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# The Effect of Plyometric Training Before and After Technical Training on Smash Ability of Male Volleyball Athletes

**Hendri Permana[1*], Endang Rini Sukamti[2], Suhadi[3], Trisnar Adi Prabowo[4]**

[1,2,3]Faculty of Sport and Health Science, Yogyakarta State University, Indonesia
[4]Study Program of Physical Education, Universitas Muhammadiyah Brebes, Indonesia

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**Abstract**

The purpose of this study was to analyze the effect of plyometric training before and after smash technique training. This type of research is an experiment with a two group, the two groups are the plyometric group before technique training (BTT) and the plyometric group after technique training (ATT). The sample was 20 male and age 18-19 years, then grouped through ordinal pairing. The training program was carried out for 6 weeks with 18 meetings. Plyometric training program: squats, sit-ups, fence jumping, push-ups, up and down the bench, back-up, skipping, jack kneef, shuttle run, stabilization, sedo smash, step and shoulder. The program is 8 – 10 repetitions, 2 – 3 sets, recovery between sets 2 – 3 minutes, intensity 85% - 95%. Meanwhile, the smash technique training program is a drill accompanied by a coach with a total duration of 60 minutes. Data collection for smash skills as a pretest-posttest using the Stanley test. The t-test result ($p<0.05$), ATT shows Sig. 0.002, than BTT Sig. 0.078. Independent t-test ($p<0.05$) also shows that there is a difference between BTT and ATT is Sig. 0.042. Conclusion is placing plyometric training after a smash technique training session (ATT) is more effective in improving smash ability for male volleyball athletes aged 18-19 years. This study recommends scheduling plyometrics after technique training as a more optimal strategy, supporting better athletic performance and efficient recovery, while minimizing the risk of injury and fatigue.

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*Corresponding email : hendripermana.2020@student.uny.ac.id

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## INTRODUCTION

In volleyball, the ability to perform an effective smash is an important skill that can determine the outcome of a match. Smashing is a crucial skill because of its vital role in ending a rally and winning a point immediately (Leo Sukma & Taroreh, 2022). This move involves hitting the ball quickly and hard into an area that is difficult for the opposing team to reach, often resulting in the ball hitting the floor before the opponent has time to respond. Technically, mastering the smash requires perfect coordination between the eyes, hands, and feet, as well as accurate timing (Komaini et al., 2022). Mastery of these skills is not only important for smashing but also for improving the player's overall performance in receiving, blocking and counterattacking (Gumay et al., 2022). Therefore, the ability to execute a powerful and consistent smash often separates a winning team from a losing team, making this skill a top priority in volleyball training. To strengthen and accelerate the smash movement, plyometric training is often integrated into an athlete's training program (SAPARİA et al., 2020 & Anggraini et al., 2023). This training method focuses on developing explosive power through fast and powerful muscle contractions.

Previous studies have shown that plyometric training provides significant benefits for volleyball athletes, especially in improving smashing ability, which is an important technique (Novita et al., 2022 & Junianto & Widodo, 2023). This drill focuses on increasing muscle strength, speed, and explosiveness, all of which are essential in volleyball to perform a powerful and effective smash (Anggraini et al., 2023). The main benefits of plyometrics for volleyball athletes include increased strength of the leg muscles and core muscles that support power and stability during jumps (Novita et al., 2022). These stronger muscles allow athletes to jump higher, an essential requirement for an effective smash. Plyometrics also improve coordination and agility, facilitating quicker, more responsive movements on the court, which is crucial when preparing for a smash (SAPARİA et al., 2020). Then, plyometric training improves the muscles' ability to contract quickly, which is vital when producing the explosive power needed for the smash (Chaturvedi et al., 2023 & Oliveira et al., 2023). Therefore, the speed and power gained through this drill allows the player to not only reach the ball faster but also to hit it with greater force, increasing the effectiveness and power of each smash.

