



Physical Condition Components of Pencak Silat Athletes in the Tanding Category at Pagar Nusa YPM Academy

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ABSTRACT

Physical condition is a fundamental determinant of performance in combat sports, including Pencak Silat, particularly in the tanding category, which requires repeated high-intensity movements across multiple rounds. This study aimed to identify and describe the physical condition components of Pencak Silat athletes in the tanding category at Pagar Nusa YPM Academy. A descriptive quantitative design with a survey approach was employed. The population consisted of all active tanding athletes at the academy, and total sampling was applied, resulting in 10 participants. Data were collected through standardized physical fitness tests, including push-up (arm muscle strength), sit-up (abdominal muscle strength), squat test (leg muscle strength), beep test (VO_2 max estimation), and 50-meter sprint (speed). Data were analyzed using descriptive statistics in the form of mean scores and percentage distributions. The results indicated that arm muscle strength was predominantly in the moderate category (mean = 34.5 repetitions), while abdominal muscle strength showed the most favorable outcome, with 50% of athletes classified in the good category (mean = 36 repetitions). Leg muscle strength was evenly distributed between moderate and good categories (mean = 36.7 repetitions). Aerobic endurance was generally moderate (mean VO_2 max = 39.1 ml/kg/min), and sprint speed showed varied distribution (mean = 7.94 seconds). Overall, the athletes' physical condition ranged from moderate to good. However, improvements in aerobic capacity, explosive power, and speed through structured resistance, interval, and SAQ training are recommended to enhance competitive performance.

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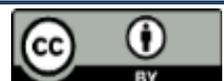
AUTHORS' CONTRIBUTION

A. Conception and design of the study;
B. Acquisition of data;
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INTRODUCTION

Sport is a structured and systematic physical activity aimed at sustainably improving an individual's physiological capacity, health, and performance (Puspodari, 2021; World Health Organization, 2020). In the context of competitive sports, improved performance is determined not only by technical training but also by physical



preparedness, understanding of competition regulations, and specific physiological adaptations to the characteristics of the sport (Bompa & Buzzichelli, 2019; Turner et al., 2019).

Pencak Silat, as an intangible cultural heritage of Indonesia, was internationally recognized by UNESCO in 2019 and developed into a competitive sport with strict regulatory standards under the Indonesian Pencak Silat Association (IPSI). In addition to instilling character values such as discipline, responsibility, and sportsmanship (Rustiyanti et al., 2025), Pencak Silat in the Tanding category demands high biomotor skills such as strength, anaerobic-aerobic endurance, speed, agility, power, and tactical control throughout the three rounds of competition (Masula et al., 2021; Aziz et al., 2022).

The main problem in academy-level Pencak Silat development is the suboptimal mapping of athletes' physical condition in a measurable and periodic manner. Many training programs are still generic and not based on specific competition requirements (periodization mismatch), resulting in underdevelopment of performance potential (Sundara et al., 2020; Loturco et al., 2019). Furthermore, low literacy in competition regulations can lead to technical errors that result in point deductions or disqualification (Dwi et al., 2022).

In the context of the Pagar Nusa YPM Academy, comprehensive physical condition evaluations based on modern physiological parameters such as estimated $VO_2\max$, sprint ability, and muscular endurance profile have not been conducted. However, research shows that measurable physical profiles significantly correlate with combat performance and the efficiency of striking techniques (Bridge et al., 2018; Chaabene et al., 2018). Therefore, systematically identifying athletes' physical condition is an urgent need to support competition readiness and the effectiveness of training programs.

Current literature shows that martial arts, including Pencak Silat, are characterized by high-intensity, intermittent physiological processes that require a combination of anaerobic and aerobic capacity (Franchini et al., 2019; Slimani et al., 2017). Biomechanical studies reveal that kicking, throwing, and combination striking techniques in Pencak Silat require explosive leg power and high core stability (Aziz et al., 2022; Ouergui et al., 2020).

