



Analysis of Leg Muscle Power and Vo2max on The Performance of Karate Athletes

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ABSTRACT

This study investigates the influence of leg muscle power and VO₂Max on the performance of karate athletes. Leg muscle power is essential for explosive actions such as kicking and rapid positional shifts, while VO₂Max reflects maximal aerobic capacity that supports endurance during matches. A quantitative descriptive method was employed through surveys and competition observations. The sample comprised six West Java Pelatda karate athletes who had competed at the national level. Instruments included the Multi-Stage Fitness Test (Beep Test) to measure VO₂Max, a Force Plate to assess leg muscle power, and a match observation rubric based on the 2024 WKF regulations. Results showed that three athletes achieved VO₂Max in the “excellent” category, while two athletes demonstrated leg muscle power in the “excellent” category. However, simple linear regression analysis revealed no significant effect of either VO₂Max or leg muscle power on performance, with significance values greater than 0.05. The findings suggest that karate performance is not determined solely by physical conditions but is also shaped by strategy, technique, and mental readiness. Coaches are therefore encouraged to develop more comprehensive training programs that integrate physical, technical, and psychological components.

Keywords: karate performance, VO₂Max, leg muscle power, athlete training

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INTRODUCTION

This study aims to analyze the effect of leg muscle power and VO₂Max on the performance of karate athletes. Although physical condition is widely recognized as a key factor in achieving athletic success, many high-performing athletes have not systematically measured these specific parameters. Previous studies have emphasized the importance of muscle power as a combination of strength and speed (Harsono, 1988), as well as the role of VO₂Max as a primary indicator of cardiorespiratory endurance (Samodra & Mashud, 2021). This research seeks to fill that gap by directly measuring and analyzing data from athletes, thereby providing empirical evidence to support more data-driven training programs. Accordingly, the main objective of this study is to quantitatively examine whether leg muscle

power and VO2Max have a significant effect on athlete performance, with the ultimate goal of offering more effective practical contributions to the field of coaching.

METHOD

This study employed a descriptive method with a quantitative approach to analyze the influence of leg muscle power and VO2Max on the performance of karate athletes, specifically focusing on leg muscle strength, VO2Max, and overall performance. The data collected were actual and factual, obtained through athlete surveys and match observations. The research design adopted was a "one-shot" model, meaning data were collected once at a specific point in time. After data collection, quantitative analysis was conducted to identify and interpret the results based on established norms. The population of this study consisted of six male karate athletes from the West Java regional training team (Pelatda) in Bandung. They were selected because they were considered to have good physical condition, motivation, and competitive records. A purposive sampling technique was applied, in which participants were deliberately chosen according to specific criteria. These criteria included being members of the Porda team, having good physical fitness, being scheduled to compete soon, and being male. To ensure accuracy, the study employed specific instruments. A force plate and a multi-stage bleep test were used to measure the research variables, namely leg muscle power and VO2Max, respectively. In addition, a performance observation rating scale was utilized to evaluate the athletes' performance.

RESULTS AND DISCUSSION

Results

Table 1. Physical Test Results

Name	Category	VO2Max (ml/kg/min)	Criteria	Leg Muscle Power (w/kg)	Criteria
AR	Kumite -67 Kg	53.6	Excellent	73	Excellent
HY	Kumite +84 Kg	47.8	Good	56	Poor
MT	Kumite -55 Kg	58.8	Excellent	76	Excellent
S	Kumite -84 Kg	44.0	Good	64	Good
RM	Kumite -60 Kg	55.3	Excellent	69	Good
IR	Kumite -75 Kg	47.5	Good	64	Good

The results presented in Table 1 indicate that the athletes generally demonstrated strong physical performance, with VO2Max values ranging from 44.0 to 58.8 ml/kg/min. Most athletes were categorized as “Excellent” or “Good,” reflecting a relatively high level of cardiorespiratory endurance. In terms of leg muscle power, the results varied more widely, with scores ranging from 56 w/kg (categorized as “Poor”) to 76 w/kg (“Excellent”). This variation suggests that while aerobic capacity was relatively consistent across participants, muscular power differed substantially among athletes. Interestingly, athletes with higher VO2Max values also tended to achieve higher scores in leg muscle power, as seen in athletes AR and MT, who both achieved “Excellent” in both parameters. In contrast, athlete HY showed a “Good” VO2Max score but a “Poor” rating in leg muscle power, indicating that endurance capacity does not always translate directly into explosive strength.

