

**Analysis of Physical and Technical Training Strategies for Enhancing Pencak Silat Athletes Performance: A Literature Review**

Angger Widorotama^{1*}, Andi Nova², Yudhi Teguh Pambudi³, Muhammad Maulana Fajar⁴,
Novriansyah⁵, Eko Putra Utama⁶

¹²⁴⁵Physical Education Faculty of Teacher Training and Education Samudra University, Langsa, Indonesia

³Physical Education Faculty Of Health Sciences Jenderal Soedirman University, Purwokerto, Indonesia

⁶Physical Education Faculty of Teacher Training and Education Dehasen Bengkulu University, Bengkulu, Indonesia

Keywords

Pencak Silat; Sports Science; Physical Conditioning; Training Methods;

Abstract

The rapid development of Pencak Silat into an international competitive sport demands flawless physical and technical readiness from athletes. Physical fatigue in the third round is often the primary cause of a 20–30% decrease in technical accuracy and significantly increases the risk of musculoskeletal injuries. Although the importance of physical conditioning is widely recognized, a comprehensive synthesis evaluating modern sports science training methods remains limited. Therefore, this study aims to map empirically tested physical conditioning methods to serve as a scientific reference for designing effective training programs for Pencak Silat athletes. This study utilized a qualitative descriptive literature review design. The data analysis technique involved an annotated bibliography approach to interpret and compare findings from original research articles published between 2020 and 2025. The literature review reveals that jump rope training effectively enhances straight kick skills in athletes. For crescent kicks (tendangan sabit), both plyometric and circuit training significantly improve performance; however, circuit training yields a substantially higher increase in kick speed (62.06%) compared to standalone plyometric training (36.56%). To address physical degradation, hollow sprint and shadow fight exercises demonstrate equal effectiveness in boosting VO₂max capacity, while circuit training effectively enhances general endurance. Furthermore, integrating physical and technical training offers a dual benefit, improving kick speed while increasing anaerobic endurance by 21%. In conclusion, the application of sports science-based training methods is empirically proven to be far more effective and efficient than conventional methods. An integrative strategy combining physical and technical training is highly recommended during the pre-competition phase to achieve peak physical condition alongside sharper technical execution.

✉ Corresponding author :

E-mail: angger.widorotama11@unsam.ac.id

INTRODUCTION

Pencak silat is a noble cultural heritage of the Indonesian people that has now rapidly evolved into a competitive sport at the international level. As pencak silat has been included in prestigious events such as the Asian Games and other world championships, competition standards have risen significantly (Ediyono et al., 2022). This phenomenon demands that every athlete be fully prepared, not only in terms of technique and mental fortitude, but also in terms of peak physical condition, which serves as the primary foundation for supporting performance in the arena (Merlin Susanto et al., 2020). In pencak silat, an athlete is required to master a complex combination of physical components to support their competitive performance (Widorotama et al., 2024). These physical requirements can be categorized based on their functional priorities. First, agility is essential for athletes to evade opponents' attacks and execute tactical positional maneuvers. Second, strength and explosive power are crucial for delivering effective strikes and kicks. Third, speed plays a vital role in enabling athletes to launch sudden attacks or respond as quickly as possible. Fourth, endurance is key to maintaining performance stability throughout the match (Widorotama et al., 2025). These four physical components are absolutely essential when athletes compete in the combat category (*tanding*). This category features a high-intensity, full-contact bout where two competitors face each other directly. In this discipline, scoring is no longer based on the aesthetic quality of the movements, but rather on the athlete's effectiveness in scoring points according to the established regulations (Lubis & Wardoyo, 2016; Mujahid & Subekti, 2021).

Although the physical components mentioned above are crucial, empirical data from the field indicates that physical fatigue in the third quarter often becomes a major factor that reduces athletes' technical accuracy by as much as 20–30% (Ridho Setiawan et al., 2022). This decline in physical condition often leads to critical setbacks, such as losing on points or accumulating penalties due to uncontrolled movements (Sabrina Rumbiak & Nurkholis, 2026). Not only does it reduce technical performance, but suboptimal physical fitness can also increase the risk of severe musculoskeletal injuries, particularly in the knee and ankle joints of pencak silat athletes when performing explosive movements or throwing techniques during competition (Pambudi et al., 2025). This on-field phenomenon underscores that well-developed cardiorespiratory endurance (VO₂max) and anaerobic endurance are the athlete's primary defenses for maintaining consistency from the first round to the last (Saefullah & Setyawati, 2021).