Then, to improve smashing ability in volleyball, proper technique training is essential. Developing proper technique through focused practice allows players to increase control over the direction and power of their shots on the ball, targeting areas on the opponent's court that are difficult to reach (Suryadi et al., 2022). Correct technique also optimizes the use of body biomechanics, reducing the risk of injury and increasing energy efficiency (Gumay et al., 2022). Correct technique training also provides players with the self-confidence to make decisive and responsive decisions on the field, as well as facilitating quicker adaptation to the opponent's strategy (Astuti et al., 2023). Therefore, proper technique training not only strengthens the physical aspect of the smash but also the strategic and mental aspects, which overall increases the player's effectiveness in the match (Wicaksono et al., 2022). But in reality, the observations made by this study show that many players have good techniques but do not have good power to jump and hit the ball. In addition, there have not been any research results that combine plyometric training with before and after technique training. This will have an

impact on one of the principles of training, namely training variations (Mylsidayu et al., 2022).

Thus, the purpose of this study is to analyze the effect of plyometric training before technique training and the effect of plyometric training after technique training. So that the results of the study can assess and recommend the results of the right plyometric training when combined with smash technique training. This aims to determine the most effective time for plyometric training in the training routine, so as to maximize the improvement of athletes' smash abilities. The results of this study are expected to provide valuable insights into the arrangement of training programs that can be more structured and effective in improving smash abilities. With a systematic approach and strong methodology, the results of this study will not only contribute to academic literature, but will also be very useful for coaches and athletes in their practice in the field.

## METHODS

### *Participants*

The population of this study were all athletes at Yuso Sleman Club, then the sample selection was carried out by purposive sampling, namely aged 18-19 years, active as athletes and had no history of injury. So that the number of samples in this study was 20 male volleyball athletes.

### *Procedures*

This type of research is an experiment with a two group pretest-posttest design, the two groups are the plyometric group before technique training (BTT) and the plyometric group after technique training (ATT). The procedure of this research is that athletes will be asked to do an initial test (pretest) to measure the initial ability of the smash. After the initial results of the smash are known, the next step is to divide the group with ordinal pairing. So that there are 10 athletes in the plyometric group before technique training (BTT) and 10 athletes in the plyometric group after technique training (ATT).

Then the athletes are given treatment for 6 weeks with 18 meetings, with 3 meetings a week. The training program is carried out in the afternoon on Monday, Wednesday, Friday. After the treatment to the athletes with a predetermined time, the athletes are asked to take a final test (posttest) to analyze the effect of BTT and ATT on smash ability.

Then the data collection instrument for the pretest and posttest used the Stanley test (Permana & Suharjana, 2013) & (Rasyono & Setiawan, 2020), the tools or equipment for this test are a wall 4.57 m from the wall, a ball, a stopwatch, assessment forms and writing instruments, a score recorder and a timer.

### *Plyometric Training Programs*

The plyometric training program is (1) squats, (2) sit-ups, (3) fence jumping, (4) push-ups, (5) up and down the bench, (6) back-up, (7) skipping, (8) jack kneef, (9) shuttle run, (10) stabilization, (11) sedo smash, (12) step and shoulder. The program is carried out between 8 - 10 repetitions, 2 - 3 sets, recovery between sets 2 - 3 minutes, intensity 85% - 95%. The plyometric training program is applied before and after technique training. While the smash technique training program is 10 athletes divided into 2 teams, 5 athletes by drill by the coach, the other 5 athletes help the coach prepare the ball. The duration is 60 minutes with a training volume of 2-3 sets. Each set uses 10 minutes with recovery per set also 10 minutes. Before the overall daily training program is carried out, athletes are asked to stretch and cool down in a measured manner by the coach.

### *Data Analysis*

The data analysis of this study used t-test to analyze the differences in training

results and independent t-test to analyze the differences in training results from both BTT and ATT groups ($p<0.05$). However, the prerequisite test will be used first through the normality test and homogeneity test ($p>0.05$). The data analysis of this study was assisted by SPSS version 26.