Physical condition components such as muscular endurance (push-ups, sit-ups), sprint speed (30–50 m), and $VO_2\max$ (beep test) have been widely used to predict the performance of martial arts athletes (Turner et al., 2019; Chaabene et al., 2018). Research by Loturco et al. (2019) confirmed that sprint acceleration is directly related to attack effectiveness in combat sports. Meanwhile, aerobic endurance plays a role in maintaining intensity during the final rounds of a match (Franchini et al., 2019).

In the Southeast Asian context, several recent studies have shown that elite Pencak Silat athletes have a $VO_2\max$ profile ranging from 48–55 ml/kg/min and significantly higher leg power than regional-level athletes (Aziz et al., 2022; Sundara et al., 2020). This demonstrates the importance of data-driven measurements as a basis for training periodization (Bompa & Buzzichelli, 2019).

In addition to physiological aspects, understanding match regulations has been shown to improve tactical awareness and decision-making during matches (Bridge et al., 2018; Ouergui et al., 2020). IPSI, as the national regulator, has established arena

standards, scoring systems, and weight classifications that simultaneously demand physical and tactical readiness (Candra, 2021).

Thus, conceptually and empirically, modern coaching approaches lead to the integration of physical condition evaluation, regulatory understanding, and data-driven performance analysis (Turner et al., 2019; Franchini et al., 2019).

Although various studies have examined the physiological profiles of martial arts athletes, several research gaps remain. First, most studies focus on national or international elite athlete populations, while studies at the academy or basic training level are still limited (Aziz et al., 2022; Sundara et al., 2020).

Second, previous research tends to examine one or two biomotor components separately, without providing a comprehensive picture of physical condition profiles integrated with the requirements of IPSI competition regulations (Chaabene et al., 2018).

Third, few studies have contextually examined the physical profiles of Pagar Nusa athletes, as one of the major schools under Nahdlatul Ulama (NU), which has a unique coaching system based on religious and cultural values (Fahmi Maulana et al., 2024).

Fourth, studies linking the results of simple fitness tests (push-ups, sit-ups, squats, sprints, and beep tests) to the specific requirements of Pencak Silat competitions in the Tanding category are still limited in reputable national literature.

This gap highlights the need for research that integrates the analysis of the physical condition of Pencak Silat academy athletes with the physiological demands and regulations of modern competitions.

This study aims to analyze the physical condition profile of Pencak Silat athletes from Pagar Nusa YPM Academy through a series of fitness tests, including muscular endurance (push-ups, sit-ups, squats), aerobic capacity (beep test/ VO_2 max estimation), and speed (50-meter sprint).

Conceptually, this study strengthens the sports science approach based on integrated biomotor evaluation in Pencak Silat. Empirically, this study provides an initial mapping of the physical condition of academy-level athletes, which can serve as a basis for data-driven training periodization planning.

The novelty of this research lies in: (1) Integrating the evaluation of physical condition components with the requirements of IPSI competition regulations in the Tanding category, (2) Focusing on the academy-level Pagar Nusa athlete population, which has not been widely studied in the literature over the past 10 years, (3) Providing a baseline physiological profile as a basis for developing an evidence-based training model.

The research results are expected to contribute to strengthening the Pencak Silat coaching system based on sports science, increasing athletes' competitive readiness, and supporting the development of sustainable Pencak Silat achievements at the national level.

METHODS

This study employed a quantitative descriptive design with a survey approach, aiming to identify and map the physical condition components of Pencak Silat athletes

competing in the Tanding category at Pagar Nusa YPM Academy. This design was chosen because it allows for objective measurement of athletes' biomotor profiles using standardized instruments, as recommended in modern martial arts performance evaluations (Turner et al., 2019; Chaabene et al., 2018). The quantitative descriptive approach was deemed relevant for providing an actual picture of athletes' physiological condition without treatment intervention, while also providing a basis for data-driven training periodization planning (Bompa & Buzzichelli, 2019; Franchini et al., 2019).

The study population included all active Pencak Silat athletes competing in the Tanding category at Pagar Nusa YPM Academy. A total sampling technique was applied to ensure representativeness and avoid selection bias in a small population of competitive athletes (Etikan & Bala, 2017). Therefore, all 10 athletes who met the inclusion criteria (actively training and registered as competing athletes) were included in the study sample. The use of total sampling in academic-level sports performance studies is considered appropriate for generating comprehensive physiological mapping (Sundara et al., 2020; Aziz et al., 2022).