However, in practice across various regions, there are still significant variations in training methods, with some coaches still tending to rely on traditional methods passed down through generations without clear data standardization (Saefullah & Setyawati, 2021). In fact, current advancements in sports science have offered various modern alternative methods such as plyometric training, circuit training, hollow sprints, and high-intensity interval training (HIIT), which have proven to be far more efficient, measurable, and effective in enhancing athletes' performance (Anugrah et al., 2022; Patah et al., 2021). Previous studies have demonstrated that specific training interventions yield distinct effects on the biomechanics and technical performance of martial artists (Zhang et al., 2025). For example, plyometric, quickness, and SAQ drills have been found to be highly significant in increasing the speed of various types of kicks, while weight training focused on grip strength has proven effective in refining throwing techniques (Patah et al., 2021).

While extensive research over the past five years has explored various sports science interventions in martial arts, empirical data regarding the most optimal training modalities specifically for competitive Pencak Silat athletes remains fragmented. Previous studies often evaluate physical conditioning in isolation, leaving a critical knowledge gap in how coaches can strategically combine physical and technical variables during the pre-competition phase to mitigate the 20–30% performance degradation observed in the third round (Akbar & Rizki, 2021; Latif et al., 2022; Ridho Setiawan et al., 2022). The novelty of this study lies in its specific approach that integrates the synergy between physical and tactico-technical variables to mitigate performance degradation during critical rounds—an integrative dimension that has yet to be comprehensively addressed in the existing Pencak Silat literature. Therefore, this literature review aims to systematically synthesize and map empirically tested training

methods focusing specifically on combat category dynamics to provide a data-driven, scientific framework for high-performance training program design.

Therefore, this literature review serves as an urgent step to collect, analyze, and synthesize existing research findings in order to avoid the implementation of outdated or inefficient training programs. The urgency of this study is paramount for pencak silat coaches, who are currently facing immense pressure to transition from traditional, intuition-based coaching to data-driven methods; without this scientific synthesis, coaches lack a validated benchmark to safely push athletes to peak physical limits, risking chronic injuries and tactical failure in the decisive final rounds. The theoretical contribution of this study is to provide a substantive scientific foundation based on reliable secondary data, while its practical contribution is to offer valid scientific references for coaches, athletes, and academics in designing integrated physical training programs. Through this integrative qualitative approach grounded in robust empirical data, the development of training programs for pencak silat athletes is expected to no longer rely on subjective intuition. This journal specifically aims to map out empirically tested methods for improving physical conditioning, so that they can be applied precisely during the pre-competition period to simultaneously boost athletes' technical sharpness and physical performance.

METHODS

The methods used in this study include a literature review. A literature review is a description of theories, findings, and other studies used to formulate the research problem under investigation. A literature review is a study that examines scientific ideas or findings in the literature, poses critical questions, and makes theoretical and methodological contributions to a topic (Hart, 2018). This study uses secondary data. Secondary data is derived from the results of research conducted by previous researchers. The data obtained from various sources is then compiled into a single document used to address the existing problem (Pranata, 2022). This stage involves collecting various sources such as books, scientific journals, and other credible literature.

The researcher chose a literature review because it requires data from various sources of literature, including books and previous research journals, to establish a theoretical foundation regarding "Physical and Technical Development of Pencak Silat Athletes." This study is qualitative in nature, meaning a systematic study to examine an object in its natural state. Qualitative research is descriptive in nature and employs inductive analysis, which involves drawing conclusions based on specific facts to arrive at a more general understanding. Qualitative research is used to examine the natural state of an object, with the researcher serving as the key instrument; data analysis is inductive, and it places greater emphasis on meaning rather than generalization (Sugiyono, 2022).

The preparation of the review article involved searching the literature across various databases using keywords corresponding to the publication period, followed by reading, reviewing, understanding, selecting, collecting, and analyzing these sources, and finally summarizing the findings based on the collected data. This study utilizes secondary data related to pencak silat training methods. The analysis technique used is annotated bibliographic analysis, which involves summarizing the content of articles, books, journals, or other sources in a straightforward manner.

This study employed a qualitative descriptive literature review design utilizing an annotated bibliography approach to synthesize recent advancements in Pencak Silat training methodologies. A comprehensive literature search was executed across the Google Scholar database for original research articles published between 2020 and 2025. The search strategy incorporated specific keyword combinations in both English and Indonesian, including: Pencak Silat training methods, 'physical conditioning in martial arts', 'kick speed electro mechanics, and anaerobic endurance in silat. Articles were selected based on rigorous inclusion criteria: (1) peer-reviewed original research, (2) specifically targeting competitive Pencak Silat athletes, and (3) examining physical or technical training interventions. Conversely, studies focusing on traditional performance arts (Seni) or published prior to 2020 were excluded. The selected

literature was then subjected to comparative analysis to evaluate training variables such as volume, intensity, and physiological adaptations.

