

## Increased Leg Power of Female Fighters through Plyometrics Double Leg Lateral Hop Exercise: An Experimental Study

Arief Samudiyanto<sup>1,\*</sup>, Nur Subekti<sup>1</sup>, Muhad Fatoni<sup>1</sup>

<sup>1</sup> Faculty of Education Sciences, Universitas Muhammadiyah Surakarta, Surakarta, Indonesia

### Abstract

This investigation aims to determine whether the Plyometric Double Leg Lateral Hop Exercise enhances leg power in female martial artists. Twenty female martial artists from the Perguruan Tapak Suci Putera Muhammadiyah in the Boyolali District, constituting twenty athletes, were the focal point of this inquiry. As outlined by Hamilton et al. (2008), the Triple Hop Jump Test was utilised to gauge the power capacity of the leg muscles as part of the data collection methodology. According to the reference cited from [id.scribd.com/document](https://id.scribd.com/document), the athlete stands on the leg under evaluation and then leaps forward as far as possible, commensurate with their ability. This assessment tool serves to evaluate dynamic stability using a single forward jump. The data analysis method employed in this study involved a t-test using SPSS version 25, with significance testing for differences. The study's outcomes reveal that the Plyometric Double Leg Lateral Hop Exercise contributes to increased limb power among female martial artists. Nonetheless, given that the study's cohort and sample exclusively comprise female combatants, prudence is advised in extrapolating the findings to broader training paradigms. Subsequent investigations should consider the specific physiological attributes that influence the performance of martial arts athletes.

### Introduction Section

Today, it is undeniable that one of the cultural heritage of the ancestors of the Nusantara nation, in the form of pencak silat martial arts, has flourished and proliferated across various countries. Although historical records cannot precisely pinpoint the birth of pencak silat, it is widely believed that its origins trace back to the archipelago, estimated to coincide with the dawn of human civilization (Subekti et al., 2019). Pencak silat martial arts are presumed to have disseminated throughout the archipelago since the 7th century AD. Numerous accounts mention the prominence of warriors adept in kanuragan or martial arts within the Majapahit and Srivijaya kingdoms. Moreover, historical evidence of martial arts in the archipelago is evident in various forms, including relics of weapons from classical (Hindu-Buddhist) times, as well as reliefs depicting pencak silat motifs on the walls of Borobudur temple in Magelang and Prambanan temple in Klaten (Subekti et al., 2019).

In pencak silat, robust leg muscle strength is essential for every athlete. Muscle strength, or power, denotes an individual's capacity to exert maximal force in the shortest possible duration (Lubis & Wardoyo, 2014; Nugroho et al., 2021; Subekti, Syaifullah, et al., 2021). Data gleaned by the author, who also serves as a trainer, through visual observations and interviews with Sarwanto, S.Pd.I, the head of Pimda 051 Tapak Suci Boyolali, and Arifin, K.Ua, one of the coaches of Tapak Suci Boyolali, indicates a deficiency in leg muscle power among female martial artists from Tapak Suci Boyolali, posing challenges in the developmental trajectory of these adolescents. According to Kriswanto (2015: 118), youth pencak silat competitions typically encompass participants aged 14 to 17. The inadequacy in leg muscle power among female fighters from the Holy Site of Boyolali District manifests in suboptimal foot attacks reliant on generated leg muscle power, compromised horse stance stability, feeble kicking strikes, susceptibility to counterattacks during kicking maneuvers, diminished scoring opportunities from kick attacks, and frequent losses in sparring matches, tournaments, and POPDA events. These indications underscore the imperative of addressing the insufficiencies in leg muscle power among the female fighters of Pencak Silat Tapak Suci Boyolali.

