

The Effect of Drilling Exercises for Smashes at Fixed and Moving Targets on Smash Accuracy Among Athletes of the PU Pati KU-2013 Volleyball Club

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Abstract

Since the smash is the main attacking method used to score points in volleyball, smash accuracy is one of the major determinants of a team's success. Based on initial observations at the PU Pati Volleyball Club in Pati Regency, athletes still exhibit weaknesses in timing, placement, and confidence when executing smashes due to a lack of specialized technical training. The purpose of this study is to ascertain how drilling activities with fixed and variable targets affect athletes' smash accuracy at the PU Pati Volleyball Club KU-2013. Twenty athletes who were chosen by purposive sampling and split into two experimental groups participated in the study, which used a quantitative approach using a Two-Group Pretest-Posttest design. The intervention was administered over 12 sessions, plus one pretest and one posttest. Using SPSS, the Kolmogorov-Smirnov normality test, the paired-sample t-test, and the independent-sample t-test were used to examine the data at a significance level of 0.05. The findings demonstrated that smash accuracy significantly improved with both training techniques ($p = 0.043$ for stationary targets and $p = 0.000$ for moving targets). Nevertheless, neither approach proved to be better, as an independent samples t-test of the posttest results for the two groups revealed no significant difference ($p = 0.157$). It was concluded that both methods are suitable for progressive implementation in the training of young volleyball athletes, beginning with fixed-target drills to develop technical automation, followed by variable-target drills to train tactical adaptation.

Keywords: Smash accuracy; drilling exercise; fixed-target practice; variable-target practice; volleyball

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1. INTRODUCTION

Sports are an integral part of daily life anywhere, anytime, for anyone, from children to

teenagers, adults, and the elderly. In general, sports are physical activities performed to promote physical health (Hita et al., 2021). Physical Education, Sports, and Health (PESH) plays a vital role in building students' character through physical activity, the development of social skills, and values of togetherness (Nurratri & Herlambang, 2024). Law No. 3 of 2005 states that sports are all systematic activities aimed at promoting, nurturing, and developing physical, spiritual, and social potential. Sports are not merely intended to develop physical potential; they also aim to develop spiritual and social potential (Permana & Sastaman, 2015). Therefore, sports development should begin at an early age so that the goal of achieving excellence in sports can be realized both at the regional level and at higher international levels.

Sports development includes volleyball, basketball, track and field, table tennis, badminton, sepak takraw, pencak silat, karate, soccer, and others. This is one way to develop the potential of athletes (Ricky, 2020). The development and promotion of these sports aim to improve athletes' performance, from the regional to the national level, particularly in volleyball, which is the focus of this study. Volleyball is a team sport that is well-known worldwide. The rules of the game are very simple and straightforward: players hit the ball back and forth over a net of a predetermined height. Volleyball can be played indoors or outdoors and involves six players on each team (Roesdiyanto, 2017).

It is hoped that volleyball training will produce talented young players who will go on to bring honor to the club. Achieving the desired results through this training program requires focused and integrated practice conducted on an ongoing basis, so that the players or athletes can develop strong volleyball skills (Kurniawan & Ramadan, 2016). Training to achieve success in volleyball is closely tied to physical conditioning, technique, tactics, and mental preparation (Wismiarti & Hermanzoni, 2020). Physical conditioning is essential for improving and refining technical skills. Without proper physical conditioning, it will be difficult to achieve high levels of performance; of the four aspects mentioned above, physical conditioning is the most important factor. According to Syafruddin in Ricky, (2020) states that improving an athlete's physical condition or baseline abilities through a structured training program enables the desired performance to be achieved.

Competitive sports refer to the development of athletes through planned, structured, phased, and continuous training via various competitive events, with the goal of achieving optimal performance supported by the application of sports science and technology (Ulatningsih et al., 2025). Strength, precision, flexibility, and movement coordination are all important for success in sports, especially volleyball (Qudsi et al., 2021). Playing techniques in volleyball especially the spike are key to scoring many points and securing victory (Bumburo et al., 2023). Since the smash is one of the most frequently used offensive plays to score points, it is the most crucial aspect of a volleyball match (Srianto, 2018). Read more, Mutohir in Srianto, (2018) The smash is a reliable technique for defeating opponents and scoring points; varying the position of the smash can make it difficult for opponents to defend. Volleyball attack strategies include smash tactics from positions 4, 3, and 2, as well as positions 1, 6, and 5 behind the attack line.

