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SPORTS SCHOOL TRAINING MANAGEMENT: CORRELATION BETWEEN BODY MASS INDEX AND THE PHYSICAL CONDITION OF KARATE ATHLETES

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Abstract

This study aims to analyze the effect of Body Mass Index (BMI) on the physical condition of karate athletes at the Riau Province Special Sports School. The physical conditions measured include arm and abdominal muscle strength, endurance, agility, flexibility, and leg muscle power. The research method used a quantitative approach with a correlational design. The sample consisted of 9 active karate athletes (5 female and 4 male) selected through purposive sampling. Data were collected through BMI measurements and a series of physical fitness tests such as push-ups, sit-ups, beep tests, Illinois Agility Runs, sit and reach tests, and standing board jumps. Descriptive analysis results showed that 89% of athletes had a normal BMI, while 11% were underweight, with no overweight or obese athletes. There was a significant relationship between BMI and flexibility (p=0.032; r=0.711), indicating that athletes with normal BMI had better flexibility than underweight athletes. Agility showed a positive but insignificant relationship with BMI (p=0.429; r=0.303). Endurance, arm and abdominal muscle strength, and leg muscle power did not show a significant relationship with BMI. In conclusion, BMI is an important indicator in supporting athletes' flexibility, but it does not directly affect other aspects of physical fitness. Monitoring BMI and holistic training programs are recommended for optimizing karate athletes' performance.

INTRODUCTION

Physical fitness is an important element in supporting the performance of karate athletes. High-level karate athletes require excellent physical condition to achieve maximum results in competition. Optimal physical condition includes muscle strength, balance, and cardiovascular endurance, which form the basis for athlete performance at the national and international levels.

Body Mass Index (BMI) is often used as a simple tool to assess a person's nutritional status and physical condition, including athletes (Prentice & Jebb, 2001). BMI helps identify a person's weight condition, such as being overweight or obese, which can affect physical performance. For athletes, nutritional status is very important to support physical activity and maintain a proportional body weight, so that they can perform optimally during training and competition (Latifah et al., 2019). Adjusting body weight based on the needs of athletes is key to maintaining fitness and improving their abilities on the field. To maintain stable high performance, one simple way to assess an athlete's optimal condition is by monitoring their BMI.

Aerobic and anaerobic capacity play an important role in supporting the performance of karate athletes. Aerobic capacity helps prevent fatigue during training and speeds up the recovery process between two competition sessions (Chaabene et al., 2012). Meanwhile, anaerobic capacity, especially explosive muscle strength, is needed to produce the fast and powerful movements that are characteristic of karate (Něma & Ružbarský, 2023).

Muscle strength, particularly explosive power, is a key element that enables athletes to perform techniques with high speed and effectiveness. Research shows significant differences in maximum strength and speed between national and international athletes, indicating the importance of muscle explosive power in achieving peak performance (Chaabene et al., 2012; Przybylski et al., 2021).

Flexibility is also a crucial factor in supporting the execution of karate techniques, especially high kicks and fast movements with optimal range of motion. Karate athletes generally have better hip and knee flexibility than non-athletes (Chaabene et al., 2012; Przybylski et al., 2021). In addition, ideal body composition, such as high muscle mass and low body fat, contributes to technical efficiency and fighting strength. Low body fat also correlates with higher anaerobic capacity, providing an advantage in karate competitions (Katić et al., 2005).

Research conducted in Batu City shows that the physical condition of martial artists, including karate practitioners, has a significant relationship with BMI and body fat levels. Athletes with ideal BMI and body fat levels demonstrate better muscle strength, balance, and endurance (Yunus et al., 2022). Additionally, 10 weeks of karate training in elementary school children was found to be effective in reducing the fat-free mass index (FFF), improving posture, and distributing fat more symmetrically (Rutkowski et al., 2020).

