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Physical Condition Mapping Model of Karate Athletes Based On Body Mass Index (BMI)

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ABSTRACT

This study aims to analyze the influence of Body Mass Index (BMI) on the physical condition components of karate athletes at the Sports Special School (SKO) Riau Province, with the underlying goal of establishing a parameter-based model for mapping optimal physical readiness. A quantitative correlational design was employed, utilizing a *purposive sample* of nine active karate athletes (five female, four male)[2]. Data were gathered by calculating BMI (kg/m^2) and administering a battery of tests for arm strength, abdominal strength, agility, endurance (VO2 max, flexibility, and leg muscle power. Analysis used descriptive statistics and the Pearson correlation test. The findings indicate that 89% of athletes had normal BMI. A significant positive correlation was exclusively observed between BMI and flexibility, (SIG. = 0.032 r = 0.711), suggesting that normal BMI strongly supports better flexibility, a critical competitive advantage in karate. Conversely, no significant relationship was found with endurance, muscular strength, or power. The results validate BMI's role as a key health indicator and parameter for developing a physical condition monitoring model. It is recommended that routine BMI monitoring and holistic training adjustments, focusing on strength and muscle mass for *underweight* athletes, be implemented to ensure optimal performance.

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

Physical fitness is a crucial element that underpins and supports the performance of karate athletes. High-level karate athletes require excellent physical condition, including muscle strength, balance, and cardiovascular endurance, to achieve maximum results in competitions, both nationally and internationally. To maintain stable, high-performance performance, one simple way to assess an athlete's optimal condition is through monitoring their Body Mass Index (BMI). BMI serves as a simple tool to assess an individual's nutritional status and physical condition. Ideal nutritional status is crucial for athletes to

support physical activity, maintain a proportional body weight, and ultimately support optimal performance during training and competition. Therefore, adjusting body weight and monitoring BMI are key to maintaining fitness and improving an athlete's abilities.

A karate athlete's physical capacity is influenced by various components, including aerobic and anaerobic capacity. Aerobic capacity is crucial for preventing fatigue and accelerating recovery between matches. Conversely, anaerobic capacity, particularly explosive muscle strength, is essential for producing the fast and powerful movements that are the hallmark of karate. Muscle strength, particularly explosive power, is key for athletes to execute techniques with high speed and effectiveness. Research has shown significant differences in maximal strength and speed between national and international athletes, demonstrating the importance of muscular explosiveness in achieving peak performance (Chaabene et al., 2012; Przybylski et al., 2021). Furthermore, flexibility is also a crucial factor supporting the execution of karate techniques, particularly high kicks and fast movements with optimal range of motion. Karate athletes generally exhibit better hip and knee flexibility than non-athletes (Chaabene et al., 2012; Przybylski et al., 2021).

Ideal body composition, with high muscle mass and low body fat percentage, contributes to technical efficiency and fighting power. A low body fat percentage is positively correlated with higher anaerobic capacity, providing an advantage in karate competitions (Katić et al., 2005). A previous study in Batu City found that the physical condition of martial arts athletes, including karate athletes, was significantly related to BMI and body fat levels, with athletes with ideal BMI and body fat levels demonstrating better muscle strength, balance, and endurance (Yunus et al., 2022). However, elite athletes tend to have a mesomorphic-ectomorphic BMI composition with a lower body fat percentage compared to amateurs, and elite athletes show increased lean muscle mass during the preparation period (Giampietro et al., 2003; Gligoroska et al., 2016). Another study also found that BMI, along with motor skills and physical self-perception, significantly contributes to the physical activity of adolescent karate athletes (Ivanović & Ivanović, 2022). However, research focusing on the relationship between BMI and each component of physical condition in detail and separately at the regional development level, particularly at the Special Sports School (SKO) in Riau Province, is still limited. This gap limits the ability of coaches and trainers to use BMI as a valid predictive tool in developing specific and individualized training programs.