This finding is consistent with previous studies, which highlight that VO2Max and muscular power, although related, represent distinct physiological components (Bompa & Buzzichelli, 2019). In karate, cardiorespiratory endurance is essential to sustain performance throughout multiple bouts, while explosive leg power directly supports rapid kicking and stepping techniques (Iide et al., 2008; Chaabène et al., 2012). Overall, these findings emphasize the importance of balanced physical development. Athletes with lower scores in either VO2Max or muscle power may benefit from tailored training interventions to address these weaknesses, thereby optimizing their competitive performance. Previous research has shown that integrated conditioning programs combining aerobic and anaerobic training can enhance both endurance and explosive strength simultaneously (Franchini et al., 2011). Thus, for karate athletes, structured training regimens that develop both VO2Max and leg power are likely to provide the greatest benefits for overall performance.

Tabel 2. Result Observasi Perkelas

Name	Category	Babak 16 Besar	Quarter Final	Semi Final	Champion	Total Point	Champion
AR	<i>KUMITE</i> -67 kg	5 point <i>yuko</i>	-	-	-	5 poin	0
HY	<i>KUMITE</i> +84 Kg	-	5 <i>yuko</i>	5 <i>yuko</i>	8 <i>yuko</i>	18 poin	1
MT	<i>KUMITE</i> - 55 Kg	3 <i>yuko</i> , 1 wazari dan 1 <i>ippon</i>	2 <i>yuko</i> dan 1 <i>ippon</i>	-	2 <i>yuko</i> dan 1 <i>ippon</i>	18 poin	1

S	KUMITE -84 Kg	1 <i>yuko</i> dan 1 wazari	4 <i>yuko</i> , 1 wazari dan 1 <i>ippon</i>	3 <i>yuko</i>	3 <i>yuko</i>	18 poin	3
RM	KUMITE -60 Kg	4 <i>yuko</i> dan 1 <i>ippon</i>	4 <i>yuko</i> dan 1 wazari	1 <i>yuko</i> dan 1 wazari	2 <i>yuko</i>	18 poin	2
IR	KUMITE -75 Kg	1 wazari	3 <i>yuko</i> dan 1 wazari	2 <i>yuko</i>	4 <i>yuko</i>	13 point	3

Tabel 3. Result Kumite Group

Name	Category	KUMITE Group	Total Point
AR	KUMITE -67 kg	12 <i>yuko</i> 4 <i>ippon</i>	24
HY	KUMITE +84 Kg	8 <i>yuko</i> 4 waza-ri 1 <i>ippon</i>	19
MT	KUMITE - 55 Kg	4 <i>yuko</i>	4
S	KUMITE -84 Kg	9 <i>yuko</i> 3 waza-ri	15
RM . N	KUMITE -60 Kg	4 <i>yuko</i>	4
IR	KUMITE -75 Kg	2 <i>yuko</i> 1 <i>ippon</i>	5

Table 4. Test and Observation Results

Name	Category	VO2Max (ml/kg/min)	Leg Muscle Power (w/kg)	Individual Class Points	Team Class Points	Total Points
AR	Kumite - 67 Kg	53.6	73	5	24	29
HY	Kumite +84 Kg	47.8	56	18	19	37
MT	Kumite - 55 Kg	58.8	76	18	4	22
S	Kumite - 84 Kg	44.0	64	18	15	33
RM.N	Kumite - 60 Kg	55.3	69	18	4	22
IR	Kumite - 75 Kg	47.5	64	13	5	18
Average / Total	—	51.17	67	90	71	161

Table 5. Test Normality

	Kolmogorov-Smirnov ^a			Shapiro-Wilk		
	Statistic	Df	Sig.	Statistic	df	Sig.
X1	.249	6	.200*	.929	6	.570
X2	.172	6	.200*	.963	6	.846
Y	.244	6	.200*	.936	6	.628

Based on the statistical analysis performed using SPSS version 21, the Shapiro–Wilk test was applied to assess the normality of the data for VO2Max, leg muscle power, and performance test scores as presented in Table 3. The results yielded significance values of 0.570, 0.846, and 0.628, respectively, all of which were greater than the alpha level of 0.05. Therefore, the null hypothesis (H₀) was accepted, indicating that the data were normally distributed.

Tabel 6 Hasil Test Linieritas

Performa VO2MAX	Between Groups	(Combined)	90.333	4	22.583	0.125	0.953	
		Linearity	63.44	1	63.44	0.351	0.659	
		Deviation from Linearity	26.893	3	8.964	0.05	0.979	
		Within Groups		180.5	1	180.5		
		Total		270.833		5		

Based on the linearity test analysis, a significant linear relationship was identified between Performance and VO₂Max (Sig. = 0.659). Furthermore, no significant deviation from the assumption of linearity was observed (Sig. = 0.979). These results indicate that the linear regression model is a valid and appropriate approach for analyzing the relationship between these two variables.