The measurement instruments were adapted to the physiological characteristics of high-intensity intermittent martial arts (Slimani et al., 2017; Ouergui et al., 2020). The components measured included: (1) Push-up tests to measure arm and shoulder muscle strength endurance, which contribute to the effectiveness of punching and defense techniques (Loturco et al., 2019), (2) Sit-up tests to assess core muscle strength and endurance, which play a crucial role in stability during kicks and throws (Chaabene et al., 2018), (3) Squat tests to evaluate leg muscle strength and endurance, key components in generating explosive power (Aziz et al., 2022), (4) The Beep Test (Multistage Fitness Test) was used to estimate aerobic capacity ($VO_2\max$), an important indicator of maintaining intensity throughout three rounds of competition (Franchini et al., 2019; Turner et al., 2019), and (5) The 50-meter sprint measured linear speed and acceleration, which correlate with offensive responses and tactical transitions during competition (Loturco et al., 2019).

All tests were conducted according to standard procedures for measuring sports fitness (American College of Sports Medicine, 2021) to ensure data reliability and validity. Each athlete received the same instructions, a structured warm-up, and adequate rest periods between tests to minimize fatigue (Bridge et al., 2018).

Data were analyzed using quantitative descriptive statistics. Raw scores from each test were converted into physical condition categories based on fitness norms relevant to the athlete's age and gender (ACSM, 2021). This approach allows for a clear interpretation of the athlete's physical profile and has been used. This method has been widely used in martial arts fitness mapping research (Aziz et al., 2022; Sundara et al., 2020). The analysis results are presented in frequency distribution and percentage tables to facilitate the evaluation of dominant biomotor components and those requiring improvement.

This method provides an empirical picture of the physical condition of Pencak Silat athletes in the Tanding category, which serves as a basis for developing evidence-based sports science training programs.

RESULTS AND DISCUSSION

Result

The results of this study are related to the research objectives that were previously formulated by the researchers. These findings are presented in a descriptive manner using tables and diagrams to provide a clear and comprehensive illustration of the data. The data presented were obtained from tests and measurements conducted on 10 Pencak Silat athletes from Pagar Nusa YPM Academy.

The test results were processed using Microsoft Excel. The researchers collected data from five physical fitness components of the Pencak Silat athletes at Pagar Nusa YPM Academy. The data collection was used to calculate descriptive statistical values, including the mean, standard deviation, and percentage. Based on the calculations performed using Microsoft Excel, the overall results of the physical condition tests can be further described as follows.

Table 1.

Summary of physical fitness test results of pencak silat athletes at Pagar Nusa YPM Academy

Number	Name	Gender	Push Up	Sit Up	Squat	Beep Test	Fast
1	LR	P	32	30	35	47,1	7,88
2	NA	L	30	32	33	42,4	7,89
3	AA	P	28	34	39	36,7	8,11
4	AS	P	35	34	36	35,3	8,24
5	MT	L	36	39	38	38,8	8,12
6	MV	P	31	37	35	33,6	8,23
7	AR	P	33	36	34	30,2	8,35
8	RR	L	35	36	37	43,6	7,35
9	RA	L	42	42	40	43,9	7,48
10	MA	L	43	40	40	45,5	7,78

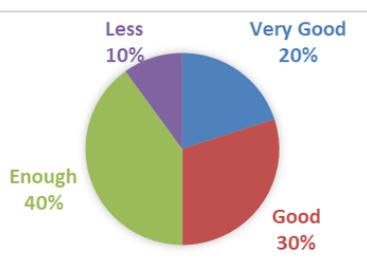
Results of Arm Muscle Strength Test

The results of the arm muscle strength test (push-up) of Pencak Silat athletes at Pagar Nusa YPM Academy in 2025, involving 10 participants consisting of 5 male and 5 female athletes, are presented in the following table and figure:

Table 2.

Result of Arm Muscle Strength Test

Number	Analysis Data	Result
1	Mean	34,5
2	Standart Deviation	4,88
3	Maxium Arm Muscle Strength	43
4	Minimum Arm Muscle Strength	28



Picture 1.

