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Anthropometric Determinants of Body Mass Index in Young Pencak Silat Athletes: The Influence of Gender and Somatotype

*Authors' Contribution: A – Study design; B – Data collection; C – Statistical analysis; D – Manuscript Preparation; E – Funds Collection

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Abstract

Nutritional status is crucial for enhancing athletic performance in Pencak Silat, which demands strength and optimal body proportions. The objective of this research was to examine the influence of gender on body mass index (BMI) among young Pencak Silat athletes and to assess the impact of anthropometric variables on BMI. A total of 38 athletes were assessed for height, weight, body composition, and somatotype. The statistical analysis comprised Pearson correlation, independent t-test, one way ANOVA, and multiple linear regression. The findings indicate that there were no significant disparities in BMI between both genders ($p = 0.113$). Most of athletes categories as mesomorphic (57.9%), followed by ectomorphic (36.8%) and endomorphic (5.3%). Regression analysis indicates that body weight ($\beta = 0.347$; $p < 0.0001$) exerts a substantial positive influence on BMI. In contrast, height demonstrates a significant negative influence ($\beta = -0.247$; $p < 0.001$). Additionally, age and gender are not significant factors towards BMI. These findings underscore the inadequacies of BMI as the exclusive measure of athletes' nutritional status and highlight the necessity of incorporating anthropometric evaluation and somatotype profile. A multidimensional evalutions may help coaches and sport nutrisionist to design effective training and nutrition strategies for long term-athletes development (LAD).

Keywords: anthropometry; body mass index; nutritional status; pencak silat; somatotype

1. Introduction

Anthropometric and nutritional assessments play crucial roles in competitive sports. Body composition monitoring using simple anthropometric indices like skinfold measurements and lean mass index can effectively track changes in athletes(Bonilla et al., 2022). Nutritional intake and energy availability significantly impact athletes' cognitive and physical performance, with deficits potentially leading to Relative Energy Deficiency in Sports (RED-S) (M. et al., 2025). Studies have identified specific anthropometric variables that distinguish silat athletes from non-athletes, including height, weight, BMI, and sitting height (Doewes, 2025). Leg length has been found to positively correlate with the speed of sabit kicks in silat athletes (Wijaya et al., 2024).

Building on these anthropometric indicators, somatotype assessment offers a more nuanced approach to evaluating athletes' physique by classifying body build into three components, namely endomorphy (relative fatness), mesomorphy (muscularity), and ectomorphy (linearity and leanness). Originally developed by Sheldon and later refined through the Heath–Carter method, somatotyping provides a broader understanding of body composition beyond simple indices like BMI. In sports science,

identifying somatotype profiles can reveal morphological advantages that align with the specific demands of a sport. For example, higher mesomorphic scores are often linked to greater strength and power, while ectomorphic tendencies may benefit endurance performance. When integrated with nutritional and other anthropometric data, somatotype profiling enables a more targeted approach to training and dietary planning, ultimately supporting peak competitive performance (Baranauskas et al., 2015; Ciftci & Kurtoglu, 2023; Martínez-Mireles et al., 2025; Toselli & Campa, 2018).

In the context of Pencak Silat, a martial art that demands a balance of strength, agility, and optimal body proportions, such comprehensive body composition evaluations become especially relevant. Anthropometric and body composition evaluation play a crucial role in Pencak Silat, a competitive martial art requiring strength, agility, and optimal body proportions. Studies have identified key physical characteristics of successful athletes, including height, weight, BMI, body fat percentage, muscle percentage, and somatotype (Doewes, 2025; Kusnaedi et al., 2024; Vybornaya, 2022). Tailored norms and weightings for physical tests have been developed to assess and improve performance in early age practitioners (Nurhidayah et al., 2024).

In Indonesia, coaches often rely solely on Body Mass Index (BMI) as an indicator of athletes' nutritional status. However, BMI does not differentiate between fat mass and muscle mass, which may result in biased assessments, particularly when comparing male and female athletes. This limitation can lead to suboptimal training and nutritional strategies, especially in sports where body composition plays a crucial role in performance.