**RESULT** (Times New Roman 12)

After the data is collected through pretest and posttest, the next stage of the research is reporting the research results. The first data analysis is to conduct a normality test. The normality test uses the Shapiro-Wilk test ($p>0.05$), because the sample is less than 30. The following is the Shapiro-Wilk test in table 1.

Table 1. Normality Test Results

| | Shapiro-Wilk | | |
|---|---|---|---|
| | Statistic | df | Sig. |
| Pre Test BTT | 0,923 | 10 | 0,385 |
| Post Test BTT | 0,899 | 10 | 0,213 |
| Pre Test ATT | 0,937 | 10 | 0,516 |
| Post Test ATT | 0,955 | 10 | 0,722 |

Based on the results of table 1, the significance value of the pretest and posttest in the BTT and ATT groups showed $p>0.05$, meaning that the research data was normally distributed. After the first analysis of the data showed a normal distribution, the second analysis was the homogeneity test. The homogeneity test used the Levene test ($p>0.05$) in table 2 below.

Table 2. Homogeneity Test Results

| | | Levene Statistic | df1 | df2 | Sig. |
|---|---|---|---|---|---|
| Stanley Test | Based on Mean | 0,674 | 1 | 38 | 0,417 |
| | Based on Median | 0,583 | 1 | 38 | 0,450 |

Based on the results of table 2, the significance value of based on mean shows 0.417 or $p>0.05$, meaning that the groups in the research population to be measured have a similar level of diversity so that the sample is homogeneous. After the data is confirmed to be normal and homogeneous, the research data is worthy of being continued with t-test and independent t-test. T-test is the third analysis to analyze the effect of the training program provided. Below are the results of the t-test ($p<0.05$) in table 3.

**Table 3**. T-Test Results on the Effects of Training Programs

| | | Mean | Std. Deviation | Std. Error Mean | t | df | Sig. (2-tailed) |
|---|---|---|---|---|---|---|---|
| BTT | Pre Test - Post Test | -1,600 | 2,547 | 0,806 | -1,986 | 9 | 0,078 |
| ATT | Pre Test - Post Test | -3,900 | 2,961 | 0,936 | -4,165 | 9 | 0,002 |

Based on the t-test results in table 3, the plyometric training group before technique training (BTT) showed a Sig. (2 tailed) value of 0.078 or $p>0.05$, so that plyometric training before technique training (BTT) did not affect the smash ability of male volleyball athletes aged 18-19 years. Then the plyometric training group after technique training (ATT) showed a Sig. (2 tailed) value of 0.002 or $p<0.05$, so that plyometric training after technique training (BTT) affected the smash ability of male volleyball athletes aged 18-19 years.

After the t-test to analyze the training program before and after the technique training, the fourth analysis is the independent t-test which aims to analyze the differences between ATT and BTT. Below is table 4 on the results of the independent t-test ($p<0.05$).

Table 4. Results of the Training Group Difference Test

| | | t | df | Sig. (2-tailed) |
|---|---|---|---|---|
| BTT Group - ATT Group | Equal variances assumed | -2.186 | 18 | 0.042 |
| | Equal variances not assumed | -2.186 | 17.411 | 0.043 |

Based on the results of table 4, the independent t-test shows a Sig. (2-tailed) value of 0.042 or p<0.05, so there is a difference in the plyometric training group before technique training (BTT) and the plyometric training group after technique training (ATT) in male volleyball athletes aged 18-19 years.

## DISCUSSION

The results of this study provide valuable insights into the combined effects of plyometric training with smash training in male volleyball athletes aged 18-19 years. Specifically, the findings highlight how the placement of plyometric training before or after a smash training session may influence the effectiveness of the training in improving smash ability.