Diagram of Arm Muscle Strength Test Results

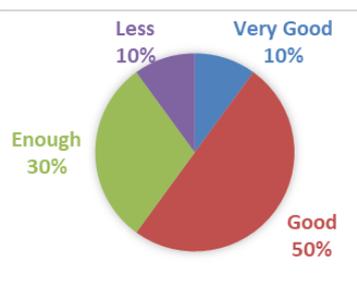
Based on the data in diagram 1.2, the following results were obtained, there are 1 or 10% of athletes in the less category, then 4 or 40% of athletes in the sufficient category, 3 or 30% of athletes in the good category, and 2 or 20% of athletes in the very good category, it can be concluded that the arm muscle strength of the Pencak Silat Pagar Nusa YPM Academy athletes is mostly in the sufficient category. This means that the training program for arm muscle endurance has met the expected standards, but needs to be further improved to reach the very good category.

Results of Abdominal Muscle Strength Test

The results of the arm muscle strength test (push-up) of Pencak Silat athletes at Pagar Nusa YPM Academy in 2025, involving 10 participants consisting of 5 male and 5 female athletes, are presented in the following table and figure.

Table 3.
Result of Abdominal Muscle Strength Test

Number	Analysis data	Result
1	Mean	36
2	Standard Deviation	3,68
3	Maxium Abdominal Muscle Strength	42
4	Minimum Abdominal Muscle Strength	30



Picture 2.
Diagram of Abdominal Muscle Strength Test Results

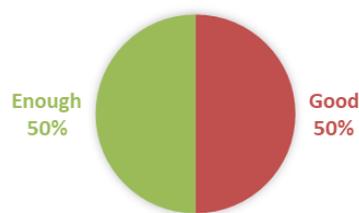
Based on the data presented in Figure 2, the results indicate that 1 athlete (10%) was classified in the poor category, 3 athletes (30%) were in the moderate category, 5 athletes (50%) were in the good category, and 1 athlete (10%) was classified in the very good category. It can be concluded that the abdominal muscle strength of Pencak Silat athletes at Pagar Nusa YPM Academy is predominantly in the good category; however, continuous improvement is still required.

Results of Leg Muscle Strengt Test

The results of the leg muscle strength test (squat) of Pencak Silat athletes at Pagar Nusa YPM Academy in 2025, involving 10 participants consisting of 5 male and 5 female athletes, are presented in the following table and figure:

Table 4.
Result of Leg Muscle Strength Test

No	Data Analysis	Result
1	Mean	36,7
2	Standard Deviation	2,50
3	Maximum Leg Muscle Strength	40
4	Minimum Leg Muscle Strength	33



Picture 3.

Diagram of Leg Muscle Strength Test Results

Based on the data presented in Figure 3, the results show that 5 athletes (50%) were classified in the moderate category, while the remaining 5 athletes (50%) were classified in the good category. It can be concluded that the leg muscle strength of Pencak Silat athletes at Pagar Nusa YPM Academy is predominantly within the moderate to good categories. However, to achieve the very good category, improvements in leg muscle training programs are required.

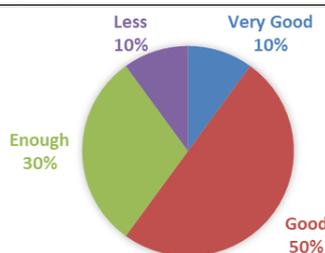
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The results of the aerobic endurance test (beep test) of Pencak Silat athletes at Pagar Nusa YPM Academy in 2026, involving 10 participants consisting of 5 male and 5 female athletes, are presented in the following table and figure:

Table 5.

Table 5. Results of Aerobic Endurance Test

No	Data Analysis	Result
1	Mean	39,1
2	Standard Deviation	5,63
3	Maximum Aerobic Endurance	47,1
4	Minimum Aerobic Endurance	30,2



Picture 4.

