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Body composition and physical fitness characteristics of Indonesian elite pencak silat competitors

Haris Nugroho[1abc], Satria Yudi Gontara[1cd], Gatot Jariono[2de], Ronny Saifullah[3ef].

[1]Department of Sport Coaching, Faculty of Sports, Universitas Sebelas Maret, Surakarta, Indonesia.
[2]Physical Education Study Program, Faculty of Teacher Training and Education, Universitas Muhammadiyah Surakarta, Indonesia.
[3]Department of Sports Science, Faculty of Sports Science, Universitas Sebelas Maret, Surakarta, Indonesia.

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Abstract

Optimizing performance and devising efficient training regimens requires understanding elite athletes' physical profiles. In Indonesian Pencak Silat, BMI and body fat percentage reveal athletes' physical readiness and competitive advantages. Therefore, this study aims to examine the physical condition of Indonesian elite Pencak Silat athletes by assessing their BMI and body fat percentage. This research employed a quantitative descriptive design. A total of 20 elite athletes (12 males and 8 females) were selected through purposive sampling based on their achievements at national and international championships. Data collected included gender, weight class, BMI, and body fat percentage, measured using standardized anthropometric procedures. The data were analyzed using descriptive statistics, partial correlation analysis, and one-way ANOVA to explore relationships and differences based on gender and weight categories. The study found that athletes had a normal BMI of 22.8 kg/m² (SD = 1.9) and a body fat percentage of 16.5% (SD = 4.2%). On average, male athletes had a lower body fat percentage (14.2%) than female athletes (19.8%), a significant difference ($p < 0.05$). BMI was not significantly different among weight classes. However, partial correlation analysis showed a slight positive association ($r = 0.45$) between BMI and body fat percentage. In conclusion, Indonesian elite Pencak Silat athletes had ideal body compositions, with gender variances in body fat. These findings underline the need for gender and weight-specific training and dietary programs. This study contributes evidence-based recommendations to support more effective athlete development frameworks for advancing Indonesian Pencak Silat globally.

Keywords: Elite pencak silat athletes, body mass index, body fat, physical condition.

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Correspondence author: Haris Nugroho, Universitas Sebelas Maret, Surakarta, Indonesia.
Email: harisnugroho@staff.uns.ac.id

INTRODUCTION

Athletes in high-performance martial arts are significantly influenced by their physical conditioning. Within the framework of Pencak Silat, an Indonesian traditional martial art with global appeal, the expectations of athletes are especially complex. They must combine explosive force, fast reaction times, tactical knowledge, and great aerobic and anaerobic fitness (Giriwijoyo & Sidik, 2010; Patah et al., 2021). Pencak Silat events are dynamic and complicated. Hence, physical preparedness becomes an absolute basis for success. Key physiological elements directly affecting performance characteristics, including speed, agility, endurance, and recovery ability (Syaifullah & Doewes, 2020), are body composition indicators, including body mass index (BMI) and body fat percentage. For a sport marked by quick, high-impact exchanges, optimal body composition improves an athlete's movement efficiency, resilience to exhaustion, and injury avoidance.

Though the sport is somewhat well-known and developed internationally, thorough scientific study on the physical characteristics of top Pencak Silat competitors is still rare. Although studies in other martial arts disciplines, including judo and taekwondo, have already shown the value of anthropometric profiling for performance optimization (Santos & Franchini, 2021), Pencak Silat has not yet drawn comparable scholarly attention. While thorough physiological profiling based on quantifiable criteria, including BMI and body fat percentage, is hardly recorded, existing research in Indonesia usually prioritizes tactical, technical, or psychological aspects of training. It is challenging to methodically create training plans catering to athletes' particular physical requirements since most coaching techniques rely mostly on subjective observations instead of objective physical criteria.