Existing studies on BMI and gender differences are predominantly conducted in the general population or in popular sports such as soccer, running, and taekwondo (Jeon et al., 2020; Toro-Román et al., 2023; Wang et al., 2020). However, there is a scarcity of scientific data focusing on young Pencak Silat athletes in Indonesia, and studies employing comprehensive statistical approaches such as ANOVA to control for relevant covariates remain limited. This study aims to investigate the effect of gender on BMI values in young Pencak Silat athletes. Additionally, it examines whether anthropometric variables exert a greater influence on BMI than gender, thereby providing deeper insight into the determinants of nutritional status in this specific athletic population.

2. Method

2.1 Participants and Data Collection

This study investigates the effect of gender on BMI values in young Pencak Silat athletes in Bandung using cross sectional design. Data collections were conducted towards 39 Pencak Silat athletes from Bandung City of West Java Indonesia. The study's inclusion criteria included athletes who were free from infectious diseases, not engaged in a weight management program, and able to take part actively in data collection procedures. Athletes who failed to complete the questionnaire or were absent during data collection were not included in this study.

Information was gathered to collect data regarding sex, age, age of début, height, weight, body composition (percentage of fat mass and muscle mass), somatotype category, and body mass index (BMI). The data were obtained from the athletes' physical assessments and organized in an Excel spreadsheet, which was subsequently cleaned and prepared for statistical analysis using IBM SPSS Statistics (Version 26). This study has been approved by the Health Research Ethics Committee Faculty of Medicine, Universitas Muhammadiyah Surakarta with number of 5847/B.2/KEPK-FKUMS/IX/2025.

2.2 Variables and Measurements

The variables studied in this research include age and age of debut, height and weight, sex, BMI, and somatotype. Height was measured to the nearest 0.1 cm using a stadiometer (Seca), and body mass was recorded to the nearest 0.1 kg using a digital scale. Skinfold thickness was measured with a Harpenden caliper to the nearest 0.2 mm. Bone breadths were measured using a sliding caliper, while girths were measured with a metline (Seca). Somatotype was calculated using the Heath Carter anthropometric method, which classifies physique into three components: endomorph, mesomorph, and ectomorph. The assessment involved the measurement of height, body mass, skinfold thickness (triceps, subscapular, supraspinal, and medial calf), bone breadths (humerus and femur), and limb girths (flexed arm and calf).

Measurements were conducted by trained enumerators with a background in nutrition science following the International Society for the Advancement of Kinanthropometry (ISAK) standards. Each measurement was taken twice, and the average value was used. Somatotype components were calculated using the Heath–Carter equations to obtain endomorphy, mesomorphy, and ectomorphy scores, which were then interpreted according to established reference categories (Carter J.E. Lindsay & Honeyman Barbara Heath, 1991)

2.3 Data Analysis

Descriptive statistics were calculated for all numerical variables. Normality of distribution was assessed using the Shapiro–Wilk test. Pearson correlation analysis was conducted to examine relationships among continuous variables. An independent samples t-test was used to compare BMI between male and female athletes. One-way ANOVA was applied to assess differences in BMI across somatotype categories. Lastly, multiple linear regression was performed to predict BMI from weight, height, and age. The significance level was set at $p < 0.05$.

3. Result

3.1 Descriptive Statistics

Characteristic of athletes based on agem debut age, height, and BMI was described in Table 1. Descriptive analysis revealed that the athletes' average age was 19.76 years, indicating that most athletes were in the late adolescence to young adulthood age group. The athletes had a mean height of 161.61 cm, mean weight of 57.52 kg, and mean BMI of 21.86 kg/m². The standard deviations indicate a relatively homogeneous group. The average debut age was 12.66 years, suggesting that most athletes began training from an early age. Body Mass Index (BMI) parameter has mean of 21.86 kg/m² (SD=2.68), ranging from 18.41 to 29.63. Most athletes were in the normal to overweight nutritional status category.

Table 1. Respondent characteristics of age, debut age, height, and BMI.