Diagram of Aerobic Endurance Test Results

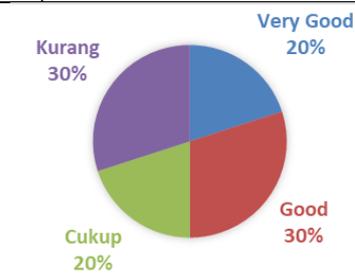
Based on the data presented in Figure 4, the results indicate that 1 athlete (10%) was classified in the poor category, 5 athletes (50%) were in the moderate category, 3 athletes (30%) were in the good category, and 1 athlete (10%) was classified in the very good category. It can be concluded that the aerobic endurance of Pencak Silat athletes at Pagar Nusa YPM Academy is predominantly in the moderate category. To improve competitive performance, it is recommended to increase the volume of aerobic training, such as long-duration running, interval training, or fartlek training, to encourage athletes to reach the good or very good categories.

Results of Speed Test

The results of the speed test (50-meter sprint) of Pencak Silat athletes at Pagar Nusa YPM Academy in 2026, involving 10 participants consisting of 5 male and 5 female athletes, are presented in the following table and figure.

Table 6.
Results of Speed Test

Number	Data Analysis	Result
1	Mean	7,94
2	Standard Deviation	0,33
3	Maximum Speed	8,35
4	Minimum Speed	7,35



Picture 5.
Diagram of Speed Test Results

Based on the data presented in Figure 5, the results indicate that 3 athletes (30%) were classified in the poor category, 2 athletes (20%) were in the moderate category, 3 athletes (30%) were in the good category, and 2 athletes (20%) were classified in the very good category. It can be concluded that the speed performance of Pencak Silat athletes at Pagar Nusa YPM Academy is predominantly distributed between the poor and good categories. Speed training plays a crucial role in Pencak Silat performance.

Discussion

The research results show that the physical condition components of Pencak Silat athletes in the Tanding category at Pagar Nusa YPM Academy vary in distribution across arm muscle strength, abdominal muscle strength, leg strength, aerobic endurance ($VO_2\max$), and speed. Conceptually, performance in intermittent martial arts like Pencak Silat is heavily influenced by the integration of strength, power, speed, and aerobic-anaerobic capacity (Franchini et al., 2019; Slimani et al., 2017).

In the tanding category, striking is the dominant technique for scoring points. Punching power is determined not only by technique but also by the neuromuscular capacity of the arm and shoulder muscles (Loturco et al., 2019). Biomechanically, an effective punch involves kinetic coordination of the lower extremities, trunk rotation, and energy transfer to the upper extremities (Turner et al., 2019). The concept of power as a combination of strength and speed of muscle contraction remains relevant in modern literature, where maximal force production in a short period of time is a key indicator of explosive performance (Cormie et al., 2016; Suchomel et al., 2018).

The findings of this study indicate that athletes' push-up capacity is in the moderate to good category, indicating adequate arm muscle endurance. However, in the

context of high-level competition, research by Chaabene et al. (2018) emphasized that elite martial arts athletes demonstrate significantly higher upper-body power capabilities than sub-elite athletes. This means that increasing explosive power through resistance training and plyometric upper-body training is still necessary to optimize punching effectiveness.

The core endurance component plays a central role in stability and movement control. The rectus abdominis and obliques serve as the center of energy transfer (core-to-limb linkage) during front kicks, crescent kicks, and T-kicks (Aziz et al., 2022). Good core stability has been shown to improve biomechanical efficiency and reduce injury risk (Reed et al., 2019). The sit-up test results in this study showed a relatively good distribution, but functional training-based core stability enhancement is still recommended. Recent studies have shown that a 6–8-week core stability program improves dynamic balance and striking effectiveness in combat sports (Prieske et al., 2016; Chaabene et al., 2018).

In a defensive context, the abdominal muscles also serve as natural protection against attacks to the abdominal area. Research in combat sports shows that core muscle strength contributes to impact tolerance and postural stability during physical contact (Bridge et al., 2018). Therefore, core strengthening serves not only aesthetic purposes but also serves as the biomechanical foundation of competitive performance.

Leg strength and power are crucial factors in kicking technique, which is the primary source of points in Pencak Silat matches. The squat test in this study demonstrated variations in ability, indicating the need to improve leg explosiveness. Physiologically, the quadriceps, hamstrings, and gluteus maximus play a role in generating propulsive force during the hip extension and knee extension phases (Cormie et al., 2016). Aziz et al. (2022) reported that elite Pencak Silat athletes have significantly higher leg power than regional-level athletes.