Seeing the importance of BMI as an indicator of health and physical condition and the need to validate the role of BMI specifically on each component of an athlete's physical condition, this study was conducted to analyze the relationship between BMI and the physical condition of karate athletes at the Special Sports School (SKO) of Riau Province. This study aims to test and map which physical condition components are most influenced by BMI, so as to produce a Karate Athlete Physical Condition Mapping Model Based on Body Mass Index (BMI). The novelty of this study lies in the detailed correlation analysis between BMI and six specific physical condition components of karate athletes in the population of athletes trained at SKO Riau, which will be a practical reference in sports development at the regional and national levels. The proposed hypothesis is that

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there is a significant relationship between Body Mass Index (BMI) and one or more specific physical condition components (strength, endurance, agility, flexibility, and leg muscle power) in karate athletes at SKO Riau Province.

METHODS

This study uses a quantitative approach with a correlational design, which aims to analyze the relationship between Body Mass Index (BMI) and the components of the physical condition of karate athletes. The population of this study was all karate athletes at the Special Sports School (SKO) of Riau Province, consisting of 5 female athletes and 4 male athletes. The sampling technique used was purposive sampling, where all athletes were used as research samples. The independent variable in this study was Body Mass Index (BMI), while the dependent variables included hand strength, abdominal strength, agility, endurance, flexibility, and leg muscle power.

RESULTS AND DISCUSSION

Result

This study involved 9 active karate athletes at the Special Sports School (SKO) of Riau Province, with a composition of 5 female athletes and 4 male athletes. Data were collected through Body Mass Index (BMI) measurements and a series of physical condition tests, including arm muscle strength (push-ups), abdominal muscle strength (sit-ups), endurance (beep test), agility (Illinois Agility Run), flexibility (sit and reach), and leg muscle power (standing board jump). Descriptive analysis showed variations in performance across all physical condition indicators. The average BMI score of the athletes was 20.10 kg/M^2, with the majority (89%) in the normal category, and the remainder (11%) included in the underweight category. No athletes were found to be overweight or obese.

Table 1.
Descriptive statistics of all measured variables

Measurement Indicators	N	Min.	Max.	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
Bleep Test	9	39.60	53.70	395.60	43.9556	4.47440	20.020
Agility Illinois 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
Weight	9	48.00	65.00	486.00	54.0000	5.00000	25.000
Height	9	1.55	1.70	14.75	1.6389	.04807	.002
Body Mass Index	9	17.30	22.49	180.88	20.0980	1.49894	2.247
Valid N (Listwise)	9						

Descriptive analysis shows variations in athletes' physical condition performance based on measurement results. For the arm muscle strength test (push-ups), the average

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athlete recorded 36.67 repetitions with a range of 0 to 61 repetitions. In the abdominal muscle strength test (sit-ups), the average athlete achieved 49.78 repetitions with a range of 36 to 63 repetitions. In the endurance aspect measured by the beep test (VO2max), the average athlete score was 43.96 ml/kg/min with a range of 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 through 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/m^2, with a range of 17.3 to 22.49 kg/m.

Table 2.
BMI Distribution Based on Criteria

No.	Classification	IMT	Amount	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%

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

Table 3.
BMI Distribution Based on Criteria

No.	Physical Condition Components	Category				
		Very Good	Good	Moderate	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%

The data presents the percentage distribution of athlete performance across six components of physical condition based on the assessment criteria. The majority of athletes demonstrated performance concentrated in the Moderate category for almost all components. Specifically, Abdominal Muscle Strength (67%) and Agility (78%) had the largest percentages in the Moderate category, with the remainder in the Very Good category and no athletes in the Poor or Very Poor categories. For Arm Muscle Strength, the majority (56%) were also in the Moderate category, although there were (22%) in the Poor category and (11%) in Very Poor. The distribution of VO2max was spread out, with (33%) in the Very Good category and (33%) in Moderate, but there were (22%) in the Poor category. Only the Flexibility component showed very superior results, where (100%) of athletes were in the Very Good category. In contrast, the Leg Muscle Power component showed the worst results, with a significant majority (56%) in the Very Poor category, and only (11%) achieved Very Good.