Meanwhile, based on first observations and talks with the coach and volleyball players at the PU Pati club in Pati Regency on April 28, 2026, it was found that when executing a spike, the players lacked an understanding of the optimal timing for the spike; the lack of dedicated practice time for spike technique resulted in the players being unaccustomed to it and lacking confidence in executing it; and athletes hesitate when attempting a smash, preventing them from executing it accurately. Additionally, athletes lack an understanding of game tactics, so they fail to place smashes in areas that are difficult for opponents to reach, making the smashes easier to block or return. An

understanding of game strategy and the ability to read opponents' movements are crucial for determining when to execute a smash. This indicates that to improve smash skills in volleyball, a comprehensive approach is needed that includes basic technical training, physical strength development, mental training, and an understanding of game strategy.

Given these challenges, appropriate training methods are essential for mastering the fundamental skill of smash accuracy on the court. There are several smash accuracy training methods that can be used, including the fixed-target smash training method and the variable-target smash training method. Both of these training methods utilize specific targets on the court. The fixed-target smash training approach is intended to enhance technical proficiency. Additionally, the fixed-target drill method is classified as closed motor learning, which means that an athlete can control and plan an activity by performing it in a set environment. It is easily controlled and planned by the athlete themselves (Mu'ammam, 2017). This is supported by the opinion that AL AJAJ, (2024) which states that fixed-target smash drills are a method or approach to training smash accuracy by using the same target continuously without changing it until a set determined by the coach is completed. This means that a closed skill is one in which the support whether a surface, an object, or another person remains stationary while the skill is performed. Closed skills are simpler than open talents since they are determined by personal aptitude and are unaffected by outside variables. Fixed-target drill workouts will therefore be highly helpful, and it is envisaged that employing this technique would effectively and efficiently increase smash accuracy.

Meanwhile, variable-target smash drills involve smashing at targets at varying distances. This means there is variation in the drills and the target settings are not fixed. These drills are conducted using a random system not in a sequential or regular order within a single training session but rather emphasize variation in target distances during the drill. In random drills, for example, the order of various tasks is mixed or interleaved throughout the training period (Broadbent et al., 2019). Practicing tasks in a random order so that no two tasks are practiced consecutively is known as variable-order or random practice (Nachmani et al., 2021). Several studies on the effects of the drill method have been conducted by Mu'ammam, (2017) demonstrates that the impact of drills with a constant target direction versus drills with a variable target direction differ significantly.

Evidence on the superiority of variable practice over constant practice, however, is far from conclusive. Ammar et al., (2023) conducted a systematic review and meta-analysis of contextual interference in sport and reported that the benefit of random practice, long assumed on the basis of laboratory research, is not fully supported in real-world sports training settings; skill acquisition, retention, and transfer did not consistently differ between block (low interference) and random (high interference) practice schedules. On the other hand, Hussain et al., (2022) reported that traditional game skill training organised within a contextual interference continuum can improve children's gross motor skills, and similar findings were supported by (Cheong & Hussain, 2024), which shows that random, game-based training schedules are effective in improving gross motor performance compared with monotonous training. These mixed findings indicate that the effectiveness of training variability depends heavily on the characteristics of the sport, the age and initial skill level of the athletes, and the duration of the training programme.

