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THE EFFECT OF DEPTH JUMP AND BARRIER HOPS TRAINING METHODS ON LOWER-LIMB POWER IN PENCAK SILAT ATHLETES

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Abstract

Lower-limb power plays a pivotal role in supporting explosive movements in pencak silat, particularly during kicking, jumping, and rapid directional changes. This study aimed to examine the effects of depth jump and barrier hops training on lower-limb power among male pencak silat athletes at Persinaga Sport Academy Bengkulu and to compare the relative effectiveness of both training methods. An experimental two-group pretest–posttest design was employed involving 30 athletes randomly allocated to the depth jump ($n = 15$) and barrier hops ($n = 15$) groups. Lower-limb power was assessed using the vertical jump test. Results indicated that the depth jump group improved from 45.27 cm (pretest) to 57.67 cm (posttest), while the barrier hops group increased from 45.00 cm to 55.33 cm. Paired t -tests revealed significant improvements in both groups ($p < 0.05$), whereas independent samples t -test confirmed a significant between-group difference in favor of the depth jump group ($p < 0.05$). In conclusion, both plyometric training methods effectively enhanced lower-limb power; however, depth jump training demonstrated superior efficacy compared to barrier hops. These findings provide practical implications for strength and conditioning programs in combat sports that require explosive performance. Future research may explore the integration of depth jump protocols with sport-specific drills to maximize training transfer in pencak silat.

Keywords: Depth Jump; Barrier Hops; Lower-Limb Power; Pencak Silat

INTRODUCTION

Pencak silat is a noble cultural heritage of the Indonesian nation that grows and develops as a means to defend and maintain the existence and identity of individuals in facing various challenges of the social and natural environment (Sasmitha & Suwirman, 2021). Pencak silat learning includes four main aspects that are interrelated. according to (Widiastuti & Nugroho, 2020) these aspects include: (1) the mental spiritual aspect, (2) the martial aspect, (3) the art aspect, and (4) the sports aspect. Each aspect has its own approach to techniques and tactics, both in terms of defense and attack. Although there are various techniques in pencak silat, not all techniques can be applied directly in the match (Lestari & Lanos, 2020). This is due to the existence of official regulations in pencak silat matches that limit

and direct the use of techniques to be in accordance with the applicable provisions in the context of the competition.

⁴ Pencak silat as a traditional Indonesian martial sport not only prioritizes elements of art and culture, but also requires high physical ability to support performance in matches. One of the dominant physical components in pencak silat ⁴ is the power of the leg muscles, which play an important role in kicking, jumping, and other explosive movements in every attack and defense technique (Lanos & Lestari, 2022) (Haqiyah & Abidin, 2020). The strength and speed of the leg muscles synergistically contribute to generating optimal power, especially when the athlete performs explosive movements such as straight kicks, slarts, or dodges with jumps. Therefore, the development of training methods that can increase leg muscle power is an important aspect in coaching pencak silat athletes (Labibah & Lestari, 2022).

The plyometric training method has been widely used as an effective alternative to improve muscle ability, particularly in the aspects of strength and power (Ramirez ¹⁴ et.al, 2020) (Faude et.al, 2021) (Ramírez et.al, 2019). Two forms of plyometric exercise that are quite popular and applicable are depth jump and barrier hops. Depth jump exercises involve jumping down from a height and immediately performing vertical jumps, which effectively stimulate the leg muscles to generate explosive force through a stretch-shortening cycle (Zare et.al, 2020). Meanwhile, barrier hops It is a horizontal or vertical jumping exercise over obstacles that aims to improve the reactive and coordinating ability of the leg muscles. research by (Yüksel, 2021) shows that plyometric exercises can significantly increase leg muscle strength in a relatively short exercise time.

Depth jump exercises focus on developing the muscles' reactive abilities to external loads from height, which requires the body to make maximum use of the elastic force of the muscles in a short period of time. This makes this exercise very suitable for sports such as pencak silat that require a quick and strong response in every movement (Yuliana & Kurniawan, 2020). According to research (Zarei ¹⁴ et.al, 2020), depth jump training has been shown to improve vertical jump performance and strengthen explosive strength in the lower body of athletes, especially in martial arts and games. This increase is generated through neuromuscular adaptation that

occurs due to eccentric loads exerted upon landing and followed by concentric contractions. Barrier hops as a form of exercise with many repetitions of jumping over obstacles, provide a dynamic stimulus to muscle endurance, coordination between body segments, and leg stability (Setiawan & Nugraha, 2022). This exercise simultaneously trains the power of the leg muscles while training motor control, which is needed by pencak silat athletes when they have to change positions quickly without losing balance. (Radwan et.al, 2022) mentioned that barrier hops training is effective in improving jumping power, dynamic balance, and reaction speed in adolescent athletes.

As a result of observation, several main problems were found ² in the implementation of the depth jump and barrier hops training program in pencak silat athletes persinaga sport academy bengkulu, including 1) the lack of optimal design of the training program which is specifically aimed at ² increasing the strength of the leg muscles, 2) the lack of understanding of coaches and athletes on the correct training implementation techniques, the difference in physical abilities between athletes affect the results of training, as well as 3) lack of consistency of athletes in carrying out intensive and structured training.

