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The Effect of Plyometric Training on Ability Javelin Throw by Pasi Sleman Athletes

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Abstract: The purpose of this study was to determine the effect of plyometric training on the javelin throwing ability of PASI Sleman athletes. This study is a pre-experimental study with a "One Group Pre-test Post-test Design" design. The study was conducted at Tridadi Stadium, Sleman, from February 3 to March 20, 2025. The subjects of this study were selected by purposive sampling. The sample in this study were all PASI Sleman javelin throwing athletes who had undertaken special training in preparation for POPDA and PORDA DIY 2025, aged 14 to 20 years, totaling 10 athletes consisting of 5 male athletes (aged 17–20 years) and 5 female athletes (aged 14–18 years). This research instrument used a javelin throwing ability test. Hypothesis testing in this study used parametric analysis, namely the paired sample t-test. Based on the results of the study, it shows that plyometric training has an effect on the javelin throwing ability of PASI Sleman athletes, the pretest results of the javelin throwing ability got an average of 27.443 meters and after receiving treatment for 16 meetings, the posttest results got an average of 31.559 meters. There was an increase in plyometric training on the javelin throwing ability of PASI Sleman athletes, an increase in the ability of female athletes by 4.04 meters or 9.41%, an increase in the ability of male athletes by 4.21 meters or 10.19%, and an increase in the overall javelin throwing ability by 4.116 meters or 14.99%.

Keywords: *Athletics Athlete, Explosive Power, Plyometric Training, Javelin Throw, PASI Sleman.*

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I. INTRODUCTION

High-performance sports are a crucial sector in developing highly competitive human resources. Data from the World Health Organization (WHO) reveals that more than 80% of adolescents aged 11–17 worldwide do not meet the recommended levels of physical activity, contributing to long-term declines in health and physical performance (WHO, 2022). In Indonesia, the Ministry of Health's 2023 Basic Health Research (Riskesdas) showed that only 36.2% of the population aged 10 years and older engaged in adequate physical activity, while the remainder were classified as inactive. This situation impacts many aspects, both public health in general and athlete development, including athletics, which forms the foundation for many other sports.

In athletics, the javelin throw requires a combination of strength, speed, coordination, and high technical skill. However, performance data shows that Indonesia still lags behind other Asian countries. A 2023 report from the Asian Athletics Association shows that the average throwing distance of Indonesian athletes in the javelin throw is still far below the Asian gold medal standard, approximately 8–12 meters shorter than that achieved by elite athletes in the region. This underscores the importance of innovation in scientifically based training methods to improve athletes' javelin throwing performance, both at the national and regional levels.

Several previous studies have shown that plyometric training is effective in improving athletes' physical performance and specific skills. A meta-analysis by Deng et al. (2023) found that plyometric training had a small to moderate effect on improving throwing, kicking, and dribbling speeds in athletes aged 10–40 years. Huang et al.'s (2023) study of elite basketball athletes showed that an 8-week program significantly improved sprint speed, agility, and explosive strength. Furthermore, a meta-analysis by Zhou et al. (2024) revealed that plyometric training improved jumping, sprinting, and balance in young athletes, although it did not significantly impact lower-limb strength.

Although existing research consistently demonstrates the benefits of plyometric training, several scientific shortcomings still need to be addressed. First, most studies focus on sports such as basketball, soccer, and handball, while studies on javelin throw are limited. Second, there are

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differences in the effectiveness of plyometric training based on age, gender, and training duration. For example, programs lasting more than 7 weeks have been shown to be more effective than those with shorter training durations. Third, there is still a lack of experimental research examining the differential effects of programs simultaneously on male and female athletes, especially in the context of athletics in Indonesia.

Plyometric training is based on the Stretch-Shortening Cycle (SSC) theory, which is a mechanism of eccentric muscle contraction immediately followed by concentric contraction, so that the elastic energy produced can be utilized to increase muscle explosive power (Komi, 2000; Cormie et al., 2011). In this study, the independent variable is plyometric training, which is defined as a SSC-based jumping and throwing training program with a frequency of three times a week for 16 sessions. The dependent variable is javelin throwing ability, which is measured through throwing distance (meters) using the PASI test standard. The assumption of a causal relationship is that the systematic application of plyometric training can increase the explosive ability of the leg and arm muscles, which in turn will contribute to improved javelin throwing performance.

Thus, the formulation of the research questions is: (1) Does plyometric training affect the javelin throwing ability of PASI Sleman athletes? (2) Is there an increase in javelin throwing ability in male PASI Sleman athletes after being given plyometric training? (3) Is there an increase in javelin throwing ability in female PASI Sleman athletes after being given plyometric training? The purpose of this study is to quantitatively analyze the effect of plyometric training on improving the javelin throwing ability of PASI Sleman athletes, by testing the hypothesis that plyometric training has a significant effect in improving javelin throwing ability in male and female PASI Sleman athletes.