In the volleyball context, Wicaksono & Hidayatullah, (2022) demonstrated that training based on a combination of part and whole practice significantly improves smash technique in 11–12-year-old volleyball athletes, while Umar et al., (2023) found that learning methods and motor skills jointly influence learning outcomes for basic volleyball techniques. Mahardika et al., (2024) also showed that target-based underhand passing drills, whether using a wall or a partner, significantly

improve volleyball accuracy. Smash accuracy itself is multifactorial: Probowo et al., (2022) developed a circuit-based smash training model that has been proven effective in improving smash skills, whereas (Nashrulloh et al., 2024) shows that plyometric bench dip exercises also have a significant effect on smash accuracy by increasing the explosive strength of the arm muscles. Beyond conditioning, the way practice itself is organised also matters: Mahmuddin et al., (2024) found that exercise variation methods improved leg muscle strength and contributed significantly to volleyball smash results, while Maulana et al., (2025) reported a very strong correlation between smash technical skill and smash accuracy in beginner club athletes, which indicates that accuracy develops alongside mastery of the technique rather than independently of it. Studies that directly compare fixed-target and variable-target smash drilling in young volleyball athletes are, however, still limited, and it is this gap that the present study seeks to address.

This study is limited to the effects of the fixed-target smash training method and the moving-target (variable) smash training method on smash accuracy in volleyball. This study does not address other basic volleyball techniques, such as serving, passing, and blocking, nor does it measure the athletes' physical, tactical, and mental conditions in depth. The study subjects were limited to athletes from the PU Pati Volleyball Club in Pati Regency in the 2013 age category (KU), with the variables under investigation limited to the two smash training methods as independent variables and smash accuracy as the dependent variable.

This study aims to determine the effect of smash training with a stationary target on smash accuracy among athletes of the PU Pati Volleyball Club KU-2013, to determine the effect of smash training with a moving (varying) target on smash accuracy among athletes of the PU Pati Volleyball Club KU-2013, and to determine the differences in the effects of smash training with a stationary target and smash training with a moving (varying) target on the accuracy of smash shots among athletes of the PU Pati KU-2013 Volleyball Club.

Based on the background of the problem as presented above, the researcher was motivated to conduct a study titled "The Effect of Drilling Exercises for Fixed- and Moving-Target Smashes on Smash Accuracy Among Athletes of the PU Pati Volleyball Club, KU-2013."

2. METHOD

This research is quantitative in nature. The goal of quantitative research is to test preconceived hypotheses. It is based on the positivist philosophy and is used to study a particular population or sample. Research instruments are used to collect data, and data analysis is quantitative or statistical in nature. A Two-Group Pretest-Posttest design is used in this investigation. A pretest is given prior to the treatment in the Two-Group Pretest-Posttest design, which allows for a more precise determination of the treatment's outcomes by comparing them to the pretreatment conditions.

2.1 Participants

A population is the realm of generalization made up of items or people with particular quantities and attributes chosen by the researcher for investigation, from which inferences are then made. 35 athletes from the PU Pati Volleyball Club KU-2013 make up the study's population. The sample represents a portion of the population with similar traits. This study employed purposive sampling in conjunction with non-probability sampling. Purposive sampling is a method for selecting a sample depending on particular factors. The athletes in the sample chosen for this study had to be active members of the PU Pati KU-2013 Volleyball Club for at least a year and have previously

received instruction in fundamental volleyball methods. Twenty athletes from the PU Pati KU-2013 Volleyball Club made up the study's sample based on these criteria.

2.2 Research Design

This research is quantitative in nature. The goal of quantitative research is to test preconceived hypotheses. It is based on the positivist philosophy and is used to study a particular population or sample. Research instruments are used to collect data, and data analysis is quantitative or statistical in nature. A Two-Group Pretest-Posttest design is used in this investigation. A pretest is given prior to the treatment in the Two-Group Pretest-Posttest design, which allows for a more precise determination of the treatment's outcomes by comparing them to the pretreatment conditions.

In order to ascertain the athletes from the PU Pati KU-2013 Volleyball Club's baseline ability, this research design comprises an initial test, or pretest; a treatment consisting of smash drilling exercises with both fixed and variable targets; and a final test, or posttest, to evaluate the athletes' smash accuracy following the treatment. The purpose of this study is to ascertain "the effect of smash drilling exercises with fixed and variable targets on smash accuracy among athletes of the PU Pati KU-2013 Volleyball Club".

2.3 Instruments

The smash accuracy test was employed as the pretest and posttest data gathering method in this investigation. This study's training regimen (treatment) included both fixed-target and moving-target smash drill versions.