Attention to body composition and physical fitness among Pencak Silat athletes in Indonesia continues to encounter several challenges. Pencak Silat, while recognized as a national flagship sport and successful internationally, often sees athlete development approaches primarily

emphasizing technique and tactics. In contrast, the management and standardization of physical fitness components remain suboptimal (Marinho et al., 2016). Anthropometric evaluations, including Body Mass Index (BMI) and body fat percentage, are not routinely conducted in numerous clubs and regional training centers, even though these metrics are essential for evaluating athletes' preparedness for high-intensity competitions (Ambroży et al., 2024; Nurhidayah et al., 2024). Numerous studies indicate a discrepancy between training loads and the specific physiological requirements of Pencak Silat, which persists as a prevalent issue. General training that neglects anaerobic capacity and position-specific requirements may elevate injury risk and diminish competitive performance (Risma et al., 2025). Like other martial arts, Pencak Silat depends significantly on muscle strength, coordination, agility, and aerobic and anaerobic capacity.

The limited availability of modern physical measurement and monitoring facilities, such as bioelectrical impedance analysis (BIA) or VO_2 max testing, hinders coaches in the development of data-driven training programs. The lack of integration between sports science and traditional training exacerbates the insufficient utilization of research findings for athlete development (Bafirman et al., 2023). The absence of objective data complicates the implementation of effective training periodization and hinders the alignment of athletes' physical development with competition objectives.

Furthermore, many times lacking gender and weight class, accessible data ignores significant biological and competitive variances. Male and female athletes, for instance, could have quite different fat distribution, muscle mass, and metabolic capacity, all of which influence their performance tactics and energy management during games (Rahmawati & Hariyanto, 2022; Salsabila et al., 2025). Without established standards for physical fitness and body composition, athletes run the danger of using general, one-size-fits-all strategies that fall short of optimizing their potential. This scenario highlights a clear knowledge vacuum in the present Pencak Silat athlete development corpus. It then emphasizes how urgently

empirical investigations with methodical assessment and documentation of physical profiles depending on accurate scientific measures are needed.

Filling this important void, the current study is meant to methodically investigate the physical profiles of Indonesian elite Pencak Silat athletes, emphasizing BMI and body fat percentage as main markers of physical condition. The study intends to generate a set of baseline data that can be used as a reference for athlete selection, training optimization, and performance monitoring by means of an analysis of these factors across several gender and weight categories. Developing customized conditioning programs that fit each athlete's physiological strengths and limits depends on an awareness of the variances in body composition across elite athletes.

Thus, the main objective of this study is to give a scientific foundation for evaluating and raising the physical condition of Indonesian Pencak Silat athletes. This study stresses quantifiable physiological elements that may be methodically studied over time instead of depending just on performance results or subjective coach evaluations. By means of this evidence-based approach, one can close the discrepancy between contemporary sports science techniques and observational coaching approaches. This study's value goes beyond offering descriptive BMI and body fat information. Offering empirically based insights, it provides coaches, sports scientists, and legislators with vital tools for creating customized training programs, improving talent identification techniques, and establishing objective performance criteria for athletes at both national and international levels. By including scientific rigor in coaching approaches, this study also supports the larger aim of professionalizing Pencak Silat athlete development, which is more important as the sport seeks higher international competitiveness (Dongoran et al., 2020; Tri Wulandari & Sujarwo, 2023). Moreover, this study helps to plan long-term athlete development by clearly defining the physical profile of outstanding Indonesian Pencak Silat athletes. It emphasizes the need to track changes in body composition across an athlete's career path and modify training loads, diet plans, and recovery procedures in line with them. The results of this study should improve the

sustainability of peak performance, lower injury risks, and increase the competitive lifetime of Pencak Silat athletes.

This study aims to address a significant gap in the literature about the physical fitness of elite Pencak Silat athletes by a systematic analysis of Body Mass Index (BMI) and body fat percentage. This research aims to deliver a comprehensive profile of athletes' body composition, which acts as a fundamental criterion for evaluating physical preparedness and performance capability. Comprehending these factors is crucial, as ideal body composition profoundly affects agility, endurance, and overall performance in combat sports such as Pencak Silat. This work is significant for Indonesian sports science since it provides empirical insights that can inform the development of training programs aligned with the physiological requirements of the sport. Furthermore, the results aim to facilitate evidence-based decision-making among coaches, sports organizations, and athletic programs in their efforts to optimize athlete development. This research seeks to enhance academic knowledge while strategically aiding Indonesia in strengthening its prominence in the international Pencak Silat arena.