Squat training and its variations (back squat, jump squat, split squat) have been shown to increase the rate of force development (RFD), which is directly related to kick execution speed (Suchomel et al., 2018). Furthermore, leg strength also strengthens the supporting leg, resulting in more efficient energy transfer to the attacking leg (Loturco et al., 2019). This aligns with the kinetic chain theory, which emphasizes the importance of proximal stability for generating maximum distal force (Turner et al., 2019).

Aerobic endurance ($VO_2\text{max}$) is an important indicator for maintaining performance throughout three rounds of competition. The match structure, consisting of three two-minute rounds with one minute rest, requires a balance of aerobic and anaerobic capacity (Franchini et al., 2019). Beep test results indicate that some athletes are in the intermediate category, potentially impacting endurance in the final rounds.

Research by Ouergui et al. (2020) indicates that a high $VO_2\text{max}$ capacity is associated with the ability to maintain attack intensity throughout the third round. Furthermore, aerobic endurance accelerates the recovery process between rounds by increasing the efficiency of the oxidative system (Slimani et al., 2017). Athletes with low $VO_2\text{max}$ tend to fatigue more quickly, which results in decreased technical accuracy and

defensive reactions (Bridge et al., 2018). Therefore, developing endurance through interval training and high-intensity interval training (HIIT) is recommended (Laursen & Buchheit, 2019).

The speed component (50-meter sprint) in this study showed a distribution between poor and good categories. Linear speed and acceleration are crucial in attacking and evasive transitions (Loturco et al., 2019). Neuromuscularly, sprint speed reflects the ability of leg muscles to generate horizontal force in a short period of time (Suchomel et al., 2018).

In competitive combat, speed provides a competitive advantage because it allows athletes to attack before their opponents react (Turner et al., 2019). The Speed, Agility, and Quickness (SAQ) program has been shown to significantly improve acceleration, reaction time, and change of direction in martial arts athletes (Hammami et al., 2018). Implementing SAQ training for 6–8 weeks can increase sprint speed and agility by 5–8% (Ari Wilujeng & Hartoto, 2013; Hammami et al., 2018).

Overall, the findings of this study confirm that the performance of Pencak Silat athletes in competitions is the result of a multidimensional integration of strength, power, core stability, aerobic endurance, and speed. A sports science-based coaching model requires periodic evaluation and structured training planning in accordance with the principles of periodization (Bompa & Buzzichelli, 2019).

Therefore, improving the performance of Pagar Nusa YPM Academy athletes requires a systematic approach through a combination of resistance training, plyometric training, HIIT, and SAQ training based on competition requirements. Holistic integration of physical components will enhance the effectiveness of technique, energy efficiency, and competitive readiness of athletes at a higher level.

CONCLUSION

Based on the research results, it can be concluded that the physical condition profile of Pencak Silat athletes in the Tanding category at Pagar Nusa YPM Academy is generally in the moderate to good category. Arm muscle strength showed an average of 34.5 repetitions (40% of the moderate category), indicating that the foundation for punching power has been established, but explosive power development is still needed to increase attack effectiveness. Abdominal muscle strength showed the most optimal results (50% of the good category; average 36 repetitions), emphasizing the importance of core stability in supporting energy transfer during kicks and maintaining balance during defense.

Leg muscle strength was evenly distributed between the moderate and good categories (average 36.7 repetitions), contributing to the effectiveness of kicking techniques as a primary source of points. However, aerobic capacity (average VO_2max 39.1; predominantly in the fair category) indicated the need for increased endurance to maintain intensity throughout the three rounds of competition. The 50-meter sprint speed (average 7.94 seconds) also remained suboptimal.

Overall, the athlete's physical condition is sufficient as a basis for performance, but structured improvement through a combination of resistance training, interval training, and the Speed, Agility, and Quickness (SAQ) method is needed to achieve a higher and more consistent competitive level.