Variable	Mean	Std. Dev.	Min	Max
Age	19.76	3.31	15	29
Debut age	12.66	3.87	7	22
Height (cm)	161.61	7.42	148.3	178.8
Weight (kg)	57.52	11.21	42.6	90.6
BMI	21.86	2.67	18.41	29.63

Of the total 38 Pencak Silat athletes analyzed, 17 (44.7%) were male athletes, while 21 (55.3%) were female athletes. The majority of Pencak Silat athletes fell into the mesomorph category, with 22

athletes (57.9%), followed by 14 athletes (36.8%) in the ectomorph category, and 2 athletes (5.3%) in the endomorph category.

Table 2. Respondent characteristic of sex and somatotype

Variable		Frequency	Percent
Sex	Male	17	44.7
	Female	21	55.3
	Total	38	100.0
Somatotype	Ectomorph	14	36.8
	Mesomorph	22	57.9
	Endomorph	2	5.3
	Total	38	100.0

The Shapiro–Wilk test was performed to assess whether the distribution of the numerical data followed a normal distribution. The analysis showed that all continuous variables had p-values greater than 0.05, indicating that the data were approximately normally distributed (data not displayed).

Pearson correlation analysis in Table 3 was conducted to determine association between numerical variables. A positive correlation value indicates a direct relationship, whereas a negative value indicates an inverse relationship. The results of the analysis in Table 3 show a positive relationship with high strength between variables.

Table 3. Correlation analysis of age, weight, height, and BMI

Variable	Age	Height	Weight	BMI
Age	1	0.15484	0.17002	0.13992
Height	0.1548	1	0.79652	0.47143
Weight	0.1700	0.79651	1	0.90611
BMI	0.1399	0.47149	0.90613	1

To investigate the gender-based BMI difference, analysis was then conducted using the Independent Samples T-Test. Correlation analysis using independent samples t-test of BMI comparison between male and female athletes revealed no statistically significant difference ($t = 1.65$, $p = 0.113$), with male athletes having a higher mean BMI (22.69) than female athletes (21.19). To examine whether there were differences in BMI values among somatotype categories, a one-way ANOVA was performed. If the p-value is less than 0.05, it indicates that BMI differs significantly between somatotype groups. The results from Table 4 showed that BMI did not differ significantly among somatotype categories ($F = 2.54$, $p = 0.093$).

Table 4. Analysis results of one-way ANOVA

Variable	Sum of square	df	F	PR(>F)
Somatotype category	33.617	2	2.543	0.093
Residual	231.359	35		
Total	264.977			

Linear regression analysis was conducted to develop a BMI model using weight, height, and age as predictors. The regression model significantly predicted BMI ($R^2 = 0.99$, $p < 0.001$). Weight had a positive and statistically significant contribution to BMI ($\beta = 0.347$, $p < 0.000$), while height showed

a significant negative effect (β = -0.247, p < 0.000). Age was not a significant predictor (β = -0.001, p = 0.958).

Table 5. Multiple linear regression analysis

Variable	β	Std.Err.	t	P Value
Constant	41.847	1.2024	34.7997	3.597e-28
Weight	0.347	0.005927	58.4627	1.055e-35
Height	-0.247	0.008932	-27.6419	6.96e-25
Age	-0.0001	0.0122	-0.05312	0.958

Overall, the descriptive and inferential analyses showed that most of the athletes had normal BMI values, with mesomorphic somatotypes being predominant. Body weight was a strong positive predictor of BMI, whereas height was negatively associated. On the other hand, no significant differences in BMI were found between sexes or across somatotype categories.

Discussion

This study investigated the influence of sex and anthropometric factors on Body Mass Index (BMI) among young Pencak Silat athletes. The primary finding was that sex did not significantly affect BMI, even when adjusting for covariates such as age, body weight, and height through ANOVA. These results are consistent with previ-ous research indicating that BMI differences between male and female athletes tend to diminish when controlling for body composition and training adaptations (Ackland et al., 2012). This suggests that in high-intensity, skill-based sports such as Pencak Silat, the physiological adaptations driven by consistent training may outweigh sex-based morphological differences, leading to comparable BMI values between male and female athletes.