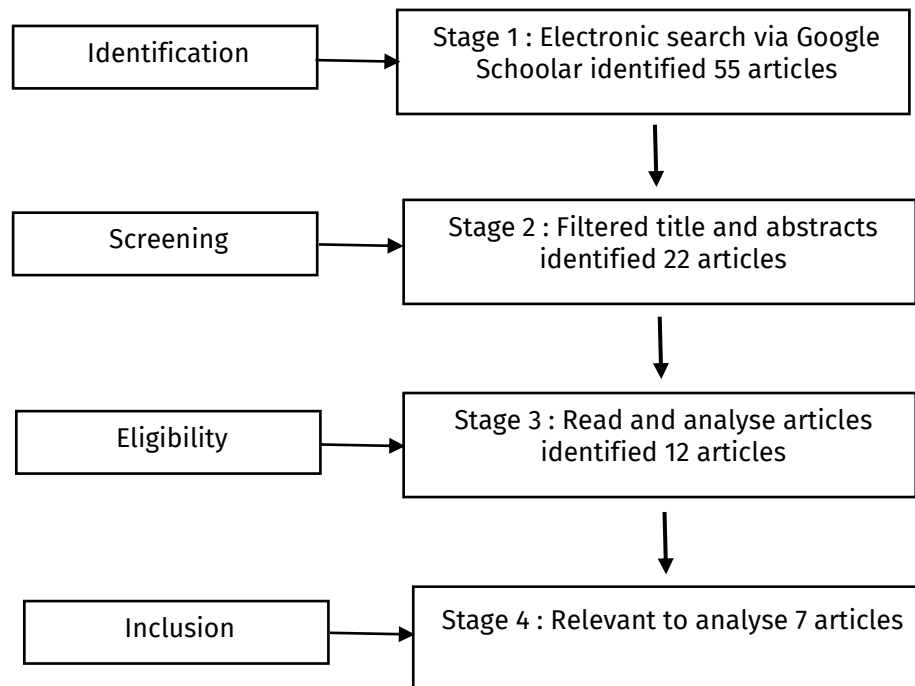


Figure 1. An illustration of the flow of the search process

RESULTS AND DISCUSSION

Based on the results of the review of the relevant article titled “Training Methods in Pencak Silat,” the following conclusions can be drawn:

Table 1. Features of the research that were examined for the review.

No	Author	Year	Title	Result
1.	Amali Barikah, Endang Pratiwi, Novri Asri	2020	The Influence of Training Methods and Motor Ability on the Straight Kick Performance of Pencak Silat Athletes	The results of this study indicate that: (1) in general, the straight kick skills in Pencak Silat achieved through the rope jump training method are higher than those developed through the hurdle jump training method; (2) for individuals with high motor ability, the rope jump training method yields higher results than the hurdle jump training method; (3) for individuals with low motor ability, there is no significant difference between the rope jump and hurdle jump training methods at the $\alpha = .05$ significance level; and (4) there is a significant interaction between training methods and motor ability toward Pencak Silat straight kick skills.

2.	Kamaruddin, Zulraflia, Ade Irma	2023	The Effects of Plyometric Training and Speed on Crescent Kick Ability	Based on the results of the data analysis, it is indicated that the plyometric training method exerts a significant effect on the crescent kick ability of Pencak Silat athletes, and speed training likewise provides a significant impact on their crescent kick performance. Furthermore, when the plyometric training method and speed training are analyzed simultaneously, a significant combined effect is observed on the crescent kick ability of Pencak Silat athletes within the Student Activity Unit (<i>Unit Kegiatan Mahasiswa</i>) at Universitas Islam Riau. Ultimately, to enhance crescent kick capability, the plyometric training method demonstrates superior efficacy compared to the speed training method.
3.	Rahmat Monoarfa, Edy Dharma Putra Duhe, Syarif Hidayat, Khoirul Anwar Pulungan.	2022	The Effects of Hollow Sprint and Shadow Fight Training on the Endurance of Pencak Silat Athletes	The results of the study indicate that: (1) there is a significant effect of hollow sprint training on the improvement of VO_{2max} in Pencak Silat athletes, with a t-value of 3.182 and a calculated significance (p) of $0.008 < 0.05$; (2) shadow fight training has a significant effect on increasing the VO_{2max} of Pencak Silat athletes, with a t-value of 3.182 and a calculated significance (p) of $0.020 < 0.05$; and (3) there is no significant difference between the effects of hollow sprint training and shadow fight training on the enhancement of VO_{2max} in Pencak Silat athletes, with a t-value of 0.100 and a significance value (p) of 0.924.
4.	Syarif Hidayat, Arief Ibnu Haryanto	2022	Combination of Physical and Technical Training: Effects on Crescent Kick Speed and Anaerobic Endurance	The results obtained over 16 sessions of treatment demonstrated a positive impact, characterized by an 18% increase in the mean speed of the crescent kick (<i>tendangan sabit</i>) for the right leg and 25% for the left leg, along with a 21% enhancement in anaerobic endurance among Pencak Silat athletes at the Student Sports Education and Training Center (PPLP) of Gorontalo Province. The researchers recommend that a combination of