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REFERENCES

- American College of Sports Medicine. (2021). ACSM's guidelines for exercise testing and prescription (11th ed.). Wolters Kluwer. <https://www.acsm.org>
- Ari Wilujeng, W., & Hartoto, S. (2013). Hubungan Kecepatan Terhadap Kecepatan Tendangan Sabit Di SMP Muhammadiyah 2 Surabaya. *Jurnal Pendidikan Olahraga Dan Kesehatan*, 01(22), 584–587.
- Aziz, A. R., Chia, M., & Teh, K. C. (2022). Physiological demands and performance characteristics in combat sports: A review. *Sports Medicine*, 52(3), 451–468. <https://doi.org/10.1007/s40279-021-01568-5>
- Bompa, T. O., & Buzzichelli, C. (2019). *Periodization: Theory and methodology of training* (6th ed.). Human Kinetics. <https://us.humankinetics.com/products/periodization-6th-edition>
- Bridge, C. A., Ferreira da Silva Santos, J., Chaabène, H., Pieter, W., & Franchini, E. (2018). Physical and physiological profiles of combat sport athletes. *Sports Medicine*, 48(8), 1867–1887. <https://doi.org/10.1007/s40279-018-0939-0>
- Candra, Juli, S.Pd., M. P. (2021). *Pencak Siat*. E Book, 1–125.

- Dwi, Nopitasari, Atik, Rizanul, Wahyudi, A. (2022). Tingkat Pemahaman Atlet Pencak Silat Usia Dewasa Kategori Tanding Di Ipsi Ponorogo Terhadap Peraturan Pertandingan Pencak Silat 2016. *Prestasi Olahraga*, 5(5), 103–108.
- Chaabene, H., Hachana, Y., Franchini, E., Mkaouer, B., & Chamari, K. (2018). Physical and physiological profile of elite combat sports athletes: A systematic review. *Sports Medicine*, 48(4), 857–891. <https://doi.org/10.1007/s40279-017-0815-0>
- Cormie, P., McGuigan, M. R., & Newton, R. U. (2016). Developing maximal neuromuscular power: Part 1–2. *Sports Medicine*, 46(10), 1445–1463. <https://doi.org/10.1007/s40279-016-0551-6>
- Fahmi Maulana, Muhammad Saleh, Bachtiar, Diki Hermawan, F. N. H. (2024). Penerapan peraturan pertandingan pencak silat kategori tanding. *Pengabdian Kepada Masyarakat Abdi Nusa*, 4(3), 327–332.
- Franchini, E., Cormack, S., & Takito, M. Y. (2019). Effects of high-intensity interval training on combat sport athletes. *Journal of Strength and Conditioning Research*, 33(1), 242–250. <https://doi.org/10.1519/JSC.0000000000002957>
- Gunawan, F. A., Jatmiko, T., Pd, S., & Kes, M. (2020). Pengaruh Latihan Squat Dan Walking Lunges Terhadap Kekuatan Tendangan Depan Atlet Pencak Silat Ma Ma'arif Udanawu Blitar. *Prestasi Olahraga*, 3(3), 1–6.
- Gunawan, G., Irawan, R., & Prasetyo, Y. (2020). The effect of squat training on leg power in martial arts athletes. *Journal of Physical Education and Sport*, 20(6), 3200–3205. <https://doi.org/10.7752/jpes.2020.06432>
- Hammami, M., Negra, Y., Shephard, R. J., & Chelly, M. S. (2018). The effect of SAQ training on physical performance in young athletes. *Journal of Strength and Conditioning Research*, 32(7), 2050–2057. <https://doi.org/10.1519/JSC.0000000000002368>
- Hammami, R., Chaabene, H., & Negra, Y. (2019). Sprint and agility performance in combat athletes. *Frontiers in Sports and Active Living*, 1, 12. <https://doi.org/10.3389/fspor.2019.00012>
- Hasyati, R. W. (2021). Korelasi kekuatan otot lengan, power, dan koordinasi terhadap pukulan atlet pencak silat. *Olahraga Pendidikan Indonesia (JOPI)*, 1(1), 96–107.
- Masula, Aris Desi Sasmita*, Jatmiko, T. (2021). Analisis Kondisi Fisik Atlet Pencak Silat Kategori Tanding Puteri (Studi Smk Negeri Mojoagung). *Jurnal Prestasi Olahraga*, 4(3), 49–57.
- Laursen, P. B., & Buchheit, M. (2019). Science and application of high-intensity interval training. *Human Kinetics*. <https://us.humankinetics.com/products/science-and-application-of-hiit>
- Loturco, I., Nakamura, F. Y., Artioli, G. G., & Franchini, E. (2019). Strength and power qualities in combat sports. *Journal of Strength and Conditioning Research*, 33(3), 1238–1246. <https://doi.org/10.1519/JSC.0000000000002912>
- Ouergui, I., Davis, P., Houcine, N., Marzouki, H., Zaouali, M., Franchini, E., & Bouhlel, E. (2020). Hormonal, physiological, and physical responses in combat sports athletes. *Frontiers in Physiology*, 11, 123. <https://doi.org/10.3389/fphys.2020.00123>
- Prieske, O., Muehlbauer, T., & Granacher, U. (2016). The role of core stability in athletic performance. *Sports Medicine*, 46(3), 295–310. <https://doi.org/10.1007/s40279-015-0423-6>