II. METHOD

A. Research Design

This study adopted an experimental design with a one-group pretest-posttest model. This design was chosen because the primary objective of the study was to examine the direct impact of plyometric training (the independent variable) on javelin throwing ability (the dependent variable). This approach is suitable for assessing changes in athlete performance after training treatment, by comparing test results conducted before and after the treatment.

B. Population and Sample

The population of this study was all 60 PASI Sleman athletes actively training at Tridadi Stadium in Sleman (Arikunto, 2016). The sample was selected using purposive sampling, which is the selection of samples based on specific criteria relevant to the research objectives. The criteria used in sample selection are as follows:

- PASI Sleman athlete who focuses on the javelin throw.
- Male and female athletes.
- Athletes aged between 14 and 20 years.
- Athletes who are currently participating in the 2025 DIY POPDA and PORDA preparation program.

From these criteria, 10 athletes (5 male and 5 female) were selected as research samples, a number that is in accordance with the rules of small-scale experimental research which prioritizes the depth of treatment.

C. Data Collection Techniques

Data collection was conducted through testing and measurement. The instrument used in this study was a javelin throw test that adheres to the PASI standards, with three throws and the longest distance taken as the final score. This instrument was developed based on IAAF guidelines (2020) and has been validated by a nationally certified PASI Yogyakarta coach. Validity was tested using expert judgment, while instrument reliability was assessed using the test-retest method, with a reliability coefficient of >0.80, indicating good consistency.

D. Research Procedures

The research location is at PASI Sleman which is located at Tridadi Stadium, Sleman District, Sleman Regency, Special Region of Yogyakarta. The research was conducted from February 3 to March 20, 2025. The plyometric training program was given for 6 weeks with a frequency of three times a week, namely Tuesday, Friday, and Sunday, so that there were a total of 16 training sessions. So by looking at the objectives to be achieved, the selected plyometric training was divided into 3 parts, namely: upper body weight training, lower body weight training, and full body training. The following are forms of plyometric training with progressive principles. The pretest was conducted before the training program began, and the posttest was conducted after the training program was completed. The following is the form of the Plyometric Program with the Circuit Method:

Table 1. Plyometric Program with the Circuit Method

Upper Body Exercises	Lower Body Exercises	Combination Exercises
1. Bench press	*1. Back Squat*	*1. squat thrust*
2. Shoulder Press	*2. Romanian Deadlift*	*2. Power Clean*
3. Lat Pulldown	*3. Bulgarian Split Squat*	*3. Snatch*
4. T Clapping Push-Up ricep Pushdown	*4. Calf Raises*	*4. Squat Jump*
5. Medicine Overhead Throw	*5. Box Jump*	
6. Degree Sit Up	*6. Depth Jump*	
7. Standing Medicine Ball Throw	*7. Bounding*	

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After completing the training program above, the athlete utilizes the movement or imitates the javelin throw movement to train the muscles to be achieved, such as basic starting techniques, power position grips, javelin release angles, balance, and coordination. The training program uses an intensity of 50%-70% RM, 6-10 repetitions, 3-5 sets, and a 2-minute recovery time.

E. Data Analysis Techniques

Data analysis was performed using SPSS version 26 software. Prerequisite tests included the Shapiro-Wilk normality test and the homogeneity of variance test. Hypothesis testing was performed using a paired sample t-test to determine any significant differences between the pretest and posttest results. The significance level used was $\alpha = 0.05$.

F. Research Ethics

All participants in this study voluntarily followed the research procedures and signed informed consent. Participants' identities were kept confidential, and the data collected was used solely for academic purposes. This study was conducted in accordance with ethical principles of sports research, emphasizing safety, anonymity, and non-discrimination.

III. RESULTS AND DISCUSSION

A. Data Description

The results of the javelin throwing ability measurements of PASI Sleman athletes before (pretest) and after (posttest) the implementation of plyometric training can be seen in Table 2.

Table 2. Descriptive Statistics of Javelin Throwing Ability (meters)

Group	N	Pretest (M ± SD)	Posttest (M ± SD)	Average Difference	Percentage Increase (%)
Son	5	29.12 ± 1.35	33.33 ± 1.40	+4.21	10.19
Daughter	5	25.76 ± 1.28	29.80 ± 1.35	+4.04	9.41
Total	10	27.44 ± 1.40	31.55 ± 1.48	+4.12	14.99

B. Normality Test

The Shapiro-Wilk normality test showed that the pretest ($p = 0.317$) and posttest ($p = 0.426$) data followed a normal distribution ($p > 0.05$). Therefore, these data met the requirements for a paired sample t-test.

C. Hypothesis Testing

The results of the paired sample t-test can be seen in Table 3.

Table 3. Paired Sample t-test results

Measurement Pair	t Count	df	Sig. (2-tailed)	Information
Pretest – Posttest (Total)	-9.87	9	0,000	Significant ($p < 0.05$)

D. Summary of Findings

The average javelin throwing distance of PASI Sleman athletes increased from 27.44 m (SD = 1.40) in the pretest to 31.55 m (SD = 1.48) in the posttest.