				physical and tactical training be administered to martial arts athletes during the pre-competition phase. This approach is highly feasible as it allows athletes to simultaneously achieve dual benefits within a single training program: optimal physical conditioning and progressively improving technical skills, specifically kicking techniques integrated with anaerobic endurance.
5.	Risa Agus Teguh Wibowo, Achmad Fandi Nur.	2022	The Effects of Single-Leg Bound Plyometric Training and Circuit Training on Enhancing Crescent Kick Speed	Based on the results of the data analysis, this study yields the following conclusions: (1) there is a significant difference in the effects between single-leg bound plyometric training and circuit training, as evidenced by the post-test calculation results of each group where $t_{count} = 3.621$, which exceeds the $t_{table} = 2.145$ at a 5% significance level; (2) the circuit training method demonstrates a superior effect compared to the single-leg bound plyometric training, as indicated by the percentage increase in the speed of the pencak silat crescent kick, which shows that Group 1 achieved 36.56%, whereas Group 2 achieved a higher increase of 62.06%.
6.	Edi Bintoro, Adhe Saputra, Fitri Diana	2025	The Influence of Circuit Training on the Endurance Capacity of Pencak Silat Athletes in Tanjung Jabung Timur	These results demonstrate that circuit training exercises exert a positive influence on enhancing the endurance of pencak silat athletes. Based on the findings of this study, it can be concluded that circuit training constitutes an effective training method for improving the endurance of pencak silat athletes.
7.	Ihsan Abdul Patah, Hasanuddin Jumareng, Edi Setiawan, Mela Aryani, Ruslan Abdul Gani	2021	The importance of physical fitness for pencak silat athletes: Home-based weight training tabata and circuit can it work?	Tabata training and circuit training combined with strength training have both been shown to be effective in improving the physical fitness components of pencak silat athletes. The latest findings from this study indicate that Tabata strength training is more effective at improving components such as VO2max, endurance, strength, and flexibility, while circuit strength training is more effective at

improving components related to muscle strength and muscular endurance.

A. Analysis of the Effectiveness of Training Methods on Speed and Attacking Skills

The application of various modern training methods in the sport of pencak silat has a tangible impact on improving technical quality, particularly regarding the effectiveness of individual attacks such as kicks. Based on a literature review, the jump rope training method has generally been shown to produce higher proficiency in straight kicks compared to conventional jumping training methods (Barikah et al., 2020). The advantages of this jump rope method are particularly significant for athletes with high motor ability. This indicates a strong correlation and relationship between an athlete's basic motor ability characteristics and the type of training method applied to refine straight kicking skills. This aligns with previous research highlighting the importance of utilizing Battle Ropes to provide high-quality training programs for developing muscular strength, endurance, and kicking performance in Taekwondo (Hassan et al., 2024).

In addition to straight kicks, performance in sickle kick techniques is also significantly influenced by specific physical training interventions. Plyometric training and speed training have been proven to positively contribute to enhancing athletes' scythe kick power. When these two methods are combined and performed together, the results still demonstrate a significant impact on athletes' performance development (Kamarudin et al., 2023). This aligns with a study by (Ahmad et al., 2024), which demonstrates that plyometric training significantly improves kicking strength and speed in pencak silat, particularly for the crescent (*sabit*), side (*T*), and front (*lurus*) kicks. However, when compared individually to assess their standalone effectiveness, plyometric training is considered superior and more recommended for improving the crescent kick ability than relying solely on standard speed training (Wibowo & Nur, 2022). Nevertheless, the effectiveness of plyometric training exhibits distinct dynamics when compared to circuit training.