The training focused on enhancing leg muscle power is pivotal for improving kicking proficiency in pencak silat, where kicks are frequently employed. In this context, the strength and capability of leg muscles assume paramount importance, and through targeted leg muscle power training, these abilities can be augmented (Patah et al., 2021; Sasmitha, 2020; Syaifullah & Doewes, 2020; Yulanda & Jariono, 2023). It is imperative for trainers to meticulously devise leg muscle power training regimes tailored to the specific demands of martial arts movements. A structured approach to leg muscle

---

\* Corresponding author: [samudiyantorief27@gmail.com](mailto:samudiyantorief27@gmail.com)

power training is essential for optimising results. This entails the implementation of exercises that are attuned to the characteristics of martial arts movements.

Plyometric training stands out as a favoured method among contemporary trainers, particularly for sports necessitating explosive strength in leg or arm muscles (Achilleopoulos et al., 2022; Tsegay et al., 2021). Its primary function lies in enhancing energy capacity, a pivotal element contributing to sporting achievements (Jariono et al., 2020; Jariono, Nugroho, et al., 2021; Jariono, Nurhidayat, et al., 2021). Such enhancements are typically realised through the execution of Plyometric exercises (Bompa & Buzzichelli, 2019), which heavily rely on explosive strength and rapidity under significant loads. Resistance in Plyometric exercises is typically manifested through swift movements aimed at overcoming gravitational force, encompassing actions like leaps, bounds, and other dynamic maneuvers (Enhancement & Zatsiorsky, 2000; Vivekanth, B. Vallimurugan, 2020).

Various approaches exist for augmenting leg muscle power, with plyometric exercises being a prominent option. Plyometric exercises encompass a range of forms, including double leg lateral hops, side jumps, depth jumps, single-speed hops, and double leg speed hops (Hanafi, 2015; Putra and Wandik, 2017). However, this research focuses on exercises involving double leg lateral hops and depth jumps. While the training protocols for both exercises are similar, it remains unclear which exercise yields superior results in enhancing leg muscle power among female fighters of Pencak Silat from the Holy Site of Boyolali District. It is on this premise that the researcher seeks to undertake this study.

The potency of leg muscle power significantly influences the efficacy of kicks, sweeps, and takedowns (Adhi et al., 2017; Lumintuarso, 2015; Subekti, Warthadi, et al., 2021; Yulanda & Jariono, 2023). The kicking power exhibited by female martial artists from the Boyolali Holy Site of Pencak Silat is perceived to be deficient, evident in their struggle to secure scoring opportunities during kicks, as well as in the assessment of leg muscle power during sweeps and takedowns, where they often fall short in successfully neutralizing opponents. This inadequacy is discernible not only in training sessions and competitive matches but also in the overall performance outcomes, including the achievements of female fighters from Tapak Suci Putera Muhammadiyah Boyolali, as well as their participation in sparring matches, pencak silat tournaments, Boyolali District POPDA competitions in 2022, and internal contests within Tapak Suci college. Such shortcomings are attributed to physical factors, particularly the perceived deficiency in leg muscle power.

Consequently, the researchers, who are also Tapak Suci Putera Muhammadiyah Boyolali trainers, have elected to focus their study on female fighters from this institution rather than male counterparts. This decision is informed by achievement data gathered from Regional Leadership 051 Tapak Suci Putera Muhammadiyah Boyolali, as well as insights gleaned from interviews with several trainers of Tapak Suci Boyolali, namely Sarwanto, K. and Hafshoh, K.Mdy. Through routine training sessions and participation in various competitions, including collegiate events, tournaments, and POPDA, male fighters from Tapak Suci Boyolali District demonstrate a robust horse stance, a propensity for victories, and a scarcity of defeats. Furthermore, visual observations reveal their kicks to be powerful and swift, often yielding scoring opportunities.

The plyometric double leg lateral hop exercise is an effective regimen for enhancing leg muscle power, which requires a raised platform or designated space. Integrating double leg lateral hops into pre- and post-treatment routines reinforces leg muscles, enhancing the efficacy of martial arts kicks. The study titled "Increasing the Power of Female Martial Artists' Legs through Plyometric Double Leg Lateral Hop Training in Pencak Silat: A Case Study of Tapak Suci Puteri Muhammadiyah Boyolali" was devised in response to the concerns above.

