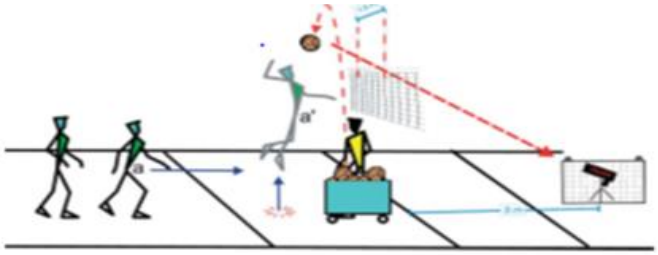

Figure 1 Spike speed testing set up

Table 3: Paired sample statistics of spike speed (Radar) test

Test	Subjects							
	EG				CG			
	Mean		Std. Deviation		Mean		Std. Deviation	
	PT	POT	PT	POT	PT	POT	PT	POT
Spike speed/ Radar (Km/h)	62.5507	70.4416	6.39528	4.10303	62.4133	62.4975	7.66591	8.51771

EG=Experimental group, CG= Control group, PT= pre-test, POT= post-test, Km/h= kilo meter per hour

The above table (3) shows analysed data of spike speed (radar) test. The Pre-test mean of spike speed for EG was found to be 62.5507km/h with a standard deviation of 6.39528 whereas mean CG found to be 62.4133km/h with a standard deviation of 7.66591. But after plyometric training, change was observed in spike speed (radar) test results among groups who did participate in the training unlike that of CG whose spike speed post test result remains almost the same. The Post-test means of spike speed for EG found 70.4416km/h with a standard deviation of 4.10302whereas CG were found to be62.4974km/h with a standard deviation of 8.51771.

Table.4. Comparison result of spiking speed variable for the two groups of pre and post test

Variable	Subjects	paired differences	T	sig. (2-

				95% Confidence Interval of the Difference			tailed)
		Mean	Std. Deviation	Lower	Upper		
Spiking speed	EGPT-POT	-7.89082	3.66585	-10.2200	-5.56166	-7.457	.000
	CG PT-POT	-.08416	2.04300	-1.38287	1.21453	-.143	.887

Table 4 shows that there were significant differences between the pre to post test scores in EG (MD = 7.89082km/h SD =3.66585, p = 0.001), significant at 0.05 level of confidence. In CG no significance difference were found (MD =0.8416km/h, SD =2.043, p=0.887). The reason behind the increment of spiking speed in EG was due to the involvement of the twelve weeks plyometric training.

4. Discussion

In order to determine how much progress the groups made during the twelve-week experimental treatment in terms of the used variables, a Univariate analysis of variance of repeated measures (ANCOVA) was used, which tested the differences between the initial and final state at the multivariate level. Only the differences whose significance was at the p<0.001 level are considered significant.

Regarding jump spike the statistical analysis indicates that the plyometric group attains 2.515 ± 0.106m .On the other hand, the strength group accomplishes 2.491± 0.111m. While the plyometric +strength group achieves 2.778± 0.089m. The CG gets 2.573 ±0.081m. The ST+PGs had a higher mean score than all other groups. This finding associates with that, the combination of strength and plyometric exercises is shown to be more beneficial for vertical jump improvement than either individually Kukric, Karalejic, Jakovljevic, Petrovic, Mandic (2012) & Kyröläinen , Avela , McBride, et al.(2005).

The three (strength, plyometric and combined) training methods were found to be statistically significant, p-value<0.001, to develop spike jump ability/explosive power) of athletes. This issue is supported by https://www.semanticscholar.org/paper/,Mann (2013) &, Palao, Manzanares, Valadés (2014), confirmed that, during the game, the volleyball players performed several different types of jumping movements, differentiated by execution and height of the jump reached. The jump height in most cases, relates to the speed of movement preceding the jump up. It was also found that the various jump movements require different properties of strength Young (2014). Based on this information, the greater improvement in this study was for the explosive power with the spike jump. The researchers supposed that it could be because of the greater similarity of the movement structure of the performed plyometric exercises with the "spiking" jump.