Elite athletes generally have a mesomorphic-ectomorphic somatotype with a lower body fat percentage than amateur athletes. Although these differences are not statistically significant, elite athletes show an increase in lean muscle mass during the preparation period, reflecting efforts to maximize skeletal muscle while minimizing body fat (Giampietro et al., 2003; Gligoroska et al., 2016). Studies have also found that BMI, along with motor skills and physical self-perception, contributes significantly to the physical activity of adolescent karate athletes. Factors such as flexibility, physical self-confidence, and self-perception have a positive influence in supporting the activity and performance of young athletes (Ivanović & Ivanović, 2022).

Given the importance of BMI as an indicator of health and physical condition, this study was conducted to analyze the relationship between BMI and the physical condition of karate athletes at the Riau Province Special Sports School. This study is expected to provide insight into the role of BMI in supporting athlete performance and serve as a reference in sports coaching, particularly karate, at the regional and national levels.

METHODS

This research design uses a quantitative approach with a correlational design to analyze the relationship between BMI and the physical condition of karate athletes. The research population consisted of karate athletes from the Riau Province Special Sports School, comprising 5 female athletes and 4 male athletes. The sampling technique used purposive sampling, where all athletes were included in the sample. The variables in this study consisted of Independent Variables: Body Mass Index (BMI) and Dependent Variables: Physical condition, including hand strength, abdominal strength, agility, endurance, and flexibility. The instruments used in this study were: BMI measurement: calculated using body weight (kg) divided by height squared (m^2). Physical condition measurements: Strength: push-up and sit-up tests, Agility: agility ilionis run, Endurance: beep test, and Flexibility: sit and reach test. The research procedure was carried out in three stages: measurement of body weight and height to calculate BMI. This was followed by physical tests to measure strength, agility, endurance, and flexibility. The data obtained was then analyzed descriptively and using Pearson's correlation test to identify whether there was a relationship between BMI and each component of the physical condition of SKO Riau karate athletes. This study used statistical tests with Statistical Product and Service Solution (SPSS) version 25.0.

Table 1. Research Instruments and Measurement Metrics

Component Measured	Instrument/Test	Used Measurement	Metrics Purpose in Research Context
		Anthropometrics	
Body Mass Index (BMI)	Calculation (Weight/Height²) kg/m2	(Categorical: Underweight, Normal, Overweight)	To evaluate the relationship between body composition and various physical fitness parameters.
		Physical Condition	
Flexibility	Sit and Reach Test	Centimeters (cm)	To measure the elasticity of the lower back and hamstring muscles, critical for high-range movements like kicks.
Agility	Illinois Agility Run Test	Time (seconds)	To assess the ability to change direction and speed quickly, essential for responsive martial arts movements.
Endurance	Bleep Test (or Multi-Stage Fitness Test)	Level and Shuttle Number (VO 2max Estimate)	To estimate aerobic capacity, crucial for maintaining intensity during matches and training.
Arm Muscle Strength	Push-up Test (Maximum Repetitions)	Count (Repetitions)	To measure the strength and endurance of the upper body muscles, important for defensive blocks and powerful punches.
Abdominal Muscle Strength	Sit-up Test (Maximum Repetitions)	Count (Repetitions)	To measure core strength, which is vital for maintaining balance, transferring power, and preventing injury.
Leg Muscle Power	Standing Board Jump Test (or Standing Long Jump)	Distance (cm)	To measure the explosive power of the lower body, necessary for jumping and dynamic kicking techniques.

RESULTS & DISCUSSIONS

Results

This study involved nine active karate athletes at the Riau Province Special Sports School, consisting of five female athletes and four male athletes. Descriptive analysis showed variations in the following physical parameters:

Table 2. Descriptive Data

Descriptive Statistics

Indicator	N	Minimum	Maximum	Sum	Mean	Std. Deviation	Variance
Push Up	9	.00	61.00	330.00	36.6667	16.53028	273.250
Sit Up	9	36.00	63.00	448.00	49.7778	9.07989	82.444
Bleeb Test	9	39.60	53.70	395.60	43.9556	4.47440	20.020
Agility Ilionis Run	9	17.04	19.09	160.51	17.8344	.71348	.509
Seat And Reach	9	4.00	24.00	141.00	15.6667	6.34429	40.250
Standing Board Jump	9	169.00	237.00	1755.00	195.0000	23.85896	569.250
Berat Badan	9	48.00	65.00	486.00	54.0000	5.00000	25.000
Tinggi Badan	9	1.55	1.70	14.75	1.6389	.04807	.002
Indeks Masa Tubuh	9	17.30	22.49	180.88	20.0980	1.49894	2.247
Valid N (Listwise)	9						

Source: Author

Descriptive analysis shows variations in athletes' physical condition performance based on measurement results. For the arm muscle strength test (push-ups), athletes recorded an average of 36.67 times with a range of 0 to 61 times. In the abdominal muscle strength test (sit-ups), athletes achieved an average of 49.78 times with a range of 36 to 63 times. In terms of endurance, which was measured using the beep test (VO2max), the average score for athletes was 43.96 ml/kg/min, ranging from 39.6 to 53.7 ml/kg/min. For the agility test using the Illinois Agility Run, the average time achieved was 17.83 seconds with a range of 17.04 to 19.09 seconds. The flexibility test using the sit and reach showed an average result of 15.67 cm with a range of 4 to 24 cm. Meanwhile, in the leg muscle power test using the standing board jump, the average distance achieved was 195 cm with a range of 169 to 237 cm. Body Mass Index (BMI) measurements showed an average of 20.10 kg/m², with a range of 17.3 to 22.49 kg/m.

Table 3. BMI Distribution Based on Criteria

No.	Classification	BMI	Total	F
1	Underweight	<18.5	1	11%
2	Normal	18.5 - 22.9	8	89%
3	Overweight	23.00 - 24.9	0	0%
4	Obesity I	25.0 - 29.9	0	0%
5	Obesity II	> 30.0	0	0%

Source: Author

Based on BMI categories, 89% of athletes had a BMI in the normal category, while 11% were in the underweight category. No athletes were found to have a BMI in the overweight or obese category.

Table 4. Frequency Distribution of Karate Athletes' Physical Condition Components

No.	Components	Category				
		Very Good	Good	Fair	Poor	Very Poor
1	VO2max	33%	11%	33%	22%	0%
2	Arm Muscle Strength	11%	0%	56%	22%	11%
3	Abdominal Muscle Strength	33%	0%	67%	0%	0%
4	Agility	22%	0%	78%	0%	0%
5	Leg Muscle Power	11%	0%	11%	22%	56%
6	Flexibility	100%	0%	0%	0%	0%

Source: Author

The distribution of athletes' physical condition shows that in terms of endurance (VO2max), 33% of athletes are in the excellent category, 11% are good, 33% are average, and 22% are poor. In terms of arm muscle strength (push-ups), 11% are in the excellent category, 56% are average, 22% are poor, and 11% are very poor. Abdominal muscle strength (sit-ups) shows that 33% of athletes are in the very good category, and 67% are in the moderate category. In terms of agility (Illinois agility run), 22% of athletes are in the very good category, while 78% are in the moderate category. For leg muscle power (standing board jump), 11% of athletes were in the very good category, 11% in the average category, 22% in the poor category, and 56% in the very poor category. Meanwhile, athlete flexibility (sit and reach) showed that all athletes (100%) were in the very good category.

Table 5. Normality Test Results

Tests Of Normality

	Kolmogorov-Smirnov[a]			Shapiro-Wilk		
	Statistic	Df	Sig.	Statistic	Df	Sig.
Push-ups	.255	9	.095	.882	9	.165
Sit-ups	.137	9	.200*	.966	9	.858
Bleeb Test	.208	9	.200*	.870	9	.124
Agility Illinois Run	.154	9	.200*	.932	9	.498
Sit and Reach	.199	9	.200*	.951	9	.698
Standing Board Jump	.180	9	.200*	.909	9	.306
Body Mass Index	.148	9	.200*	.976	9	.943

*. This Is a Lower Bound of The True Significance.