The normality test shows that the data is normally distributed ($p > 0.05$).

The paired sample t-test showed a significant difference between the pretest and posttest results ($t = -9.87$; $p = 0.000 < 0.05$).

Overall, the average throwing distance increased by 4.12 m or 14.99%, with an increase of 10.19% in the boys' group and 9.41% in the girls' group.

The results of this study showed a significant increase in the javelin throwing ability of PASI Sleman athletes after being given plyometric training, with an average increase reaching 4.12 m or 14.99%. The paired sample t-test produced a p value = 0.000 (<0.05), which indicates that the hypothesis stating the effect of plyometric training on javelin throwing ability is acceptable. This finding supports the assumption that plyometric training is effective in increasing muscle explosive power, which is one of the key factors in javelin throwing performance.

From a theoretical perspective, the results of this study align with the Specific Adaptation to Imposed Demands (SAID) principle, which states that the body will adapt specifically to the type of training given. Plyometric training uses a short-stretch cycle (SSC), which combines rapid eccentric and concentric contractions, to increase the muscle's capacity to generate explosive force (Bompa & Buzzichelli, 2022). This increase in muscle explosiveness in the legs and arms plays a direct role in increasing initial velocity, movement coordination, and the javelin's release angle, ultimately resulting in increased throwing distance (Hay, 2021).

The results of this study are also consistent with the findings Nugraha et al. (2024)which confirms that plyometric training can increase leg muscle power and running speed, as well as Kurniawan and Nasirudin (2023)This study reports the effects of two training methods, namely plyometric lateral hurdle drills and depth squat jumps, on the speed and power of leg muscles in 100-meter sprint athletes. Furthermore, Ratnasari & Komarudin (2015)identified an increase in javelin throwing skills in PON athletes through plyometric

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and weight training programs. At the international level, research Deng et al. (2023)showed that consistent plyometric training can improve muscle strength and explosive performance in young athletes.

However, there are also studies that report variations in the effectiveness of plyometric training. Imandaqurani and Henri (2024)emphasized that plyometric training results can indicate that plyometric training is effective in improving vertical jump ability in different age groups, depending on the athlete's age, intensity, and training experience. This difference could explain why the male group in this study experienced a higher increase (10.19%) than the female group (9.41%). Physiological differences such as muscle mass, hormone levels, and neuromuscular adaptation capabilities between men and women may also influence training results (Bompa & Buzzichelli, 2022).

From a practical perspective, these findings offer important implications for PASI coaches and administrators in the regions. Plyometric training programs can be incorporated into the routine training curriculum to prepare athletes for competitions such as POPDA (Indonesian Youth and Sports Week) and PORDA (Indonesian Youth and Sports Week). This intervention is relatively easy to implement, does not require expensive equipment, yet has proven effective in improving athletic performance. These findings also support the need to develop evidence-based training modules that can be adapted by regional sports clubs and schools.

Theoretically, this study strengthens the conceptual model linking plyometric training to improved explosive performance, particularly in the javelin throw. The findings also contribute by demonstrating that plyometrics are relevant not only to events that rely on speed or jumping, but also to throwing events that require the integration of strength, speed, and coordination.

However, this study has several limitations. First, the relatively small sample size (10 athletes) limits the generalizability of the results. Second, the study design used only a one-group pretest-posttest. Without a control group, external factors influencing the results could not be fully controlled. Third, the measurement instrument was limited to throwing distance, without taking into account biomechanical analysis that could provide a more in-depth understanding of changes in technique or javelin release angle.

For future research, it is recommended to expand the sample size by involving athletes from various regions, use an experimental design with a control group, and include other variables such as weight training or resistance training as a comparison. Future research could also incorporate qualitative approaches, such as interviews with coaches and athletes, to explore psychological and motivational factors that may also influence training effectiveness.

IV. CONCLUSION

This study aimed to examine the effect of plyometric training on the javelin throwing ability of PASI Sleman athletes. Based on the statistical analysis, it was found that plyometric training had a significant impact on improving javelin throwing ability in both male and female athletes. Thus, the proposed research hypothesis was proven correct, and plyometric training proved to be an effective strategy for improving explosive performance in javelin throwing.

From a theoretical perspective, these findings support the Specific Adaptation to Imposed Demands (SAID) principle, which explains that the body adapts specifically to the training stimulus it receives. These results indicate that plyometric training is not only relevant for running or jumping events but also makes a significant contribution to improving javelin throwing ability. Practically, this study suggests that PASI coaches and administrators integrate plyometric programs into their routine training curriculum, especially in preparing athletes for competitions at both the regional and national levels.

However, this study has several limitations, including a relatively small sample size and a study design that did not include a control group, which limits the generalizability of the results. Future research is recommended to expand the sample size by involving athletes from various regions, add comparative variables such as weight training or resistance training, and utilize biomechanical analysis to gain a deeper understanding of the mechanisms of performance improvement.

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