Tabel 7 Result Test Linierity

Performa Power Power Otot tungkai	Between Groups	(Combined)	Sum of Squares	df	Mean Square	F	Sig.
		Linearity	158.333	4	39.583	0.352	0.833
		Deviation from Linearity	79.754	1	79.754	0.709	0.554
		Within Groups	78.579	3	26.193	0.233	0.87
		Total	112.5	1	112.5		
			270.833		5		

Based on the linearity test analysis, a significant linear relationship was found between Performance and Leg Muscle Power (Sig. = 0.554). In addition, no significant deviation from

the assumption of linearity was observed (Sig. = 0.870). Therefore, the linear regression model is considered appropriate for analyzing the relationship between these two variables.

Table 8. Simple Linear Regression Test Results

Model	Unstandardized Coefficients		Standardized Coefficients	T	Sig.
	B	Std. Error	Beta		
(Constant)	65.558	34.817		1.883	0.156
VO2MAX	-0.171	1.115	-0.127	-0.154	0.888
Power Otot Tungkai	-0.448	0.845	-0.439	-0.531	0.632

The results of the regression analysis (Table 8) indicate that neither VO2Max nor leg muscle power had a statistically significant effect on performance among the karate athletes studied. The constant value of 65.558 ($p = 0.156$) was not significant, while VO2Max recorded a coefficient of $B = -0.171$ ($p = 0.888$) with a standardized Beta of -0.127 , and leg muscle power recorded $B = -0.448$ ($p = 0.632$) with a standardized Beta of -0.439 . Since all significance values were greater than the alpha level of 0.05, both predictors were found to be non-significant. These findings suggest that variations in VO2Max and leg muscle power do not directly predict karate performance within this sample. This result may be attributed to the small sample size ($n = 6$), which limits statistical power, or to the fact that karate performance is multifactorial, relying not only on physiological variables but also on technical execution, tactical adaptability, and psychological readiness (Chaabène et al., 2012; Tabben et al., 2013).

Discussion

The regression analysis indicated that neither VO2Max nor leg muscle power had a statistically significant effect on karate performance in this study ($p > 0.05$). Although previous literature has consistently highlighted the importance of aerobic capacity and muscular power in combat sports (Chaabène et al., 2012; Iide et al., 2008), the absence of significant results in this case can be attributed to several factors. Studies with larger samples have shown positive correlations between VO2Max, muscular strength, and competitive performance in karate and other martial arts (Sterkowicz-Przybycień et al., 2014; Chaabène et al., 2015). Thus, the non-significant findings should be interpreted cautiously. Second, karate performance is inherently multifactorial. While VO2Max supports cardiorespiratory endurance necessary to maintain performance across multiple bouts, and leg muscle power enables explosive kicking and

stepping techniques, competition outcomes are also strongly influenced by technical execution, tactical awareness, and psychological readiness (Franchini et al., 2011; Tabben et al., 2013). For example, an athlete with moderate physical capacities may still outperform peers if they demonstrate superior timing, strategy, and stress management during matches. Finally, the context of testing may also have influenced the results.

The VO2Max and leg power tests were conducted in controlled conditions, whereas actual competition performance depends on dynamic interactions with opponents. This gap between laboratory measures and applied performance outcomes highlights the need for integrated assessment models that combine physiological, technical, and psychological variables (Chaabène et al., 2015). In summary, although this study did not find significant statistical effects, VO2Max and leg muscle power remain crucial components of athletic conditioning in karate. Future research with larger sample sizes and multifactorial models is recommended to clarify their relative contributions and to design evidence-based training interventions. Performa optimal karate dipengaruhi oleh power otot tungkai dan VO2Max.

CONCLUSION

Based on the coefficient table analysis, it can be concluded that in this study, neither VO₂Max nor Leg Muscle Power individually demonstrated a statistically significant effect on Performance at the 0.05 significance level. Although the regression coefficients (B) indicated the direction of the relationship (negative in both cases), the high p-values for both independent variables suggest that these effects were not sufficiently strong or consistent to be considered statistically significant. This may indicate the presence of other dominant variables or unaccounted interactions influencing performance outcomes. Nevertheless, the athletes still achieved remarkable results: first place in the team kumite category, two athletes winning first place in their respective individual classes, two athletes securing third place, and one athlete attaining second place. These outcomes highlight that karate is a complex, non-measurable sport in which multiple factors—beyond physical capacity—play crucial roles in determining success. This study found that VO2Max and leg muscle power did not show a statistically significant effect on karate athletes' performance. Although these physical attributes are widely recognized as important components in combat sports, the present results suggest that karate performance is determined by a combination of physiological, technical, tactical, and psychological factors. The small sample size may also have limited the detection of significant relationships. Therefore, while VO2Max and leg power remain essential for supporting athletic

conditioning, they should be developed alongside technical skills, tactical awareness, and mental preparation. Future studies with larger participant groups and multifactorial models are recommended to provide a more comprehensive understanding of performance determinants in karate.

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