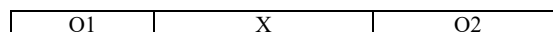
## Research Methodology

### Research Methods

The research methodology of functional exercise models for weight loss, with a focus on experimental research, encompasses two primary components:

1. Application of functional exercise models for weight loss.
2. Acquisition of empirical data regarding the effectiveness and efficiency of Plyometrics double leg lateral hop training on Pencak Silat athletes from Tapak Suci Puteri Muhammadiyah Boyolali.

This study adopts a quantitative approach, employing experimental techniques to investigate the impact of Plyometrics double leg lateral hop training. The ultimate finding of the study underscores the efficacy of double leg lateral hop plyometric exercises in enhancing leg power. The layout of the research is depicted in the following image.



**Figure 1.** One group pretest and posttest design

Where:

- O1 : Pretest Limb Power Measurement
- X : Experimental groups using Exercise Plyometrics double leg lateral hop
- O2 : Posttest Limb Power Measurement

The population under study comprises 20 female fighters from Tapak Suci Putera Muhammadiyah in the Boyolali District. Employing a purposive sampling technique, the study aims to select participants based on specific criteria relevant to the research objectives. The research is scheduled to be conducted from early September to mid-November 2023.

### Data Collection Techniques

To gather the required data for this study, the power capacity of the leg muscles was assessed using the Triple Hop Jump Test developed by Hamilton et al. in 2008. As described in the [id.scribd.com/document](https://www.scribd.com/document) page, this test is a measurement tool to evaluate dynamic stabilization by requiring the athlete to perform a single forward jump to cover a distance. During the test, the athlete stands on the designated leg to be evaluated and then executes a forward jump to their maximum capacity. Additionally, a pretest is conducted during the initial meeting to establish the baseline ability before proceeding with subsequent treatment protocols.

### Data Analysis Techniques

Quantitative data analysis procedures were employed to describe weight loss based on pretest and posttest results, commencing with descriptive statistical analysis. The study utilized version 25.0 of the Statistical Package for Social Sciences (SPSS) software to process data from both the pretest and posttest phases. Descriptive statistics, including mean and standard deviation, were calculated to estimate weight loss scores. Subsequently, inferential analysis was conducted on the sample data, with the outcomes extrapolated to the population to test the research hypothesis. Before hypothesis testing, a prerequisite test known as the Kolmogorov-Smirnov Normality Test was administered to determine whether the collected data exhibited a normal distribution.

Should the pretest and posttest data from the population exhibit normal distribution, the final step involves statistical hypothesis testing. Specifically, if the calculated t-table significance (2-tailed) is greater than or equal to  $\alpha=0.5$ , the null hypothesis ( $H_0$ ) is accepted, and the alternative hypothesis ( $H_a$ ) is rejected. This indicates that the administration of Plyometrics exercises, including double leg lateral hops with depth jumps, leads to an increase in leg muscle power among female martial artists from Pesilat Putri Pencak Silat Tapak Suci Puteri Muhammadiyah Boyolali. Conversely, if the calculated t-value exceeds the critical t-value, the null hypothesis ( $H_0$ ) is rejected, and the alternative hypothesis ( $H_a$ ) is accepted. This suggests that Plyometrics exercises, particularly double leg lateral hops, enhance leg muscle power in female fighters.

## Results and Discussion

### Research Results

Results of a descriptive analysis including the average value, minimum value, maximum value, range value, and total number were reported in this study on Increasing the Power of the Legs of Female martial artist through Plyometrics Double Leg Lateral Hop Pencak Silat Exercise Tapak Suci Puteri Muhammadiyah Boyolali. The explanation is as follows:

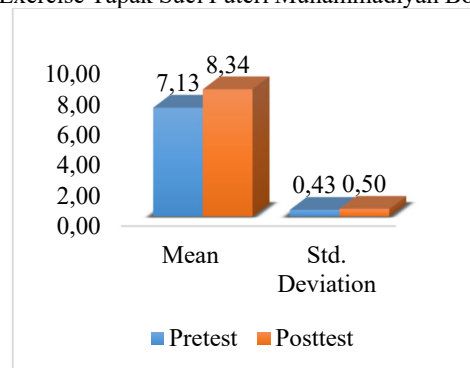


Figure 2. Limb power pretest and posttest results

Based on the descriptive analysis results presented in Figure 1, it is evident that there is an increase in leg power among female martial artists from Tapak Suci Putera Muhammadiyah Boyolali District between the pretest and posttest phases. This conclusion is supported by the average values of 7.13 and 8.34 for leg power in the pretest and posttest, respectively, representing an increase of 1.21. Therefore, it can be inferred that following treatment with the Plyometrics Double Leg Lateral Hop Exercise, female fighters from Tapak Suci Putera Muhammadiyah Boyolali District notably improved leg power by 1.21 units.

After comprehensively explaining the descriptive analysis results, the data normality test serves as a precondition for the research hypothesis test. The findings of this test are displayed in the following table:

**Table 1.** Kolmogorov-Smirnov Z normality test results

Statistics	Power limbs	
	Pretest	Posttest
Number of Samples	20	20
Kolmogorov-Smirnov Z	.217	.197
Asymp. Sig. (2-tailed)	.118	.063

Based on the data normality test results, all data groups exhibited Kolmogorov-Smirnov Z (KS-Z) values greater than  $\alpha = 0.05$ , as indicated in the table. This suggests that the study's sample was drawn from a population that adheres to a normal distribution. Consequently, the first prerequisite for hypothesis testing has been met, enabling the hypothesis proposed in this study to be tested using parametric statistical analysis.

Moreover, the homogeneity test used the Barlett test at the significance level of  $\alpha = 0.05$ . Table 2 below summarizes the findings from the homogeneity analysis utilizing the Oneway Anova test of homogeneity of variances and the Barlett test.

**Table 2.** Homogeneity test results

Group	$\chi^2$	$\chi^2_{tables \alpha = 0.05}$	Sig. (p)	Conclusion
Pretest	0.000	37,341	0.605	Homogeneous

Based on the test results, it was determined that the eight data groups exhibited homogeneous variance, as indicated by the Levene test, yielding a significance level of  $p = 0.987$ , which is greater than  $\alpha = 0.05$ . Additionally, the test statistic value (2 count) of  $\chi^2_{0.000}$  was found to be smaller than the critical value (2 table) of  $\chi^2_{37.341}$ , with a significance level (p) of 0.605. These results support the analysis requirements, confirming that the conditions for conducting variance analysis are satisfied.

Subsequently, with the test conditions fulfilled, a hypothesis test was conducted to ascertain the significance of increasing the power of the limbs of female martial artists through Plyometrics Double Leg Lateral Hop training at Tapak Suci Puteri Muhammadiyah Boyolali. The table below presents the findings of the hypothesis test.

**Table 3.** Recapitulation of significance test (t-test)

Variable	$t_{hitung}$	Sig.	$t_{tabel}$	
			5% (0,05)	10% (0,1)
Pretest and Posttest Weight Loss	15,169	0.000		1.684

Using the t-test correlation coefficient analysis shown in table 5 above,  $t_{count}$  values of 15.169 and  $t_{count} (49)_{(0.05)}$  of 1,684 were determined. These findings indicate that the correlation coefficient (t-test) between the significant weight reduction pretest and posttest, or  $H_0$ , is rejected, and  $H_1$  is accepted. Therefore, it can be said that the Plyometrics Double Leg Lateral Hop Pencak Silat Exercise of the Holy Site of the Princess of Muhammadiyah Boyolali significantly enhances the strength of the Puteri Pesilat limbs. This indicates that the coefficient, when a sample of 20 people is taken, can be applied to the entire population of students.