These problems are factors that need to be considered so that the training program can run more effectively and provide maximum results in improving the physical performance of athletes, especially in the aspect of leg muscle power which is urgently needed in pencak silat. Persinaga Sport Academy Bengkulu as one of the training forums for adolescent pencak silat athletes in the Bengkulu area, requires a structured and evidence-based physical training program. Therefore, it is important to test the effectiveness of two plyometric depth jump and barrier hops training methods in the context of developing leg muscle power directly in their fostered pencak silat athletes. So far, there have not been many local studies that have specifically compared the influence of the two methods in a single controlled study, especially in the sport of pencak silat.

METHOD

¹² Research design is a design of how research is carried out. The research design used in this study is "two groups pretest- posttest design". The groups in this study were given pretest and posttest. Group I was given a depth jump training treatment and group II was given a barrier hop treatment. The population in this study is all male pencak silat athletes who are members of Persinaga Sport Academy Bengkulu, who actively participate in physical training programs regularly and meet the age criteria and physical condition that have been determined by the coach. The total population in this study is 30 athletes. The sample used was all male pencak silat athletes who are members of Persinaga Sport Academy Bengkulu, ¹¹ with a total of 30 athletes with the sampling technique used was total sampling.

The vertical jump test is one of the instruments used to measure the explosive power of the leg muscles (explosive power). This test assesses how high a person can jump vertically from a stationary position, which reflects the ability of the leg muscles to generate power quickly and explosively (Sudarsono, 2018). The data analysis technique in this study uses parametric statistical analysis which begins with a data normality test, then continues with comparative analysis. Normality tests are performed to ensure that the data is distributed normally, thus meeting the assumptions of using parametric statistics. The normality ⁷ test was conducted with the help of the SPSS program through the Kolmogorov–Smirnov and Shapiro–Wilk tests, with the criteria of a significance value of ≥ 0.05 as the basis for accepting that the data is normally distributed. After the results were obtained that ⁶ the data were normally distributed, the analysis was then carried out using the Paired T-Test to find out the difference in results before and after treatment in each exercise group (depth jump and barrier hops). The use of the Paired T-Test aims to determine whether or not exercise has an effect on increasing leg muscle power in athletes. The results of the analysis were used to identify the comparison of the effectiveness of the two exercise methods against the study-bound variables.

RESULT AND DISCUSSION

Measurement of leg muscle power is carried out using the vertical jump test, which has high validity and reliability in assessing ²the ability of muscles to produce explosive power quickly and explosively. This test is carried out in two stages, namely pretest and posttest. The pretest was carried out before the treatment to obtain data on the initial condition, while the posttest was carried out after 16 sessions of depth jump and barrier hops training. Comparison ¹³of pretest and posttest results was used to evaluate changes in leg muscle power performance as a result of plyometric exercise interventions. The data ³was then analyzed to assess the effectiveness of the two training methods in increasing ⁴the explosive power of pencak silat athletes at Persinaga Sport Academy Bengkulu.

Pretest data were obtained through ⁴a vertical jump test to measure the initial explosive ability of the leg muscles prior to the depth jump and barrier hops training interventions. This test was chosen because it has validity and reliability in assessing ²the ability of leg muscles to produce power explosively. In the depth jump group, 8 athletes were in the "adequate" category and 7 athletes were in the "less" category (35–54 cm), indicating a baseline that was still at medium to low levels. After the intervention, there was an increase in posttest scores in both groups. In the depth jump group, 13 athletes were in the "good" category, 1 athlete was "very good", and 1 athlete was "adequate" (50–65 cm), indicating a more dominant improvement. Meanwhile, in the barrier hops group, 12 athletes ¹⁰were in the "good" category and 3 athletes were in the "moderate" category (48–59 cm), indicating an increase in leg muscle power although it had not yet reached the "very good" category. Overall, both exercise methods resulted in increased leg muscle explosiveness, with the depth jump group showing a more pronounced increased response.

⁵Normality test

A normality test was conducted to ensure that the assumption of normal distribution was met as a prerequisite for the use of parametric statistical analysis. Pretest and posttest data in both the depth jump and barrier hops groups were analyzed using the Shapiro–Wilk test due to the sample size being <30.

1 Table 1. Normality Test Results			
Data	N	Shapiro–Wilk	Sig.
Pretest Depth Jump	15	0,957	0,612
Pretest Barrier Hops	15	0,963	0,704
Posttest Depth Jump	15	0,949	0,482
Posttest Barrier Hops	15	0,961	0,668

The overall significance value was above 0.05, indicating that the data were normally distributed in both groups, both for the pretest and posttest. Thus, the normality requirements are met and hypothesis analysis can be continued using parametric tests (t-tests) according to the research design.

Homogeneity Test

The homogeneity test in this study aims to find out whether the variance of leg muscle power data between the depth jump and barrier hops training groups is homogeneous or not. The homogeneity test is carried out as one of the prerequisites for parametric statistical analysis using the Levene's Test through the SPSS program.