A. Lilliefors Significance Correction

Source: Author

Normality testing using Kolmogorov-Smirnov and Shapiro-Wilk showed that all data were normally distributed (sig. > 0.05).

Table 6. Pearson Correlation Test Results

No.	Physical Condition Components of Karate	BMI		Description
		Sig. Value	Pearson Correlation	
1	VO2max (Bleeb Test)	0.744	-0.128	No Relationship
2	Arm Muscle Strength (Push-ups)	0.939	-0.03	No Relationship
3	Abdominal Muscle Strength (Sit-ups)	0.857	-0.071	No Relationship
4	Agility (Ilionis Agility Run)	0.429	0.303	Relationship Exists
5	Leg Muscle Power (Standing Board Jump)	0.499	-0.26	No Relationship
6	Flexibility (Sit and Reach)	0.032	0.711	No Relationship

Source: Author

Pearson's correlation test between BMI and physical condition components showed varying results. There was no significant relationship between BMI and endurance (VO2max) with a Sig. value of 0.744 (r = -0.128). Similarly, there was no significant relationship between BMI and arm muscle strength (Sig. 0.939, r = -0.030) or abdominal muscle strength (Sig. 0.857, r = -0.071). However, a positive relationship was found between BMI and agility with a Sig. value of 0.429 (r = 0.303), although this relationship was not significant. Meanwhile, there was a significant relationship between BMI and flexibility (Sig. 0.032, r = 0.711), indicating that athletes with a more ideal BMI had better flexibility. However, in terms of leg muscle power (standing board jump), no significant relationship was found with a Sig. value of 0.499 (r = -0.260). These results indicate that normal BMI supports optimal performance, especially in terms of flexibility. Athletes with underweight BMI showed limitations in several aspects, such as muscle strength and endurance. The absence of athletes with overweight or obese BMI limited the understanding of the impact of these categories on physical performance. Therefore, managing ideal BMI needs to be a concern in karate athlete training to ensure optimal physical performance in all components of physical condition.

Discussions

The results of this study provide an overview of the effect of Body Mass Index (BMI) on the physical condition of karate athletes at the Riau Province Special Sports School. In general, BMI shows a varied relationship with physical condition components such as flexibility, agility, endurance, arm muscle strength, abdominal muscle strength, and leg muscle power.

This study found a significant relationship between BMI and flexibility, with a Sig. value of 0.032 (r = 0.711). Athletes with normal BMI had better flexibility than athletes in the underweight category. This is in line with the study by Chaabene et al. (2012), which states that flexibility is very important in supporting technical movements such as high kicks in karate. Optimal flexibility supports a wider and more efficient range of motion, which is a competitive advantage for karate athletes.

A positive relationship was also found between BMI and agility, with a Sig. value of 0.429 (r = 0.303), although it was not significant. Athletes with normal BMI tended to be more agile in the Illinois Agility Run test. This finding is consistent with the study by Katić et al. (2005), which showed that body composition with ideal muscle mass supports fast and responsive movement in martial arts.

In terms of endurance (VO2max), arm muscle strength (push-ups), abdominal muscle strength (sit-ups), and leg muscle power (standing board jump), no significant relationship with BMI was found. This indicates that performance in these aspects is more influenced by other factors such as training programs, cardiorespiratory capacity, and explosive techniques. Research by Chaabene et al. (2012) and Němа & Ružbarský (2023) supports these findings, stating that muscle strength and endurance are more determined by specific training and its intensity than by anthropometric parameters such as BMI.

A total of 89% of athletes in this study had a BMI in the normal category, while 11% were in the underweight category. No athletes with overweight or obese BMI were found, so the impact of BMI on these categories could not be evaluated. Athletes with underweight BMI showed limitations in several aspects such as muscle strength and endurance, which is consistent with the findings of Yunus et al. (2022) that ideal BMI supports better physical performance.