The study's findings, "Improvement of Female Martial Artist Leg Power through Plyometrics Double Leg Lateral Hop Training at Tapak Suci Puteri Muhammadiyah Boyolali," are supported by several other studies in the field. Hutabarat (2023) studied the impact of front jump and single-leg bound plyometrics training on leg muscle power in pencak silat athletes at SMKN 1 Medan. Their findings align with the current study, indicating a substantial enhancement in leg power among athletes. Similarly, Utamayasa (2020) explored the effects of box jump training on explosive power in male volleyball players. Their research revealed a notable increase in explosive power following the training sessions, which included plyometric exercises like box jumps.

Furthermore, Utamayasa (2020) also investigated the impact of double leg speed hop training on the explosive power of Pencak Silat players from PAT BAN BU. Their findings further validate the efficacy of plyometric training in enhancing leg muscular explosive power. Yenes and Leowanda (2019) studied junior Semen Padang athletes, focusing on the effects of front jump training on limb muscle explosive power. Their findings supported the notion that front jump training significantly increased explosive power in athletes. Moreover, Yenes and Leowanda (2019) also found that side jump training considerably impacted the explosive strength of junior Semen Padang athletes' leg muscles, further reinforcing the importance of plyometric exercises in improving leg power.

## Conclusion

The Plyometrics Double Leg Lateral Hop Pencak Silat Training conducted at the Holy Site of Puteri Muhammadiyah Boyolali has been shown to effectively increase the power of female martial artists' limbs, as demonstrated by the findings and discussion of the research. However, future research needs to proceed cautiously, considering that this study identified only one factor contributing to the growth of leg power. Further investigation is warranted, particularly on the potential benefits of incorporating additional training techniques, such as lahin training, for enhancing leg strength among martial arts competitors.