2.4 Procedures

After obtaining a research permit from the Faculty of Sports Science, the researcher submitted a research permit request to the manager and coach of the PU Pati KU-2013 Volleyball Club. After the data was collected, the researcher selected a sample of 20 players from the PU Pati KU-2013 Volleyball Club. After obtaining the sample from the population, the next step was to conduct the initial smash test. This study consisted of 12 treatment sessions, one pretest session, and one posttest session.

The table showing the research group assignments is as follows:

Table 1.

Research Group Assignment

Group	Sample Size	Pretest	Treatment	Posstest
Experiment 1	10	Smash Accuracy Test	Variations on Drills for Hitting a Fixed Target	Smash Accuracy Test
Experiment 2	10	Smash Accuracy Test	Variations in Target Smash Drilling Exercises	Smash Accuracy Test

Source: Primary Data

This study consisted of 14 sessions or treatment sessions: 1 pretest session, 12 treatment sessions, and 1 posttest session, for a total of 14 sessions. The sample was divided into 2 groups, and each training session lasted approximately 90 minutes.

2.5 Data Analysis

In order to ascertain the impact of smash drilling exercises aimed at both stationary and moving targets on smash accuracy among athletes from the PU Pati Volleyball Club KU-2013, the data analysis methodologies employed in this study encompassed multiple rounds of statistical analysis, namely:

- **Dekriptive Statistics**

The general features of the study data were described using descriptive statistics. The accuracy test results for the smash during the pretest and posttest are included in this analysis along with their mean, standard deviation, minimum value, and maximum value. Descriptive statistics aim to provide an initial overview of the athletes' smash accuracy levels before and after undergoing a training intervention involving smash drills targeting both fixed and variable targets.

- **Normality Test**

To ascertain whether or not the research data are regularly distributed, a normality test is employed. One of the requirements for using parametric statistical analysis is a normality test. The Shapiro-Wilk (or Kolmogorov-Smirnov) test with a significance level of 0.05 was used in this investigation to test for normality. The data are deemed normally distributed if the significance value (Sig.) is larger than 0.05; on the other hand, if the significance value is less than 0.05, the data are deemed non-normally distributed.

- **Paired Sample T-tes**

The accuracy of athletes' smashes in the groups that received training including fixed-target and variable-target smash drills was tested using a paired-sample t-test to see if there was a significant difference between the pretest and posttest results. The purpose of this test was to evaluate how much the students' smash accuracy had improved following their participation in the study period's training program.

- **Independent Sample T-test**

The improvement in smash accuracy between the experimental group, which received fixed-target smash drilling practice, and the control group, which received variable-target smash drilling practice, was compared using an independent samples t-test. In comparison to the group that did not receive the treatment, this test was done to see if the training approach had a substantial impact.

With a significance level of 0.05, statistical software like SPSS was used for the entire data analysis procedure in this investigation. Conclusions about the impact of smash drilling activities with fixed and variable targets on smash accuracy among athletes from the PU Pati Volleyball Club KU-2013 were then made using the analysis's findings.

3. RESULTS

The smash accuracy test results for Experiments 1 and 2 are as follows:

Table 1.

Description of Research Data for Experimental Group 1 and Experimental Group 2

Method	N	Mean Pretest	Standar Deviasi	Mean Posttest	Standar Deviasi
Variations on Drills for Hitting a Fixed Target	10	13	3,590	15,30	2,751
Variations in target smash drills	10	9,60	1,897	13,90	1,197

Source: Primary Data

Based on Table 1, both groups showed an increase in their average shot accuracy scores after receiving the treatment. Experimental Group 1 (fixed target) increased from 13.00 to 15.30, while Experimental Group 2 (variable target) increased from 9.60 to 13.90. This indicates that the variable-target training variation resulted in a greater improvement compared to the fixed-target training variation.

This study requires the normalcy test, and the Kolmogorov-Smirnov test will be used to assess the test results with a significance level of 0.05.

Table 2.

Results of the Kolmogorov-Smirnov^a Normality Test for Experimental Group 1 and Experimental Group 2

Variable	Sig.	Description
Pre-test for Experimental Group 1	0,200	Data Normal
Posttest for Experimental Group 1	0,200	Data Normal
Pre-test for Experimental Group 2	0,168	Data Normal
Posttest for Experimental Group 2	0,200	Data Normal

Source: Primary Data

The significant values from the pre-test and post-test data for Experimental Group 1 and Experimental Group 2 were $P > 0.005$, suggesting that the data are normally distributed, according to the necessary test findings displayed in Table 2 above.