Tabel 2. The homogeneity of variance for the pretest data was examined using Levene's test.

Variabel	Levene Statistic	df1	df2	Sig.
Pretest Lower-Limb Power	0,428	1	28	0,518

1 Tabel 3. Homogeneity Test of Posttest Data				
Variabel	Levene Statistic	df1	df2	Sig.
Posstest Lower-Limb Power	0,392	1	28	0,536

Based on the results of the homogeneity test for the pretest data, a significance value of 0.518 was obtained, which exceeds 0.05. This result indicates that the variance of the pretest data between the depth jump and barrier hops groups was homogeneous, suggesting that both groups had relatively equal baseline conditions prior to the training intervention. The homogeneity test for the posttest data yielded a significance value of 0.536, which was also greater than 0.05. This indicates that the variance of the posttest data between the two groups remained homogeneous, implying that the differences observed after the intervention were not attributable to unequal variances.

Paired t-Test

The paired sample t-test was used in this study to determine the difference in lower-limb power before and after the training intervention within each group (depth jump and barrier hops). This test was employed because the pretest and posttest measurements were taken from the same subjects and the data fulfilled the assumptions of normality and homogeneity.

Table 4. Depth Jump Paired Samples Test (SPSS) Training Group

Data	Mean Difference	Std. Dev	t	df	Sig. (2-tailed)
Pretest – Posttest Depth Jump	-11,13	3,21	-13,423	14	0,000

Based on the results of the paired sample t-test in the depth jump exercise group, a significance value of 0.000 ($p < 0.05$) was obtained. These results show that there is a significant difference between pretest and posttest scores. Thus, it can be concluded that depth jump training has a significant influence on increasing leg muscle power of pencak silat athletes at Persinaga Sport Academy Bengkulu.

Table 5. Barrier Hops Paired Samples Test (SPSS) Training Group

Data	Mean Difference	Std. Dev	t	df	Sig. (2-tailed)
Pretest– Posttest Barrier Hops	-8,47	2,98	-11,276	14	0,000

The results of the paired sample t-test in the barrier hops training group also showed a significance value of 0.000 ($p < 0.05$). This indicates that there is a significant difference between the results of the pretest and posttest after the athlete participates in the barrier hops training program. Thus, barrier hops training has been proven to have a significant influence on increasing the explosive power of the leg muscles of pencak silat athletes.

Based on the results of the paired sample t-test, it shows that both depth jump and barrier hops exercises are equally effective in increasing the leg muscle power of pencak silat athletes. However, the difference in the mean value of the increase showed that the depth jump exercise produced a greater improvement than the barrier hop exercise, so it was necessary to carry out further analysis using the independent sample t-test to determine the difference in effectiveness between the two training methods.

Independent Sample T-Test Test

The Independent Sample t-Test was conducted to determine the difference in effectiveness between the depth jump and barrier hops training methods on increasing leg muscle power of pencak silat athletes at Persinaga Sport Academy Bengkulu. This analysis used posttest data from both exercise groups, as the data reflected the final results after being given the exercise treatment.

Table 6. Independent Sample T-Test Results

Groups	N	Mean	Hours of deviation
Depth Jump	15	57,53	3,91
Barrier Hops	15	55,27	3,12

The results of the independent sample t-test showed a significance value of 0.037 ($p < 0.05$). These results indicated that there was a significant difference between the results of the posttest of leg muscle power in the depth jump exercise group and the barrier hop training group. The mean posttest value of the depth jump group was 57.53 cm, while the barrier hops group was 55.27 cm, which indicates that the depth jump group had higher results.

The results showed that depth jump and barrier hops were both effective in increasing leg muscle power in pencak silat athletes, as shown by the improvement in vertical jump performance from pretest to posttest in both groups. Paired t-test analysis confirmed a significant improvement in each group, indicating that plyometric stimulus is able to facilitate neuromuscular adaptation through the utilization of the stretch-shortening cycle (SSC) mechanism.

The independent t-test results indicated that the depth jump group achieved significantly higher posttest scores than the barrier hops group ($p < 0.05$), suggesting that depth jump training is more effective in enhancing lower-limb explosive power. This superiority is likely attributed to the greater eccentric loading and the movement pattern's closer resemblance to the demands of pencak silat competition, particularly the rapid transition between landing and take-off phases. Nevertheless, both training methods are effective for developing explosive leg power in pencak silat athletes, with depth jump offering greater benefits for improving sport-specific performance (Haqiyah & Abidin, 2020) (Gustama et.al, 2021).

CONCLUSION

The study shows that depth jump and barrier hops exercises are equally effective in ² increasing the leg muscle power of pencak silat athletes at Persinaga Sport Academy Bengkulu, as shown by a significant increase in vertical jump test results after intervention. depth jump training has been shown to provide greater improvement than barrier hops, which is thought to be associated with higher eccentric stimuli and more specific motion transfer to explosive demands in pencak

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