The block jump score for the PG is 2.591± 0.120m, while the ST+PG attain 2.733±0.086. The strength group executes 2.457 ± 0.114m. Likewise, CG gains 2.618± 0.146.The combined group had higher means score than all of the groups.

The eventual aim of scheming and working any sport exercise plan is to develop the physical and physiological performance of trainees. In nature, the trainees encompass their own inherent performance which they obtain hereditarily from their families to do the sport activities. However the key trouble here is, arranging and execute scientific based preparation programs that is important with the over status of trainees to nurture their innate talent and capability. Preceding studies observed the effects of combined (plyometric and strength), training on the performance of vertical jump (explosive power) of athletes. For example, studies by PAULC (2016), & Markovic (2007), confirms that the players need a minimum of 2 weeks to adapt to the increased load and to achieve improvement. This result does differ from that of other studies such as by Shaji, Isha (2009), where maximal vertical jump has shown an increase of 4.8 cm. It was similar to that in the studies conducted by Lehnert, Lamrova, Elfmark (2009), Where the improvement in the height was about 4.9 cm. In their experiment, Faigenbaum, McFarland, Keiper et al. (2007), achieved an increase in vertical jump of about 3.4 cm.

Milic, Nejic, Kostic (2008), investigated the 2-foot block jump and performance increased 3.53 cm. It can be assumed that the difference between results is affected mostly by the length of the PT application, performed exercises and especially the intensity of execution.

When we compare the mean score of EG before and after 12 weeks plyometric training, the mean difference value increased by 7.98082km/h. This result showed that effective enhancement was perceived on players spiking speed who involved in twelve weeks plyometric training. This shows that plyometric training is an actual method of improving spiking speed. So, the framed hypothesis that Twelve weeks aerobic exercise would have major effect on spiking speed of players were accepted at 0.05 level of confidence.

The present study results indicate that spike speed, which is a sport-specific performance, was improved and transferability of strength gains were realized by plyometric training methods. Because of the spike is a complex and the most explosive movement form among the overhead

Volleyball skills Celik (2017), our outcomes are even more important. Hence, it seems that the use of plyometric is highly suggested for young volleyball players in order to improve their spiking speed performance levels.

Likewise, on other study, experimental group showed significantly greater performance improvement in the spiking speed (+18%) at the end of the 12-week (51.48 km/h in pre-training vs. 87.20 km/h in post training). In contrast, the controls showed no change in spiking speed ability (0%). In other words, the effects of the plyometric training program contributed to the velocity of volleyball spike. DeRenne, Ho, Murphy (2001).

5. Conclusion

Different training studies show that physical suitability can increase performance in explosive power (vertical jumping) of volleyball players. The aim of identifying optimal training methods to increase explosive performance is crucial to optimize performance in adolescent volleyball players Sharawy (2013).

Likewise, Both plyometric and strength training are recognized as important components of fitness programs and are safe methods for improving explosive actions in young players Lesinski, Prieske, Granacher (2016) & de Villarreal, Requena, Newton (2010). According to the above findings, the current study showed that 12 weeks involvement training meaningfully enriched explosive power /vertical jump/ on the performance young volleyball players.

In general, there was a statistically significance difference b/n the EGs and CG group in regarding to explosive power performance in the pre-test and post-test totals of the performance of Amhara region male volleyball U-17 project players who accomplished plyometric and strength training exercises. Thus, the researcher has proved that a 12-week PT and ST intervention (with the range of exercise intensity from (60% to 90%) impacts the increase in explosive power of the lower legs, and thus boosts the vertical jumping abilities Twelve weeks plyometric training was also found to be effective and significantly improving spiking speed of volleyball players .

Merging a number of components into one training session seems to be a safe training method in this age group. This study on PT and ST trainings provide important information about how to coach youth volleyball players with implications for the design of training schedules. Strength and conditioning professionals, particularly in volleyball, should focus on offered combined training as a portion of special preparation package.

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