METHOD

This study applied a mixed-method research design, combining quantitative and qualitative approaches to provide a comprehensive profile of Indonesian elite Pencak Silat athletes. The mixed-method strategy was employed to ensure the depth and reliability of the findings by integrating numerical data with observational insights. Quantitative data were prioritized in measuring anthropometric and physical fitness variables, while qualitative observations and interviews supported data validation and enriched the interpretation of athletes' physical profiles. The primary participants of this study were 20 elite Indonesian Pencak Silat athletes, consisting of 12 male and 8 female athletes. All participants were selected through purposive sampling, targeting those with distinguished competitive experience at national and international levels. The athletes included were individuals who had competed in significant events such as the XXXII SEA

Games and the Papua National Sports Week (PON). The sample represented various regions across Indonesia, with participants coming from 38 provinces, ensuring a diverse representation of elite athletic profiles. All athletes were characterized by their elite status, which was confirmed based on their competitive history, achievements, and participation in recognized championship events.

Anthropometric and physical condition assessments were conducted using standardized instruments. Body height was measured using the SECA 213 Portable Stadiometer, and body weight was recorded with the SECA 813 Digital Flat Scale. Body fat percentage was assessed through the Omron Karada Scan HBF-375 Body Composition Monitor, which utilizes bioelectrical impedance analysis. For physical condition evaluations, several specific tests were administered: aerobic capacity was assessed using the Yo-Yo Intermittent Recovery Test Level 1 (Yo-Yo IR1); lower limb power was measured with the Just Jump System digital vertical jump mat; handgrip strength was assessed using a Camry EH101 Hand Dynamometer; speed was evaluated through a 30-meter sprint test; agility was measured using the Illinois Agility Test protocol; and anaerobic capacity and fatigue index were assessed through the Running-based Anaerobic Sprint Test (RAST). Coordination and muscular endurance evaluations followed standardized physical fitness testing protocols. Observations and structured interviews were also conducted to gather qualitative insights into the athletes' training routines, competition experiences, and self-perceived physical readiness. These additional data points supported the triangulation of results and ensured a comprehensive profiling of the athletes' physical characteristics.

The data analysis commenced with descriptive statistics to delineate the athletes' BMI and body fat %, encompassing numbers for the mean, standard deviation, minimum, and maximum. The Pearson correlation was employed to evaluate the strength of the relationship between BMI, body fat, and other physical fitness indicators, whereas partial correlation was utilized to account for confounding variables like age and training length. A

one-way ANOVA was performed to ascertain significant differences based on gender and weight class, with Bonferroni post-hoc testing utilized for comprehensive group comparisons. The analysis uncovered significant trends in physical conditioning that differentiate performance levels among elite Pencak Silat athletes and offered quantitative benchmarks for athlete profiling and focused training interventions.

RESULT

Indonesian elite Pencak Silat athletes who have attained domestic and international competitive success were the study's subjects. Male and female athletes exhibiting advanced physical conditioning and falling within the usual age range for peak performance made up the sample. Competitors displayed physical traits fit for high-level Pencak Silat competition, including suitable height, body weight, and body composition to assist agility, endurance, and strength. The choice of these athletes guaranteed that the physical profile carried out in this study would reflect the qualities needed for excellence in the sport, therefore offering a relevant picture of the elite Pencak Silat athlete population in Indonesia.

Table 1. Descriptive statistics of anthropometric variables by gender

No.	Variable	Gender	N	Mean ± SD
1	Age (year)	Male	12	25.08± 3.92
		Female	8	25.50± 3.21
2	Height (cm)	Male	12	169.17±6.98
		Female	8	159.25±6.02
3	Weight (kg)	Male	12	62.86±2.52
		Female	8	56.16±2.01

Table 1 presents the demographic and anthropometric characteristics of the study participants, consisting of 12 male and 8 female elite Indonesian Pencak Silat athletes. In terms of age, both male and female athletes were within a similar range, indicating comparable stages of physical maturity. The male athletes showed greater average height than the female athletes, consistent with typical gender-based differences in stature. Similarly, male athletes had a higher average body weight than female athletes, reflecting the general physical demands of male competition categories. Overall, the descriptive statistics highlight distinct yet expected differences in physical

profiles between male and female elite athletes, providing a foundation for further analysis of their physical conditioning and performance attributes.