In specific testing, there was a highly significant difference in the effects between single-leg bound plyometric training and circuit training on the parameters of scythe kick speed. Statistical data show that the group undergoing circuit training was far superior, with a percentage increase in kick speed reaching 62.06%, while the plyometric training group only reached 36.56% (Wibowo & Nur, 2022). On the other hand, the integration of physical and tactical aspects proved to be a highly adaptive strategy. The intervention, consisting of a combination of physical and technical exercises performed 16 times per session, successfully boosted the average speed of the scythe kick significantly, by 18% for the right leg and 25% for the left leg (Hidayat & Haryanto, 2022a). If the focus is solely predicated on the percentage surge in speed, circuit training yields the most significant isolated impact (62.06%). However, the integration of physical and technical training (Hidayat & Haryanto, 2022b) offers a more balanced and adaptive approach to real-world performance, driving uniform skill enhancement across both legs.

B. Analysis of Training Methods for Improving Athletes' Endurance

Endurance is a vital foundation for maintaining the performance stability of pencak silat athletes, preventing a decline in movement accuracy due to fatigue in the final rounds of a match (Nugroho et al., 2025; Syahputra et al., 2022). Scientific research describes several effective training methods for improving the cardiorespiratory capacity (VO₂max) and anaerobic endurance of pencak silat athletes.

Hollow sprints and shadow fighting are two empirically proven methods capable of significantly increasing the VO₂max levels of pencak silat athletes (Monoarfa et al., 2022). This is further reinforced by findings indicating that hollow sprint training exerts a significant effect on the improvement of anaerobic endurance (Subagia et al., 2015). Meanwhile, in line with prior research, shadow fighting training effectively enhances the blocking speed of Pencak Silat athletes and can be recommended as a supplementary training method to improve performance (Hasanuddin, 2025). Interestingly, a comparative analysis shows that there is no

significant difference in effectiveness between the two methods, meaning that both hollow sprints and shadow fighting are equally effective in boosting athletes' aerobic endurance capacity. Consistent with these results, circuit training has also been identified as a highly effective training tool for building athletes' physical endurance (Caglayan & Ozbar, 2017). This finding is corroborated by prior studies demonstrating that circuit training programs enhance muscle strength, agility, anaerobic capacity, and cardiovascular endurance (Sonchan et al., 2017). Consistent implementation of a circuit training program has been proven to have a tangible positive impact on improving the overall endurance of pencak silat athletes. Additionally, endurance optimization can also be achieved simultaneously through an integrated training program. Through a combination of physical and technical training, athletes not only gain technical agility but also simultaneously reap physical benefits in the form of a significant increase in anaerobic endurance, reaching as high as 21% (Hidayat & Haryanto, 2022).

According to (Patah et al., 2021), if a coach's focus is on improving VO₂max, general endurance, strength, and flexibility in a short period of time, then Tabata-based weight training is the best option. However, if the pre-competition goal is to build specific local muscle endurance to handle impacts and takedown techniques, then circuit weight training is more recommended.

C. Integrative Discussion Based on Sport Science

The physical demands on a pencak silat athlete in today's era of international competition are highly complex, requiring a combination of agility for maneuvering, strength and explosiveness for effective attacks, reaction speed, and consistent endurance. Empirical field data indicates that physical fatigue in the third round often becomes the primary factor reducing technical accuracy by as much as 20–30% (Nelson et al., 2026). This decrease in accuracy has been reported to result in the loss of points or violations due to uncontrolled movements (Aini et al., 2025). Moreover, physical condition deficits also significantly increase the risk of severe musculoskeletal injuries in the knee and ankle joints of silat practitioners when executing explosive movements or throwing techniques. The descriptive findings from this literature synthesis provide a scientific basis that the use of sport science-based training methods—such as circuit training, plyometrics, hollow sprints, and shadow fighting—is far more efficient and measurable compared to conventional methods passed down through generations without standardized data (Bintoro et al., 2025; Kamarudin et al., 2023; Monoarfa et al., 2022).

Endurance training methods like circuit training offer a concrete solution to address physical decline and technical deterioration in the third round (Hidayat & Haryanto, 2022a). The continuous application of training loads via circuit training can optimize fast-twitch muscle fiber activation and anaerobic energy production. Ultimately, these physiological adaptations enable athletes to consistently maintain lower-limb power during high-intensity competitions. Meanwhile, specific plyometric, quickness, and SAQ drills are crucial for refining the biomechanics and speed of various kick types in the competition arena (Fajar et al., 2023).

