Innovations

# The Effects of Strength and Plyometric Training on the Development of Skill Related Physical Fitness on U-17 Volleyball Players

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***Abstract***

***Background:*** *There are differences in anthropometric, muscular strength and power characteristics of volleyball athletes according to the position they are playing. Plyometric is a speed -strength training, a combination of strength and speed. 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.* ***Objective:*** *The purpose of this study was to examine the effect of plyometric and strength training intervention on skill related physical fitness ofU-17male volleyball trainees.* ***Methods****: A total 68 project players participated in the study and randomly allocated into four intervention groups. The first group participated in plyometric training, the second and third group took part in strength and combined training respectively. The fourth group, the control group, had participated only in the usual volleyball training program. The training session underwent 3 times per week, ninety minutes per session for 12 weeks. To reveal the effect of each of the three training interventions in improving the explosive power of young players, the researcher measured the Spike jump, Block jump and Standing broad jump using for Boys (AAHPER test item). In addition, the standing broad jump test was measured using steel measuring tape.* ***Results:*** *The outcomes shown a significant difference between the four groups (Pre vs. Post) and the combined group scored the most prominent result of all other groups. The current study indicated that 12 weeks involvement training meaningfully enriched explosive power /vertical jump/ on the performance of young volleyball players.* ***Conclusion:*** *we concluded that a 12-week plyometric training and strength training intervention with the range of exercise intensity from 60% to 90% can positively impacts explosive power of the lower legs.*

***Keywords:*** *1.Explosive power; 2.plyometric training;3.strength training; 4.volleyball.*

## 1. Introduction

Volleyball is a group of sports that has gained its' place in every competitive stage, depends on very speedy and explosive actions, such as jumping, hitting, diving and blocking Marques (2009). Black(1995),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 jumpsBlack (1995). 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".

Plyometric is a speed -strength training, a combination of strength and speed"Sáez-Sáez de Villarreal (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 resistancehttp://library1.nida.ac.th/termpaper6/sd/2554/. 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 Baechle and Earle ''*Essentials of Strength Training''(2008)*. Incorporating strength and plyometric 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 plyometric and that doing strength and plyometric exercises can help increase the explosive power of an athlete, but not many know how to safely and effectively add them into their off season training programs Baechle and Earle ''*Essentials of Strength Training''(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 /Physical Education teachers/, and coaches to create programs that would address deficits in player performance.

## 2. Materials and Methods

The research design was experimental (randomized pre-test post-test control group) design. A total 68 project players participated in the study and randomly allocated into four intervention groups.

The first group participated in plyometric training, the second and third group took part in strength and combined training respectively. The fourth group, the control group, had participated only in the usual volleyball training program. The training session underwent 3 times per week, ninety minutes per session for

12 weeks**.** 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.To reveal the effect of each of the three training interventions in improving the explosive power of young players, the researcher measured the Spike jump, Block jumpand Standing broad jump. We used Statistical Package for Social Sciences (SPSS) version 26 Software for data processing was used to organize and analyze the data.

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 thepost 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 2019 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 (Kuric et al., 2006) STGs(Ahmad & Hassan, 2018), Combined (Shajih&Isha, 2009), andControl, 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 Milic, Nejic&Kostic, 2008). 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. 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 five measuring test items which cover the area of explosive type strength. These test items labeled in the following manner:

The block jump (BJ)
The spike jump (SJ)
The standing Broad jump (SBJ)

The correctness of the first two tests proven by measuring the calculable features by means of proceedings dealing with factors, proceedings proving any predictable capabilities, and which will be administered by the authors of the research.

### *The Block Jump*

***The instruments***: a board with a darkened background, fastened to the wall and a steel measuring tape.

***The task:*** the examinee stands facing the wall and resting both outstretched arms next to the fixed measuring tape, so that they are on the same level. After noting the height within reach for the block jump, the examinee takes off with both feet, and touches the board with the fingers of both hands.

The evaluator should be standing, so that his head is at level with the height within reach of that jump, so as to increase the accuracy of the results. Three jumps are made. Any incorrectly performed jumps are repeated.

***Marking:*** the height within reach for that jump is measured in centimeters, and then the height within reach is subtracted from it, and we get the height of that jump. Only the best attempts were actually used in the statistical analysis.