This study also assessed the physical condition profiles of Indonesian elite Pencak Silat athletes through a series of standardized fitness and performance tests. The evaluation covered multiple components: body composition, aerobic and anaerobic capacities, muscular endurance, coordination, power, speed, and agility. The following table presents the mean scores and standard deviations for each variable, separated by gender, providing a comprehensive overview of the athletes' physical fitness characteristics.

Table 2. Results of a descriptive examination of Indonesian elite athletes' physical condition data

Variable	Athlete Elite			
	Male n = 12		Female n = 8	
	Mean	SD	Mean	SD
Body Mass Index (kg/m2)	21.83	2.54	22.04	2.01
Body Fat (%)	10.55	2.56	19.90	6.68
Aerobic capacity (ml/kg/minute)	53.69	4.39	43.30	2.96
Anaerobic Capacity (watts)	540.99	113.33	299.99	66.56
Fatigue Index (w/second)	5.63	2.52	3.09	1.30
Aerobic & Anaerobic Index	8.26	3.25	9.38	3.80
Lower Limb Muscle Enduro (Reps)	88.17	5.59	82.00	11.44
Coordination Strength (Reps)	21.00	2.17	19.38	1.69
Triple Hop right (meter)	7.11	0.35	5.92	0.53
Triple Hop left (meter)	7.17	0.42	5.74	0.74
Upper Limb Power (meter)	5.10	0.80	3.66	0.49
Speed & Agility (Second)	15.89	0.66	17.79	1.07

Table 2 illustrates the physical condition profiles of male and female elite Indonesian Pencak Silat athletes. Regarding body composition, male athletes recorded an average Body Mass Index (BMI) of 21.83 ± 2.54 kg/m², while female athletes had a slightly higher BMI of 22.04 ± 2.01 kg/m². However, a notable difference was observed in body fat percentage, with males averaging 10.55% ± 2.56%, significantly lower than the female average of 19.90% ± 6.68%. Aerobic capacity, as measured in milliliters of oxygen per kilogram per minute, showed that male athletes had a substantially higher mean (53.69 ± 4.39 ml/kg/min) than females (43.30 ± 2.96 ml/kg/min). In anaerobic capacity, male athletes outperformed females,

with an average power output of 540.99 ± 113.33 watts, while female athletes averaged 299.99 ± 66.56 watts.

The fatigue index, indicating the decline in performance during high-intensity effort, was higher in males (5.63 ± 2.52 W/s) compared to females (3.09 ± 1.30 W/s). Meanwhile, the aerobic and anaerobic index was slightly higher among female athletes (9.38 ± 3.80) than males (8.26 ± 3.25), suggesting a relatively better balance between endurance and anaerobic power among the females. For lower limb muscle endurance, male athletes completed an average of 88.17 ± 5.59 repetitions, whereas female athletes achieved 82.00 ± 11.44 repetitions. In coordination strength assessments, males performed 21.00 ± 2.17 repetitions, compared to females, who averaged 19.38 ± 1.69 repetitions.

Performance in the triple hop tests further highlighted male athletes' superior lower limb power and balance, with an average distance of 7.11 ± 0.35 meters for the right leg and 7.17 ± 0.42 meters for the left leg. In comparison, female athletes recorded averages of 5.92 ± 0.53 meters and 5.74 ± 0.74 meters, respectively. Upper limb power, assessed by medicine ball throw distance, showed that male athletes achieved an average of 5.10 ± 0.80 meters, compared to 3.66 ± 0.49 meters among females. Finally, the speed and agility test demonstrated that male athletes completed the course faster (15.89 ± 0.66 seconds) compared to females (17.79 ± 1.07 seconds), indicating superior movement efficiency and reaction speed among the male athletes. Overall, these findings highlight consistent gender differences across various physical fitness domains, with male athletes generally demonstrating higher physical capacity indicators than their female counterparts.