This study emphasizes the importance of BMI management as part of karate athlete training. A normal BMI not only supports flexibility but is also a relevant health indicator in the context of athletic performance. These findings highlight the need for a holistic approach to athlete training, which includes data-driven training programs, nutrition management, and physical recovery to optimize their overall Performance.

The qualitative nature of the existing study, while providing valuable contextual insights, presents several methodological and scope limitations that must be acknowledged. First, the study design is cross-sectional, capturing the relationship between BMI and physical condition at a single point in time. This prevents the establishment of a causal relationship; we cannot conclude that maintaining a normal BMI causes better flexibility, only that the two are correlated. A longitudinal study is required to track changes in physical condition as athletes' BMIs fluctuate over a training cycle.

Second, the limited variability in the sample BMI significantly restricts the generalizability of the findings. With 89% of athletes in the normal category and 11% in the underweight category, the study was unable to evaluate the impact of overweight or obesity on the physical components. Given that high BMI is often correlated with reduced agility and cardiovascular endurance in the general population, this represents a major gap. Future research must utilize a larger, more diverse sample that includes athletes from various competitive levels or age groups to capture a broader spectrum of body compositions.

Third, the study relied solely on Body Mass Index (BMI), which is an anthropometric measure with inherent limitations. BMI does not differentiate between fat mass and fat-free mass (muscle mass). The lack of correlation found between BMI and strength/endurance components may be misleading, as these components are predominantly influenced by muscle mass. For a more accurate understanding of body composition's effect on performance, future research should incorporate advanced body composition analysis methods, such as Dual-Energy X-ray Absorptiometry (DXA) or bioelectrical impedance analysis (BIA), to provide precise data on fat percentage and lean muscle mass.

Based on these limitations, a comprehensive follow-up action plan is proposed to deepen the understanding and optimize the training protocol for SKO Riau athletes. The priority is the Implementation of Longitudinal Performance Tracking. This involves establishing a dedicated database to monitor athletes' body composition (using BIA or skinfold caliper testing) and physical condition metrics (flexibility, strength, VO2 max) at three key time points: pre-season, mid-season, and post-competition. This longitudinal approach will allow coaches to determine individualized optimal body composition for peak performance.

The second key action is the Development of a Data-Driven Nutritional Intervention Program. The finding that 11% of athletes are underweight, coupled with reported limitations in strength and endurance, necessitates targeted nutritional support. This program will involve a collaboration between the coaching staff and a certified sports nutritionist to educate athletes and implement personalized meal plans focused on adequate calorie and protein intake to optimize lean muscle mass, directly addressing the underlying factors of strength and endurance not fully captured by BMI alone.

Finally, the non-significant but positive trend found for agility suggests a need to refine training programs. The recommended action is to Integrate Sport-Specific Physical Literacy Training. This involves redesigning warm-up and conditioning drills to explicitly target the psychological and cognitive aspects of physical literacy, enhancing agility and responsiveness through varied movement environments and decision-making drills. This holistic approach,

informed by the initial findings on flexibility and agility, aims to translate a normal BMI into measurable, competitive advantages in complex karate movements.

CONCLUSION

This study shows that BMI plays an important role in the physical condition of karate athletes at the Riau Province SKO. Athletes with normal BMI tend to have better flexibility, which is one of the main supporting factors in karate performance. However, no significant relationship was found between BMI and endurance, muscle strength, and leg muscle power. These results confirm that BMI is a health indicator that needs to be considered, but physical performance development is also influenced by training programs and other factors such as nutrition and training patterns. Based on the research results, regular monitoring of Body Mass Index (BMI) is necessary to ensure athletes are in the ideal category that supports optimal physical performance. Training programs also need to be tailored to the physical condition of individual athletes, especially those in the underweight category, with a focus on increasing muscle mass and flexibility. A holistic coaching approach, involving diet management, training intensity, and recovery, is recommended to maximize athlete performance. Further research with a larger population and additional variables, such as body composition and nutritional intake, is needed to provide more comprehensive insights.

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