The results from the ANOVA suggest that BMI variation is primarily driven by quantifiable anthropometric metrics, particularly body weight and height. Notably, body weight exhibited a positive and significant effect on BMI, while height showed a negative and significant association. These findings reflect the mathematical structure of BMI and reinforce the need to interpret it within the context of specific anthropometric profiles, especially in trained athletic populations (Nevill et al., 2006). For instance, athletes with similar BMI values may present very different body compositions, one being predominantly mesomorphic with high muscle mass, and another being more endomorphic with higher fat mass, thus leading to different implications for performance and conditioning (Rogers et al., 2023).

Furthermore, the lack of significant sex differences aligns with findings in combat and aesthetic sports, where both sexes undergo similar training stimuli and selection pressures, potentially leading to convergent physical adaptations (Langan-Evans et al., 2011). Despite this, a medium effect size (Cohen's d = 0.56) was observed, suggesting a practically relevant difference that may warrant further investigation in larger samples or with additional physiological indicators. This effect size could be particularly important when considering weight-category sports, where even small differences in body composition can influence competitive readiness and strategy (Milošević et al., 2024).

Our findings highlight the limitations of using BMI as a standalone measure for athlete assessment. As recommended by International Olympic Comitee, comprehensive athlete evaluation should incorporate somatotype, body fat percentage, and lean mass to accurately capture physical readiness (Ackland et al., 2012). In this study, somatotype analysis revealed that most athletes were mesomorphic (57.9%), followed by ectomorphic (36.8%) and endomorphic (5.3%). The dominance of mesomorphic

profiles is consistent with the biomechanical and physiological demands of Pencak Silat, which relies on muscular strength, agility, and explosive movements. Previous studies in combat sports have similarly linked higher mesomorphy scores with improved power output, striking force, and agility (Franchini et al., 2014; Kusnaedi et al., 2024).

From a practical standpoint, integrating somatotype assessment into regular athlete monitoring can help coaches tailor training programs according to morphological strengths and weaknesses. For example, mesomorphic athletes may benefit from optimizing explosive power and speed, whereas ectomorphic athletes might require flexibility, long jump, sprint, and reaction time (Terzi & Kalkavan, 2024). Additionally, endomorphic athletes may benefit from conditioning programs aimed at improving body composition without compromising strength and stability (Stone et al., 2024).

Finally, these findings reinforce the importance of a multidimensional approach to athlete assessment. Beyond anthropometry, incorporating functional performance tests, dietary monitoring, and longitudinal tracking can provide a more accurate representation of an athlete's readiness and long-term development. Future research should explore the interaction between somatotype, functional performance, and sport-specific technical skills in Pencak Silat to better inform athlete selection and training periodization. Longitudinal studies with larger and more diverse samples are recommended to examine how anthropometric and somatotype profile interact with training adaptation and performance. Integrating nutritional intake and functional performance measurement may provide a more comprehensive understanding of athlete's development.

4. Conclusion and Recommendation

This study highlights the limitations of relying solely on BMI for assessing the nutritional status of young Pencak Silat athletes. While BMI values in this cohort generally fell within the normal range, somatotype profiling revealed a predominance of the mesomorphic type, which aligns with the physical demands of the sport. Regres-sion analysis demonstrated that weight and height significantly influenced BMI, whereas gender and age were not significant predictors. These findings emphasize the importance of incorporating detailed anthropometric and somatotype assessments alongside BMI to obtain a more accurate evaluation of athletes' physical readiness. Implementing such comprehensive assessments can guide coaches and sports nutritionists/dietitians in designing individualized training and nutrition strategies, ultimately enhancing performance and supporting long-term athlete development. As one of the first studies on young pencak silat athletes, these findings offer important implications for athletes monitoring and preparation at both national and international level. Future research should explore longitudinal monitoring of somatotype and anthropometric parameters to track developmental changes and optimize preparation for competitive performance.

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Conflict of interest

The authors declare that there is no conflict of interest regarding the publication of this article.

References

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