- Puspodari. (2021). Tingkat Volume Oksigen Maksimal Atlet Cabor Konsentrasi Unggulan Senam Puslatkot Kota Kediri Dalam Menghadapi Pekan Olahraga Provinsi 2022. *Jurnal Kesehatan Jasmani Dan Olah Raga*, 6(1), 207-211.
- Reed, C. A., Ford, K. R., Myer, G. D., & Hewett, T. E. (2019). Core stability and injury prevention. *Current Sports Medicine Reports*, 18(8), 289-295. <https://doi.org/10.1249/JSR.0000000000000615>
- Rustiyanti, Sri, Listiani, Wanda, E.M., Ningdyah, Anrilia, Dwiatmini, Sriati, S. (2025). Pencak Silat Dan Seni Pencak Berbasis Digitalisasi Sebagai Proses Pembelajaran Yang Efektif. *Jurnal ISBI Bandung*, 313-330.
- S, Adi, Apriyanto, Rohmad, Chabibullah, M. (2021). Daya Tahan Atlet Pencak Silat Kategori Tanding Pencak Organisasi Tuban. *CITIUS: Jurnal Pendidikan Jasmani, Olahraga, Dan Kesehatan*, 1(2), 31-36.
- Slimani, M., Chaabène, H., Miarka, B., Franchini, E., Chamari, K., & Cheour, F. (2017). Kickboxing review: Physiological and physical demands. *Biology of Sport*, 34(2), 185-196. <https://doi.org/10.5114/biolSport.2017.65338>
- Suchomel, T. J., Nimphius, S., & Stone, M. H. (2018). The importance of muscular strength in athletic performance. *Sports Medicine*, 48(4), 765-785. <https://doi.org/10.1007/s40279-018-0862-4>
- Sukron, M. (2021). Kontribusi Kekuatan Otot Perut dan Kelentukan Pinggang terhadap Tendangan Lurus Atlet Pencak Silat Satria Muda Indonesia (SMI) Komwil Kota Padang. *DJS (Dharmas Journal of Sport)*, 1(1), 32-42.
- Sundara, A., Rahman, A., & Putra, D. (2020). Physical fitness profile of pencak silat athletes. *International Journal of Human Movement and Sports Sciences*, 8(4), 145-150. <https://doi.org/10.13189/saj.2020.080404>
- Sundara, C., Meirizal, Y., & Hambali. (2020). Kondisi fisik atlet pencak silat pplp jawa barat. *MULTILATERAL Pendidikan Jasmani Dan Olahraga*, 19(1), 74-82.
- Turner, A. N., Comfort, P., McMahon, J. J., & Bishop, C. (2019). Developing speed and power in combat sports athletes. *Strength and Conditioning Journal*, 41(3), 1-15. <https://doi.org/10.1519/SSC.0000000000000458>
- World Health Organization. (2020). Guidelines on physical activity and sedentary behaviour. <https://www.who.int/publications/i/item/9789240015128>