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Table 4.
Data Normality Test Results

	Kolmogorov-Smirnov[a]			Shapiro-Wilk		
	Statistic	Df	Sig.	Statistic	Df	Sig.
Push Up	.255	9	.095	.882	9	.165
Sit Up	.137	9	.200*	.966	9	.858
Bleeb Test	.208	9	.200*	.870	9	.124
Agility Ilionis Run	.154	9	.200*	.932	9	.498
Seat And Reach	.199	9	.200*	.951	9	.698
Standing Board Jump	.180	9	.200*	.909	9	.306
Indeks Masa Tubuh	.148	9	.200*	.976	9	.943

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

Table 5.
Pearson Correlation Test Results

No.	Physical Condition Components of Karate	IMT		Information
		Sig. Value	Pearson Correlation	
1	Vo2max (Bleep Test)	0.744	-0.128	There is no relationship
2	Arm Muscle Strength (Push Up)	0.939	-0.03	There is no relationship
3	Abdominal Muscle Strength (Seat Up)	0.857	-0.071	There is no relationship
4	Agility (Ilionis Agility Run)	0.429	0.303	There is a Relationship
5	Leg Muscle Power (Standing Board Jump)	0.499	-0.26	There is no relationship
6	Flexibility (Seat and Reach)	0.032	0.711	There is no relationship

Pearson 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 have a better level of flexibility. However, in the aspect 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 a normal BMI supports optimal performance, particularly in flexibility. Athletes with an underweight BMI showed limitations in several aspects, such as muscle strength and endurance. The absence of athletes with an overweight or obese BMI limits understanding of the impact of these categories on physical performance. Therefore, ideal BMI management needs to be a priority in the development of karate athletes to ensure optimal physical performance across all components of physical condition.

Discussion

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 Special Sports School (SKO) in Riau Province. In general, BMI showed varying relationships 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 a normal BMI had better flexibility than those in the underweight category. This is consistent with research by Chaabene et al. (2012), which stated that flexibility is crucial for 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 not significant. Athletes with a normal BMI tended to be more agile in the Illinois Agility Run test. These findings align with a study by Katić et al. (2005), which showed that body composition with ideal muscle mass supports fast and responsive movements in martial arts.

No significant correlations were found with BMI for endurance (VO2max), arm muscle strength (push-ups), abdominal muscle strength (sit-ups), and leg muscle power (standing board jumps). This indicates that performance in these aspects is more influenced by other factors such as training program, cardiorespiratory capacity, and explosive technique. Research by Chaabene et al. (2012) and Němа & Ružbarský (2023) supports these findings, stating that muscle strength and endurance are more determined by the specific training and its intensity than by anthropometric parameters such as BMI.

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

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

CONCLUSION

This study concludes that Body Mass Index (BMI) plays a significant and specific role in the physical condition of karate athletes in the Riau Province SKO. Critically, the results show that a normal BMI has a significant positive correlation only with flexibility, confirming that an ideal BMI is a key contributing factor to the performance of karate techniques requiring maximum range of motion. This finding advances scientific understanding by validating BMI not only as an indicator of general health but also as a specific performance parameter for flexibility in a martial arts context.

However, the results show that BMI does not significantly correlate with VO2max endurance, muscle strength, and leg explosiveness. This lack of correlation confirms

that performance in these areas is more determined by specific training programs, physiological capacity, and other non-anthropometric factors. Limitations of this study lie in the small sample size and the homogeneity of BMI (predominance of the normal category), which limits the ability to generalize the effect of BMI on other physical components or evaluate the impact of BMI in the overweight or obese categories. Overall, this study has advanced scientific knowledge by demonstrating the dual role of BMI as both a health indicator and a predictor of flexibility.

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