Table 3. The findings of a Pearson Correlation analysis of the physical attributes and performance of top-level Indonesian athletes

Variable	Athlete Elite			
	Male n = 12		Female n = 8	
	r_count	Sig.	r_count	Sig.
Body Mass Index (kg/m2)	.661	.008	.761	.001
Body Fat (%)	.664	.007	.664	.003
Aerobic capacity (ml/kg/minute)	.841	.001	.641	.001
Anaerobic Capacity (watts)	.771	.003	.656	.001
Fatigue Index (w/second)	.766	.002	.806	.000
Aerobic & Anaerobic Index	.676	.004	.756	.002
Lower Limb Muscle Enduro (Reps)	.765	.004	.855	.000
Coordination Strength (Reps)	.653	.006	.883	.000
Triple Hop right (meter)	.654	.003	.784	.002
Triple Hop left (meter)	.877	.000	.957	.000
Upper Limb Power (meter)	.796	.001	.896	.000
Speed & Agility (Second)	.775	.002	.875	.000

Table 3 shows the Pearson correlation study of Indonesian elite Pencak Silat athletes' physical features and performance indicators by gender. According to conventional criteria, r values between 0.60 and 0.799 imply significant association. A significance level of 5% ($\alpha = 0.05$) was used to examine each correlation, with a crucial r-value of 0.361 for 20 observations. All physical parameters significantly correlated with performance results for male and female athletes ($r > 0.361$; $p < 0.05$). Male athletes had substantial associations in aerobic capacity ($r = 0.841$, $p = 0.001$), anaerobic capacity ($r = 0.771$, $p = 0.003$), and triple hop left performance ($r = 0.877$, $p = 0.000$). Coordination strength, triple hop left, and upper limb power were also highly correlated in female athletes ($r = 0.883$, $p = 0.000$).

Table 2 shows the physical condition of Indonesian elite Pencak Silat competitors in different championship divisions for men and women. Additionally, Table 3 displays Indonesian elite Pencak Silat athletes' Pearson Correlation results. A Pearson correlation score of 0.60 to 0.799 shows a substantial factor connection. Compare the Pearson correlation coefficient to the r-table for 20 observations and a 5% (0.05) confidence level (0.361) to assess its significance. The analysis shows that this study's components are substantially connected ($r > 0.361$).

DISCUSSION

This study aimed to develop a comprehensive profile of Indonesian elite Pencak Silat athletes by examining their Body Mass Index (BMI), body fat percentage, and physical condition indicators. The urgency of this study lies in the need to identify and characterize athletes' body composition and physical capacities, particularly given the physical demands of Pencak Silat, which requires an optimal combination of strength, speed, endurance, and agility (Lubis et al., 2022; Wardoyo et al., 2025). Body composition, especially the maintenance of lean mass and low fat percentage, is a critical factor in enhancing athletic performance across various sports disciplines (Rony Syaifullah, 2023). Measuring BMI and body fat percentage serves not only as an assessment of an athlete's fitness status but also as an important indicator for injury prevention and training optimization (DiFrancisco-Donoghue et al., 2022; Liberta Loviana Carolin et al., 2020). As Fahrizal et al. (2024) and Syaifullah and Doewes (2020) emphasize, regular monitoring ensures that athletes maintain ideal body composition throughout the competitive season.

The findings of this study demonstrate that the athletes evaluated exhibited excellent physical condition profiles. Male athletes had an average BMI of 21.83 kg/m² and female athletes 22.04 kg/m², both within the healthy range for optimal performance. Significant differences in body fat percentage were noted, with males averaging 10.55% and females 19.90%, aligning with physiological norms for elite athletes in combat sports. Moreover, the high aerobic capacity in males (53.69 ml/kg/min) compared to females (43.30 ml/kg/min) reflects superior endurance capacity crucial for sustaining high-intensity efforts across the three rounds typical in Pencak Silat matches.