Following the completion of the preparatory testing stage, hypothesis testing was carried out. Conclusions regarding the research problem were the aim of this testing. The hypotheses in this study were tested using a paired-sample t-test. The outcomes of the hypothesis testing are as follows.

Table 3.

Results of the Hypothesis Test (Paired-Sample T-Test) for Experimental Group 1 and Experimental Group 2

Variable	Pretest			Posttest			P Value (Sig.)
	n = 10			n = 10			
	M	±	SD	M	±	SD	
Experimental Group 1	13,00	±	3,59	15,30	±	2,751	0,043
Experimental Group 2	9,60	±	1,897	13,90	±	1,197	0,000

Description: n = Sample, M = Mean, SD = Standard Deviation

Source: Primary Data

The paired-sample t-test findings for Experiment Group 1 revealed a significance value of 0.043, whereas Experiment Group 2 showed a significance value of 0.000, according to the data in Table 3. Given that the significance values are less than 0.05, it can be concluded that both the fixed-target and variable-target smash drilling exercises significantly affect volleyball players' smash accuracy.

Table 4.

Hypothesis Test Results (Independent Samples t-Test) for Experimental Group 1 and Experimental Group 2

Variable	Posttest for Experimental Group 1			p Value (Sig.)	Posttest for Experimental Group 2			p Value (Sig.)
	M	±	SD		M	±	SD	
Smash Accuracy	15,30	±	2,751	0,157	13,90	±	1,197	0,157

Description: n = Sample, M = Mean, SD = Standard Deviation

Source: Primary Data

The independent samples t-test findings for both Experimental Group 1 and Experimental Group 2 indicate a p-value of 0.157, based on the data in Table 4. Since this p-value is higher than 0.05, it may be inferred that there is no discernible difference between the post-test results of Experimental Group 1 and Experimental Group 2.

4. DISCUSSIONS

The results of this study indicate that both forms of smash drilling fixed-target and variable-target had a significant effect on the accuracy of the smashes performed by the KU-2013 PU Pati Club volleyball athletes. With a p-value of 0.043 for the fixed-target training group and 0.000 for the variable-target training group (both < 0.05), the paired-sample t-test verified a substantial improvement in both groups. Nevertheless, the independent-samples t-test findings on the two groups' posttest scores revealed no significant difference ($p = 0.157$), indicating that neither approach was statistically shown to be better than the other in enhancing smash accuracy during the intervention period under investigation.

The finding that both methods are equally effective can be explained through the lens of motor learning theory. Fixed-target practice falls under the category of “closed skills” skills performed in a stable environment that is fully predictable by the performer, allowing athletes to repeatedly control and plan their movements until the technique becomes automated. In contrast, variable-target training introduces variations in target distance and position that require continuous movement adjustments, in line with the principles of contextual interference and practice variability, which are believed to strengthen the formation of long-term motor schemas.

Interestingly, the variable-target group showed a much stronger level of statistical significance ($p = 0.000$) compared to the fixed-target group ($p = 0.043$), even though the pretest mean for this group was actually lower (9.60 versus 13.00). Critically, this finding must be interpreted with caution: the higher statistical significance in the variable-target group is most likely influenced by greater room for improvement due to a lower baseline, rather than solely evidence of the absolute superiority of the variable method. Baseline differences between groups that were not controlled for through matching or initial covariates represent a methodological limitation that could potentially introduce bias in the interpretation of the true effect sizes of each treatment.

The finding that there was no significant difference between the two groups on the posttest is consistent with the recent systematic reviews and meta-analyses outlined in the introduction, which cast doubt on the generalisability of the superiority of randomised/varied training (contextual interference) over block training in the context of applied sports. The benefit of random training, which has long been assumed on the basis of laboratory research, is not fully supported in real-world sports training settings, and performance in skill acquisition, retention, and transfer does not consistently differ between block (low interference) and random (high interference) training schedules. These concerns are further supported by the present study's findings, which show that both fixed-target and variable-target training eventually produced statistically comparable smash accuracy levels.