As a practical recommendation based on previous research (Nelson et al., 2026; Aini et al., 2025; Bintoro et al., 2025; Fajar et al., 2023; Kamarudin et al., 2023; Hidayat & Haryanto, 2022a; Monoarfa et al., 2022), coaches are advised to implement a combination of physical and tactical training, particularly during the pre-competition phase. This integrative approach is highly efficient because it offers dual benefits within a single training program: achieving peak physical condition while simultaneously enhancing technical skills to a more refined level. Consequently, the design of training programs for pencak silat athletes is no longer based on subjective intuition but is grounded in scientific references supported by robust empirical data.

Previous research, specifically indicates that the effectiveness of attacks can be optimized through highly targeted methods. For instance, jump rope training has been proven more effective in enhancing straight kick skills compared to conventional methods, particularly for athletes with high motor ability (Barikah et al., 2020). In terms of crescent kick (*tendangan sabit*) speed, empirical data reveals that while plyometric training provides a

positive impact, the application of circuit training yields significantly higher results, with a percentage increase in speed reaching 62.06%, surpassing standalone plyometric training which only reached 36.56% (Wibowo & Nur, 2022). To mitigate the critical physical degradation observed in the third round, hollow sprint and shadow fight exercises have been validated as equally effective in boosting VO₂max capacity and anaerobic endurance (Monoarfa et al., 2022).

Furthermore, the selection of training modalities should be aligned with the specific goals of the training phase; Tabata-based weight training is recommended for rapid improvements in general fitness (VO₂max and strength), whereas circuit weight training is more effective for building the specific local muscle endurance required to respond to throwing techniques (*bantingan*) and impacts (Patah et al., 2021). As an integrative strategy, the implementation of a combination of physical and technical training over 16 sessions has been shown not only to enhance crescent kick speed uniformly across both legs (18–25%) but also to increase anaerobic endurance by 21%. This synergy is paramount for ensuring that athletes remain explosive and maintain technical precision until the final moments of a match (Hidayat & Haryanto, 2022a).

CONCLUSION

Based on a review and descriptive analysis of various scientific literature on physical training strategies and techniques for pencak silat athletes. The application of sports science-based training methods such as plyometrics, circuit training, hollow sprints, and shadow fighting has been empirically proven to be far more effective and efficient in improving athlete performance compared to conventional methods. In terms of improving attacking techniques, jump rope training is effective for enhancing a silat practitioner's straight kick skills. Meanwhile, the technical ability for the crescent kick can be significantly improved through plyometric and circuit training, where the circuit training method yields a higher percentage increase in kicking speed (62.06%) than single-session plyometric training.

To address the challenges of physical decline and a 20–30% drop in technical accuracy due to fatigue in the third round, endurance training interventions are a crucial solution. Hollow sprints and shadow fighting have been shown to be equally effective in improving VO₂max capacity, while circuit training has also proven effective in enhancing athletes' overall endurance. An integrative strategy combining physical and technical training is highly recommended for the pre-competition period. This approach offers dual benefits simultaneously: achieving optimal physical condition (including a 21% increase in anaerobic endurance) while enhancing technical attack skills with greater precision. Overall, this literature review has successfully mapped various empirically validated physical and technical training methods. These findings can serve as a valid, data-driven scientific reference for coaches, athletes, and academics in designing effective, modern, and targeted pencak silat training programs

REFERENCES

- Ahmad, A., Prasetyo, Y., & Nugroho, S. (2024). The effect of plyometric training on pencak silat kicks: Literature review. *Retos: Nuevas Tendencias en Educación Física, Deporte y Recreación*, 61, 185–192. <https://recyt.fecyt.es/index.php/retos/index>
- Aini, H. A., Asgus, A. R., Hidayat, I. I., Tono, T. H., Tian, T. K., Iman, I. I., & Unun, U. U. (2025). Pengaruh kelelahan otot tungkai terhadap parameter kinematika teknik tendangan depan atlet pencak silat. *Innovative: Journal of Social Science Research*, 5(2), 1787–1798. <https://doi.org/10.31004/innovative.v5i2.18392>
- Akbar, A., & Rizki, P. (2021). Manajemen latihan dan kondisi fisik atlet pencak silat. *Jurnal Olahraga dan Kesehatan Indonesia*, 2(1), 1–6. <https://doi.org/10.55081/joki.v2i1.538>
- Anugrah, N., Permadi, A. A., & Sonjaya, A. R. (2022). Pengaruh latihan quickness terhadap peningkatan kecepatan tendangan atlet kategori tanding cabang olahraga pencak silat. *Jurnal JPDO*, 5(1), 22. <https://doi.org/10.24036/ISOP1.71>
- Barikah, A., Pratiwi, E., & Asri, N. (2020). Pengaruh metode latihan dan kemampuan gerak (motor ability) terhadap keterampilan tendangan lurus pencak silat. *Journal of S.P.O.R.T*, 4(1), 44–52.
- Bintoro, E., Saputra, A., & Diana, F. (2025). Pengaruh latihan circuit training terhadap daya tahan atlet pencak silat Tanjung Jabung Timur. *Jurnal Cerdas Sifa Pendidikan*, 14(1), 15–25. <https://doi.org/10.22437/csp.v14i1.42443>