***Notes:*** No double take off is allowed. The examinee can jump either barefoot or in his sneakers, but his fingers previously coated with white color.

## *The Spike Jump*

***The instruments***: a board with a darkened background, fastened to the wall and a steel measuring tape.

***The task:*** the examinee stands facing the wall and resting both outstretched arms next to fixed measuring tape, so that they are on the same level. After noting the height within reach for the spike jump, the examinee takes a step back, and with a running start of just one step, takes off with both feet, and touches the board that is next to the steel measuring tape with the fingers of both hands, which will be coated with white color. The evaluator should be standing, so that his
head is at level with the height within reach of that jump, so as to increase the accuracy of the results. Three jumps are made. Any incorrectly performed jumps are repeated.

***Marking:*** the height within reach for that jump is measured in centimeters, and then the height within reach is subtracted from it, and we get the height of that jump. Only the best attempts were actually used in the statistical analysis.

***Notes:*** No double take off is allowed. The examinee can jump either barefoot or in his sneakers, but his fingers should previously coated with white color.

**The standing Broad jump (SBJ):**

***The instruments***: a steel measuring tape and suitable court for long jump.

***The task:*** the examinee athlete begins with both feet approximately shoulder width apart and on the starting line, Arms should be used to assist the jump, the athlete is allowed to use a countermovement (bending the hips and knees prior to jumping) for accessing elastic strength to assist in the jump, this downward countermovement prior to upward propulsion is the eccentric phase of the stretch-shortening cycle which contributes to a maximum height of the jump, the Distance traveled should be measured to the nearest half inch at the heal of the back foot, athlete should try to leap as far forward as possible in a linear direction, the best of 3 trials is recorded

## 3. Results

**Table 1:**Tests of Between-Subjects Effects

Dependent Variable: Broad jump post( ANCOVA )

| Source | Type III Sum of Squares | Df | Mean Square | F | Sig. | Partial Eta Squared |
|---|---|---|---|---|---|---|
| Corrected | 3.994[a] | 4 | .999 | 33.562 | .000 | .681 |
| Model | .126 | 1 | .126 | 4.230 | .044 | .063 |
| Intercept | 1.413 | 1 | .1413 | 47.509 | .000 | .430 |
| Broadjumppre | .253 | 3 | .084 | 2.833 | .045 | .119 |
| Typeoftraining | 1.874 | 63 | .030 | | | |
| Error | 5.868 | 67 | | | | |
| Corrected Total | | | | | | |

a. R Squared = .681 (Adjusted R Squared = .660)

ANCOVAs was carried out to test effect of the training for both groups based on their performance gain or development we find a significant value F=47.51,P<.001, and 43% effect size of broad jump after 12 week training. This result indicates that the performance of young volleyball players increases for each parametric factor Table 1. The output of Broad jump for the F measures provides statistics for between subject effects different training types. The statistics show measure of linear relationship between different training models and performance. Types of trainings and performance are statistically significant. Therefore,we are rejecting the null hypothesis.

| **Table 2. Ancova Tests of Between-Subjects Effects** | | | | | | |
|---|---|---|---|---|---|---|
| **Dependent Variable: Spikejumppost /2/** | | | | | | |
| Source | Type III Sum of Squares | Df | Mean Square | F | Sig. | Partial Eta Squared |
| Corrected Model | 1.373[a] | 4 | .343 | 88.851 | .000 | .851 |
| Intercept | .046 | 1 | .046 | 11.896 | .001 | .161 |
| Spikejumppre | .351 | 1 | .351 | 90.804 | .000 | .594 |
| Typeoftrainig | .803 | 3 | .268 | 69.316 | .000 | .770 |
| Error | .240 | 62 | .004 | | | |
| Total | 459.225 | 67 | | | | |
| Corrected Total | 1.613 | 66 | | | | |
| a. R Squared = .851 (Adjusted R Squared = .842) | | | | | | |

In order to know the effect of the training on spike jump, a test was carried out based on their performance progress and find F statistic 90.804,p<0.001 with effect size59.4%, Table 2. This shows that performance of players increases for each specific training models.