On the other hand, as reviewed earlier, a number of studies continue to show that variation and contextual interference contribute to the improvement of gross motor skills when provided with sufficient intensity and duration, including through traditional game skill training and random, game-based training schedules. This suggests that the effectiveness of training variability depends heavily on the characteristics of the sport, age, the athletes' initial skill level, and the duration of the training program; therefore, results from one population cannot be directly generalized to another, including young volleyball players at the PU Pati club.

The effectiveness of fixed-target training in this study is also consistent with earlier findings showing that training based on a combination of part and whole practice significantly improves smash technique in 11–12-year-old volleyball athletes, which confirms that structured repetition under stable conditions remains relevant for developing technical automation in both beginner and young athletes. Previous work has also found that learning methods and motor skills jointly influence learning outcomes for basic volleyball techniques, suggesting that the success of a training method cannot be separated from athletes' basic motor skills prior to undergoing the training program an aspect that was not explicitly controlled for in this study.

These results also align with the previous studies reviewed in the introduction, which demonstrate that target-based drills, regardless of their variation, consistently and effectively improve technical accuracy in volleyball. However, smash accuracy is not solely determined by the target pattern of the drill: circuit-based smash training models and plyometric exercises that increase the explosive strength of the arm muscles have likewise been shown to improve smash skills and smash

accuracy. These findings confirm that smash accuracy is multifactorial, influenced not only by the training target pattern but also by physical conditioning components such as muscle strength and power, coordination, and mastery of basic techniques factors that were not manipulated separately in this study's design and therefore need to be controlled for in future research.

This study has some methodological flaws that must be carefully considered. First, the result showing $p = 0.157$ in the independent-samples t-test must be interpreted cautiously because the relatively small sample size (10 athletes per group) may reduce statistical power in detecting differences in effects between groups; the lack of a significant difference does not necessarily prove that the two methods are truly practically equivalent. Second, although the contextual interference framework states that the primary distinction between fixed-target and variable-target training lies precisely in the long-term retention of skills, not just in short-term performance, this study only assessed performance immediately following the treatment (posttest) without retention or transfer tests at predetermined time intervals. Third, the results should not be extrapolated to a population of volleyball players with varying ages, skill levels, or training environments because this study was limited to a specific club and age group (KU-2013).

It is clear from the preceding discussion that coaches can train young volleyball players to increase smash accuracy using both fixed-target and variable-target smash drilling exercises. Since there is no discernible difference in the two approaches' efficacy, coaches might think about introducing both gradually, beginning with fixed-target drills to automate fundamental skills and moving on to variable-target drills to develop flexibility and tactical judgment in the face of changes in real-world scenarios. To draw more robust conclusions on the relative efficacy of these two training approaches, future research is advised to incorporate a bigger sample size, a control group without treatment, retention and transfer tests, and control of physical condition variables.

5. CONCLUSIONS

Both smash drilling activities with a fixed target and smash drilling exercises with a variable target significantly improve smash accuracy among athletes at the PU Pati Volleyball Club, according to the research findings and discussion shown above. Both the fixed-target training group and the variable-target training group significantly improved, according to the paired-sample t-test results. However, there was no discernible difference between the two groups' posttest scores according to the results of the independent-sample t-test. Consequently, it can be said that no method was statistically superior to the other in terms of increasing smash accuracy during the intervention period under study.

These findings indicate that both training methods are suitable for use as alternatives in training programs for young volleyball players. Coaches are advised to implement both methods progressively, starting with fixed-target drills to develop automatic execution of basic smash techniques, and then continuing with variable-target drills to train athletes' adaptability and tactical decision-making skills in dealing with a variety of real-game situations.

This study has a number of drawbacks, such as a small sample size, no assessments of skill transfer and retention over time, and a focus on a single club and age range. Therefore, in order to draw stronger conclusions about the relative efficacy of the two training methods, future research is advised to use a larger sample size, include a control group without treatment, test skill retention and transfer, and account for athletes' physical condition variables.

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