- Caglayan, A., & Ozbar, N. (2017). The examination of the effects of functional training program applied on instable ground on anaerobic capacities of elite martial arts athletes. *European Journal of Education Studies*, 3(12), 812–824. <https://doi.org/10.5281/zenodo.1133471>
- Ediyono, S., Nugraha, R. S., & Ahmad, A. A. H. (2022). Indonesian pencak silat tradition models as the intangible cultural heritage of humanity. *International Journal of Science and Applied Science: Conference Series*, 6(1), 167–174. <https://doi.org/10.20961/iisasc.v6i1.69953>
- Fajar, M. K., Rusdiawan, A., & Ar Rasyid, M. L. S. (2023). Improving leg power and dolyo chagi kick speed in taekwondo using plyometric, SAQ, and circuit training methods. *Jurnal Keolahragaan*, 11(1), 87–94. <https://doi.org/10.21831/jk.v11i1.57955>
- Hart, C. (2018). *Doing a literature review*. SAGE Publications.
- Hasanuddin, M. I. (2025). The effect of shadow fighting training on blocking speed in pencak silat athletes. *ETDC: Indonesian Journal of Research and Educational Review*, 4(2), 446a–457a. <https://doi.org/10.51574/iirer.v4i2.3417>
- Hassan, A. K., Alibrahim, M. S., & Hammad, B. E. (2024). Effect of a 10-week training program on muscle power, endurance, and jump kick performance in young male taekwondo athletes using the 4D PRO Bungee Trainer and battle ropes exercises. *International Journal of Human Movement and Sports Sciences*, 12(6), 930–942. <https://doi.org/10.13189/sai.2024.120605>
- Hidayat, S., & Haryanto, A. I. (2022a). Kombinasi latihan fisik dan teknik: Efek terhadap kecepatan tendangan sabit dan ketahanan anaerob. *Multilateral: Jurnal Pendidikan Jasmani dan Olahraga*, 21(2), 156–165. <https://doi.org/10.20527/multilateral.v21i2.13604>
- Hidayat, S., & Haryanto, A. I. (2022b). Kombinasi latihan fisik dan teknik: Efek terhadap kecepatan tendangan sabit dan ketahanan anaerob. *Multilateral: Jurnal Pendidikan Jasmani dan Olahraga*, 21(6), 156–168.
- Kamarudin, Zulrafi, & Irma, A. (2023). Latihan pliometrik dan kecepatan terhadap kemampuan tendangan sabit. *Jambura Health and Sport Journal*, 5(1), 66–73.
- Latif, R. A., Yusoff, Y. M., Tumijan, W., Linoby, A. F. L. R., & Yoyok, S. (2022). Injury in martial art activities: Focusing on pencak silat athletes. *Ido Movement for Culture*, 22(2S), 53–62. <https://doi.org/10.14589/ido.22.2S.7>
- Lubis, J., & Wardoyo, H. (2016). Pencak silat (Edisi ke-3). Kharisma Putra Utama Offset.
- Monoarfa, R., Dharma, E., Duhe, P., Hidayat, S., & Pulungan, K. A. (2022). Pengaruh latihan hollow sprint dengan latihan shadow fight terhadap daya tahan atlet pencak silat. *Jambura Sports Coaching Academic Journal*, 1(1), 25–34.
- Mujahid, H., & Subekti, N. (2021). Analisis taktik pertandingan pencak silat kategori tanding. *Journal Coaching Education Sports*, 2(2), 123–136. <https://doi.org/10.31599/ices.v2i2.693>
- Nelson, S., Neldi, H., & Bahtra, R. (2026). Analisis kebutuhan fisik dan energi atlet pencak silat sebagai dasar pengembangan model latihan HIIT. *Jurnal Sporta Saintika*, 11(1), 351–361. <https://doi.org/10.24036/Sporta>
- Nugroho, H., Gontara, S. Y., Jariono, G., & Saifullah, R. (2025). Body composition and physical fitness characteristics of Indonesian elite pencak silat competitors. *Jurnal SPORTIF: Jurnal Penelitian Pembelajaran*, 11(1), 121–137. https://doi.org/10.29407/jis_unpgri.v11i1.25213
- Pambudi, Y. T., Widorotama, A., Yunika, N., Hasan, M. F., Ilsa, M. N. F., & Hartianto, N. D. (2025). Sports injury patterns and incidence among adolescent pencak silat athletes. *Jurnal Sains Keolahragaan dan Kesehatan*, 10(2), 131–144. <https://doi.org/10.5614/isk.2025.10.2.10>
- 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 between tabata and circuit can it work? *Journal Sport Area*, 6(1), 108–122. [https://doi.org/10.25299/sportarea.2021.vol6\(1\).6172](https://doi.org/10.25299/sportarea.2021.vol6(1).6172)
- Pranata, D. (2022). Pengaruh olahraga dan model latihan fisik terhadap kebugaran jasmani remaja: Literature review. *Jurnal Kesehatan Olahraga*, 10(2), 107–116.
- Rumbiak, M. S., & Nurkholis. (2026). Analisis respon fisiologis dan psikologis pada atlet pencak silat Perisai Putih SMPN 18 Surabaya. *Jurnal Prestasi Olahraga*, 9(1), 45–52.
- Saefullah, & Setyawati, H. (2021). Pengaruh latihan konvensional dan imagery terhadap latihan tendangan sabit atlet kategori tanding di perguruan silat Asad Kabupaten Wonosobo. *Indonesian Journal for Physical Education and Sport*, 2(3), 69–76. <https://journal.unnes.ac.id/sju/index.php/inapes>
- Setiawan, M. R., Najat, F. Z., Farhan, R. V., & Suhendan, A. (2022). Analisis faktor kondisi fisik atlet pencak silat. *Jurnal Olahraga dan Kesehatan Indonesia (JOKI)*, 3(1), 35–42. <https://jurnal.stokbinaguna.ac.id/index.php/joki>
- Sonchan, W., Moungrmee, P., & Sootmongkol, A. (2017). The effects of a circuit training program on muscle strength, agility, anaerobic performance and cardiovascular endurance. *International Journal of Sport and Health Sciences*, 11(4), 176–189.
- Subagia, G. A., Kardiawan, I., & Muliarta, I. (2015). Pengaruh pelatihan fartlek dan hollow sprint terhadap daya tahan anaerobik atlet kyorugi remaja putra usia 15-19 tahun Buldog Tae Kwon Do Club tahun