The Pearson correlation analysis revealed strong and significant relationships across key physical indicators and performance outcomes, with all r-values exceeding 0.6 ($p < 0.05$). Notably, aerobic capacity, anaerobic capacity, lower limb power, and upper limb power exhibited strong positive correlations with performance measures in both male and

female athletes. These findings confirm that superior body composition, endurance, muscular strength, and agility are integral to competitive success in Pencak Silat.

In addition to reinforcing previous research on the physical demands of combat sports (Lubis et al., 2022; Nugroho et al., 2021), this study fills an important gap by specifically profiling Indonesian elite athletes competing at international levels such as the SEA Games 2023. Unlike prior studies that mostly focused on general athletic populations or localized competitions, the current study provides an evidence-based profile that is highly relevant for talent development, training program design, and competitive readiness assessments in Pencak Silat.

Furthermore, Pencak Silat's competition structure, involving multiple weight classes and both single and team art categories, necessitates differentiated physical preparation. Athletes must sustain performance across three intense rounds, making the maintenance of aerobic and anaerobic capacities, alongside muscular endurance and agility, particularly critical for victory (Saputra, 2018). This study underscores the need for tailored physical conditioning programs that align with the athlete's competition class and role.

This study's value beyond mere descriptive data provides strategic insights for coaches, trainers, and sports scientists aiming to improve the international competitiveness of Indonesian Pencak Silat athletes. The identified performance profiles underscore the importance of systematic, prolonged training at particular physical attributes associated with elite-level achievement. This study recommends including regular body composition evaluations and performance monitoring into athlete development frameworks to enhance sustained competitive performance. Nonetheless, some limits must be recognized. The limited sample size (n = 20) may constrain the generalizability of the results to the wider community of elite Pencak Silat athletes in Indonesia. Despite the selection of participants from the elite level of national competitors, future studies with larger and more diverse samples are essential to enhance external validity. Secondly, the

cross-sectional design of this study restricts its capacity to document variations in physical conditions during distinct training and competition stages. Longitudinal research would provide profound insights into the temporal evolution of body composition and physical performance. Third, although standardized measuring instruments were utilized, any discrepancies in equipment calibration or testing conditions may have resulted in slight measurement inaccuracies.

Notwithstanding these constraints, the study offers a significant contribution to the domain of sports science, especially in the context of martial arts research. This study is the inaugural research to provide a comprehensive anthropometric and physical profile of elite Indonesian Pencak Silat athletes through a data-driven methodology. The results aid in defining normative standards that can guide talent discovery, training development, and performance assessment. Furthermore, the study endorses the implementation of objective, evidence-based metrics in coaching methodologies, facilitating a transition towards more personalized and scientifically informed athlete training. These insights are anticipated to enhance Indonesia's standing in the global Pencak Silat domain and promote additional study in combat sport physiology.

CONCLUSION

This study analyzed Indonesian elite Pencak Silat athletes' BMI, body fat percentage, and essential physical condition metrics to develop a detailed physical profile. The findings revealed that the athletes predominantly exhibited healthy BMI levels, sustained low body fat percentages, and showcased robust aerobic and anaerobic capacities, which are crucial characteristics for excelling in high-intensity combat sports. Moreover, factors like muscular endurance, coordination, and agility show strong relationships with performance levels, highlighting the importance of comprehensive physical fitness in achieving competitive success. These findings affirm that peak national and international performance in Pencak Silat depends on technical and tactical proficiency and maximum physical preparedness.

The ramifications of this study are especially pertinent for sports scientists, coaches, and athlete development initiatives. The results underscore the necessity of conducting regular and thorough evaluations of body composition and physical fitness within athlete training programs. Secondly, the data provide empirical standards to facilitate the creation of personalized training regimens customized by gender, weight class, and performance objectives. Third, the results promote a more empirical methodology for talent discovery and athlete assessment in the sport. This study fortifies the scientific basis for performance enhancement in martial arts and provides practical recommendations for enhancing Indonesia's competitive standing in international Pencak Silat tournaments.

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