The first analysis is, the effect of plyometric training before smash technique training, shows that there is no significant effect of carrying out plyometric training before smash technique training. This could be caused by muscle fatigue that occurs after plyometric training, which can interfere with the athlete's ability to carry out technique training that requires high precision such as smashing (Barahona-Fuentes et al., 2020, Aurell-Badenas et al., 2020, & Ghorbani et al., 2022). This fatigue can cause decreased performance during technical training, thus hampering the potential for learning or improving technical skills (Znazen et al., 2022). Therefore, prioritizing plyometric training before or after technical training should be considered based on training goals, athlete condition, and the phase of the competitive season. In reality, coaches can place plyometric training programs after technical training, which is more beneficial to maximize training quality and reduce injury risk. However, if plyometrics are chosen to be placed at the beginning, it is important to ensure that athletes perform a comprehensive warm-up and adjust the training load to suit the athlete's ability and condition for each session (Silva et al., 2019 & Jariono et al., 2024).

The second analysis is, the positive effect of plyometric training after smash technique training. The findings from this group's results are different from previous findings, this study found that there was a significant positive effect when plyometrics were performed after a smash technique session. This suggests that performing plyometrics after technique training can be more effective because athletes have spent time focusing on the technique aspect of the smash without the distraction of early muscle fatigue (Anggraini et al., 2023). Plyometric scheduled after a technique session can be effectively used as a way to improve fitness and endurance once focus on the technical aspects has been facilitated (Oliveira et al., 2023 & Guimarães et al., 2023).

Studies based on the analysis of physiological responses, performing plyometrics after technical training can increase neuromuscular stimulation and the secretion of anabolic hormones such as growth hormone and testosterone in male athletes, which are vital for muscle development and recovery (Bulqini et al., 2023 & Oliver et al., 2024). Plyometrics after technique training also causes a post-exercise hyperemic response that aids muscle healing and recovery by increasing nutrient and oxygen rich blood flow to the working tissues (Guan et al., 2021 & Huang et al., 2021). Thus, the ATT approach not only maximizes performance during the training session, but also supports long-term adaptation to training

by triggering structural and functional improvements in the muscle. This in turn effectively enhances the athlete's explosive performance capabilities.

The third analysis is, the difference in results between plyometric training before and after smash technique training. This result shows a significant contrast difference between BTT and ATT, which confirms the importance of scheduling in plyometric implementation. Scientific evidence was also found, when plyometrics are placed after technique training, this not only avoids potential fatigue that affects the technique session but also may provide additional stimulus to the muscles that are ready (Ramírez-delaCruz et al., 2022 & Kons et al., 2023), thus increasing the effectiveness of the plyometric itself. Therefore, ATT can be recommended to carry out plyometric training after the smash technique session. This recommendation is supported by the results of this study that the ATT approach is more successful in improving athlete abilities. This is in line with the theory that plyometric training can be more effective when the muscles are already strong and prepared through technical activities that are not as difficult as plyometrics in terms of intensity (Kons et al., 2023) & (Chen et al., 2023).

The limitation of this study is that at the beginning of the program, the BTT group experienced rapid fatigue and some experienced momentary pain. So it takes additional recovery time until the athletes feel ready. However, when the BTT group was given a longer stretching time than the ATT, they were able to run this training program smoothly. The hope for future research is the need for stricter sample selection when conducting plyometric research and a measurable training program based on the results of previous research and validation of training programs from experts such as lecturers. A wider sample can also strengthen the results of subsequent research.

## CONCLUSION

This study has revealed that plyometric training after a smash technique training session (ATT) is more effective in improving smashing ability in 18-19-year-old male volleyball athletes compared to performing it before the technique session. This is mainly because plyometric training performed after the technique helps to avoid premature fatigue that can interfere with proper technique learning and mastery. In addition, performing plyometrics after the technique session also takes advantage of the prepared muscle condition, increasing neuromuscular stimulation and anabolic hormone secretion, which are vital for muscle development and recovery. This study recommends scheduling plyometrics after the technique training as a more optimal strategy, supporting better athletic performance and efficient recovery, while minimizing the risk of injury and fatigue. These findings can be used as a guide for coaches in preparing training programs that optimize overall athletic performance and

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