2015. Jurnal Pendidikan Kepelatihan Olahraga Undiksha, 3(1), 12–22. <https://doi.org/10.23887/iipko.v3i1.5574>
- Sugiyono. (2022). Metode penelitian kuantitatif kualitatif dan R&D. Alfabeta.
- Susanto, D. M., & Lesmana, H. S. (2020). Kondisi fisik atlet pencak silat. Jurnal Patriot, 2(3), 815–826.
- Syahputra, R., Bakhtiar, S., Putri, L. P., Oktarifaldi, O., & Mardela, R. (2022). Establishing of identification system in pencak silat: Coaches perspective on physical performance contribution. Halaman Olahraga Nusantara (Jurnal Ilmu Keolahragaan), 5(2), 472–481. <https://doi.org/10.31851/hon.v5i2.7939>
- Wibowo, R. A., & Nur, A. F. (2022). Pengaruh latihan plyometric single leg bound dan circuit training terhadap peningkatan kecepatan tendangan sabit pada siswa pencak silat Persaudaraan Setia Hati Terate Rayon Wiyoro Ranting Ngadirojo Pacitan tahun 2021. Jurnal Ilmiah: Sport, Pendidikan, Ilmu dan Riset, 2(1), 56–65.
- Widorotama, A., Akbari, M., Roberto, J., & Mahardhika, N. A. (2025). Korelasi power otot tungkai dengan kecepatan tendangan sabit pencak silat. Jurnal Ilmiah Sport, 7(1), 88–95.
- Widorotama, A., Rahayu, T., Setiawan, I., & Pambudi, Y. T. (2024). Analysis of anxiety and self-efficacy on athlete performance in pencak silat. Journal of Physical Education and Sports, 13(2), 16–21.
- Zhang, S., Huang, W., Soh, K. G., Luo, S., Li, L., & Wang, X. (2025). Effects of core strength training on the technical skill performance of striking combat sport players: A systematic review. PeerJ, 13, Artikel e19615. <https://doi.org/10.7717/peerj.19615>