## References

- Achilleopoulos, I., Sotiropoulos, K., Tsakiri, M., Drikos, S., Zacharakis, E., & Barzouka, K. (2022). The effect of a proprioception and balance training program on balance and technical skills in youth female volleyball players. *Journal of Physical Education and Sport*, 22(4), 840–847. <https://doi.org/10.7752/jpes.2022.04106>
- Adhi, B. P., Sugiharto, & Soenyoto, T. (2017). Pengaruh Latihan dan kekuatan Otot Tungkai terhadap Power Otot Tungkai. *Journal of Physical Education and Sports*.
- Bompa, T. O., & Buzzichelli, C. A. (2019). Peridization: Theory and Methodology of Training. In *Journal of Chemical Information and Modeling* (Vol. 53, Issue 9).
- Enhancement, P., & Zatsiorsky, V. M. (2000). *BIOMECHANICS IN SPORT: Performance Enhancement And Injury Prevention: Vol. IX*. Blackwell Science Ltd.
- Hanafi, S. (2015). Efektifitas Latihan Beban dan Latihan Pliometrik Dalam Meningkatkan Kekuatan Otot Tungkai dan Kecepatan Reaksi. *Jurnal ILARA*, 1(2), 32–35.
- Hutabarat, C. S. (2023). Pengaruh Latihan Plyometrics Front Jump Dan Single Leg Bound Terhadap Power Otot Tungkai Kaki Pada Atlet Pencak Silat. *J2IO Jurnal Jendela Ilmu Olahraga*, 22–27.
- Jariono, G., Nugroho, H., Hermawan, I., Fachrezzy, F., & Maslikah, U. (2021). The Effect of Circuit Learning on Improving The Physical Fitness of Elementary School Students. *International Journal of Educational Research & Social Sciences*, 2(1), 59–68. <https://doi.org/10.51601/ijersc.v2i1.22>
- Jariono, G., Nurhidayat, N., Sudarmanto, E., Nyatara, S. D., & Marganingrum, T. (2021). Pendampingan Dan Pelatihan Peningkatan Kondisi Fisik Pada Unit Kegiatan Mahasiswa Bolavoli Universitas Muhammadiyah Surakarta. *Indonesian Collaboration Journal of Community Services*, 1(4), 236–243.
- Jariono, G., Nursubekti, N., Indarto, P., Hendarto, S., Nugroho, H., & Fachrezy, F. (2020). Analisis kondisi fisik menggunakan software Kinovea pada atlet taekwondo Dojang Mahameru Surakarta. *Transformasi: Jurnal Pengabdian Masyarakat*. <https://doi.org/10.20414/transformasi.v1i6i2.2635>
- Lubis, J., & Wardoyo, H. (2014). *Pencak Silat*. PT Raja Grafindo Persada.
- Lumintuarso, A. I. R. (2015). Pengembangan Model Latihan “Kribo” untuk powertungkai atlet lompat jauh dan sprint SKO SMP. 3(April), 16–28.
- Nugroho, H., Gontara, S. Y., Angga, P. D., Jariono, G., & Maghribi, I. L. (2021). Quality Of Physical Condition Of Youth Pencak Silat Athletes Reviewed From Speed, Power, and Strength. *Kinestetik : Jurnal Ilmiah Pendidikan Jasmani*, 5(1), 154–162. <https://doi.org/10.33369/jk.v5i1.14376>
- Patah, I. A., Jumareng, H., Setiawan, E., Aryani, M., & Gani, R. A. (2021). The importance of physical fitness for pencak silat athletes : Home-based weight training tabata and circuit can it work ? *Journal Sport Area*, 6(1), 86–97.
- Putra, I. P. E. W., & Wandik, Y. (2017). Pengaruh Latihan Pliometrik Jump To Box dan HIIT Terhadap Peningkatan Kapasitas VO2 Max. *Jurnal Pendidikan Jasmani Olahraga Dan Kesehatan*, 3(1), 49–57.
- Sasmitha, W. (2020). The Effect of Plyometric Exercise on Leg Muscle Explosive Power of Pencak Silat Athletes. *Advances in Social Science, Education and Humanities Research*, 460(Icpe 2019), 217–220.
- Subekti, N., Sudarmanto, E., & Fatoni, M. (2019). *Belajar dan berlatih pencak silat*. Muhammadiyah University Press.
- Subekti, N., Syaifullah, R., Fatoni, M., & Syaukani, A. A. (2021). Pencak silat combat match : Time motion analysis in elite athletes championship. 16(June), 21–22. <https://doi.org/10.14198/jhse.2021.16.Proc4.05>
- Subekti, N., Warthadi, A. N., Mujahid, H., & Abdullah, A. (2021). Analisis Performa Speed dan Power. *Samrt Sport*, 18, 39–45.
- Syaifullah, R., & Doewes, R. I. (2020). Pencak silat talent test development. *International Journal of Human Movement and Sports Sciences*, 8(6), 361–368. <https://doi.org/10.13189/saj.2020.080607>
- Tsegay, M., Mondal, S., Mekonen, H. K., & Berhanu, T. (2021). Effect of Varied Intensity of Football Specific Circuit Training on Agility , Speed and Explosive Strength among U-17 Football Players in Ethiopia. *Indian Journal of Public Health Research & Development*, 12(2), 537–541.
- Utamayasa, I. G. D. (2020). Efek Latihan Multiple Box Jump Terhadap Peningkatan Power Otot Tungkai. *Jurnal Pendidikan Kesehatan Rekreasi*, 6(1), 1–8.
- Vivekanth, B. Vallimurugan, D. . (2020). Effect of Strength Training and Endurance Training on Selected Physical Fitness Variables. *International Journal of Applied Research*, June 2019, 63–65.

- Yenes, R., & Leowanda, D. (2019). Latihan Plyometrik Front Jump dan Side Jump Terhadap Daya Ledak Otot Tungkai Atlet Bola Voli Perbedaan Pengaruh Differences In The Effect Of Plyometric Exercise Front Jump And Side Jump Against The Explosion Of Limbs In The Volleyball. *Jurnal Performa*, 4(2).
- Yulanda, M. N., & Jariono, G. (2023). Analysis of the Physical Fitness of Trained Individuals in Power, Speed, and Agility: A Descriptive Study. Atlantis Press SARL. [https://doi.org/10.2991/978-2-38476-086-2\\_104](https://doi.org/10.2991/978-2-38476-086-2_104)