| **Table 3. Tests of Between-Subjects Effects** | | | | | | |
|---|---|---|---|---|---|---|
| Dependent Variable: Blockjumppost /table/ **Ancova/** | | | | | | |
| Source | Type III Sum of Squares | df | Mean Square | F | Sig. | Partial Eta Squared |
| Corrected Model | 1.263[a] | 4 | .316 | 119.015 | .000 | .883 |
| Intercept | .011 | 1 | .011 | 3.981 | .050 | .059 |
| Blockjumppre | .518 | 1 | .518 | 195.168 | .000 | .756 |
| Typeof training | .500 | 3 | .167 | 62.890 | .000 | .750 |
| Error | .167 | 63 | .003 | | | |
| Total | 464.548 | 68 | | | | |
| Corrected Total | 1.430 | 67 | | | | |
| a. R Squared = .883 (Adjusted R Squared = .876) | | | | | | |

In order to observethe effect of the training on block jump,a test was carried out based on their performance progresswe find, F =195.168, p<0.001 with 75.6% effect size Table 3. This shows that performance of players increases for each specific exercise.

**Table 4:**Tests of Between-Subjects Effects
Dependent Variable: Broad jump post( ANCOVA )

| Source | Type III Sum of Squares | Df | Mean Square | F | Sig. | Partial Eta Squared |
|---|---|---|---|---|---|---|
| **Corrected** | 3.994[a] | 4 | .999 | 33.562 | .000 | .681 |
| **Model** | .126 | 1 | .126 | 4.230 | .044 | .063 |
| **Intercept** | 1.413 | 1 | .1413 | 47.509 | .000 | .430 |
| **Broad** | .253 | 3 | .084 | 2.833 | .045 | .119 |
| **jumppre** | 1.874 | 63 | .030 | | | |
| **Typeof training** | 5.868 | 67 | | | | |
| **Error** | | | | | | |
| **Corrected** | | | | | | |
| **Total** | | | | | | |

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ANCOVA as was carried out to test effect of the training for both groups based on their performance gain or development we find a significant value F=47.51,P<.001, and 43% effect size of broad jump after 12 week training. This result indicates that the performance of young volleyball players increases for each parametric factor Table 1. The output of Broad jump for the F measures provides statistics for b/n subject effects different training types. The statistics show measure of linear relationship b/n different training models and performance. Types of trainings and performance are statistically significant. Therefore, we are rejecting the null hypothesis.

**6. Discussion**

In order to determine how much progress the groups made during the twelve-week experimental treatment in terms of the used variables, analysis of covariance (ANCOVA) was used, and we find a significant improvement on both the training groups as compared to the control group. Likewise, this researcher objectives goes with the Studies conducted by Milic(2088),and Çımenlı (2016), revealed a significant increase in horizontal jump performance after the plyometric training intervention. However, another study did not show significant differences in this regard Idrizovic(2017),and the study carried out by Gjinovci(2017), presented only a small effect of plyometric training on horizontal jump performance. The benefits of plyometric on horizontal jump were observed in both sexes and across the ages, standing long jump, depth leap long jump Idrizovic(2017),triple standing jump Ahmad(2018), and unilateral jumps with either no steps or one step taken Myer (2006), were used as tests. In the standing long jump, meaningful improvements of 7.6% were observed in senior female players after 12 weeks of plyometric training Gjinovci (2017), a 7.6% improvement was observed in under-16 players after six weeks of training Myer (2006), and a 3.6% improvement was seen in 12- to 19-year-old players after 16 weeks of training Idrizovic(2017). Thus, twelve week strength and plyometric trainings intervention are important for explosive power development of young volleyball (U-17) players. 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 (2012), or Kyröläinen(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,The_effects_of_arms_and_countermovement_on.15.pdf., Mann (2013), and Palao(2014).

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. 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 Omfort(2016), and 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(2009), where maximal vertical jump has shown an increase of 4.8 cm. It was similar to that in the studies conducted by Lehnert (2009). Where the improvement in the height was about 4.9 cm. In their experiment Faigenbaum(2007), achieved an increase in vertical jump of about 3.4 cm.Milic(2088), 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.

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## 7. Conclusion

In conclusion 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. Finally, we recommend assimilation 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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