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Original Article

High intensity interval training method potentially increases muscle strength in karate athletes

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Abstract
Background & Objective This study aims to analyze the potential of HIIT training methods to increase the muscle strength and explosive power of karate athletes.
Method This experimental research used a pre and post-control group design. The research subjects were selected using a purposive sampling technique and then the subjects were divided into 2 groups, namely the control group (K1) with aerobic exercises such as jogging and the treatment group (K2) with the HIIT method. A total of 24 healthy men aged 20-25 years participated in this study. The treatment was given in 17 meetings which were held 3 times in 1 week. Before being given treatment, pre-test data were collected for muscle strength, after being given treatment for 17 meetings, data were collected for post-test muscle strength. Muscle strength was measured using a leg dynamometer. Statistical analysis in this study used the IBM SPSS version 26 application, descriptive tests were carried out to obtain the mean, standard deviation, and standard error. Furthermore, the normality test was carried out using the Shapiro-Wilk method, if the data were normally distributed, the difference test was performed using a paired t-test, but if the data were not normally distributed, the difference was performed using the Wilcoxon signed-rank test.
Results The results of this study reported that the group that was given the HIIT method was able to increase muscle strength significantly (*$p<0.05$) compared to the control group.
Conclusion The HIIT training method which is carried out 17 times which is carried out 3 times in 1 week has the potential to increase the muscle strength of karate athletes. Since muscle strength is a component of physical condition that is very necessary for karate athletes, it is highly recommended to apply the HIIT method in compiling a training program.
Keywords: HIIT**, Muscle Strength, Exercise, Karate**

Introduction

Karate martial arts require physiological and physical conditions to achieve optimal performance, this is also influenced by mastery of techniques, technical skills, training methods, nutritional intake and mental conditions (Zhu, Li and Jankowicz-Pytel, 2020; Romanova *et al.*, 2022). Meanwhile in the sport of karate martial arts, the components of the dominant physical condition to improve performance are strength, explosiveness, and speed (Mischenko *et al.*, 2020; Et.al, 2021).

During the COVID-19 Pandemic that hit the world some time ago, many athletes were at home, prohibited from leaving the house if it was not too emergency, and all sports and recreation infrastructure was closed (Vargas, 2020). This causes a decrease in the physiological and physical condition of everyone, especially athletes (Sun *et al.*, 2020). In 2022, the current incidence of COVID-19 has decreased and entered the endemic era, so it's time for elements of society and the sportsman component to rise.

One of the training methods to improve athlete performance is the High-Intensity Interval Training (HIIT) training method (Grace *et al.*, 2018; Lu *et al.*, 2022; Sherafati-Moghadam *et al.*, 2022). HIIT is performed with an intensity of 90% of VO2max, short periods of around 1 minute and interspersed with several minutes of rest (Arboleda-Serna *et al.*, 2019; Hayes *et al.*, 2021). HIIT has been widely used to improve cardiorespiratory physiological fitness (García-Hermoso *et al.*, 2016; Martin-Smith *et al.*, 2020). In addition, a systematic review and meta-analysis study reported that HIIT was able to increase aerobic capacity in sedentary women (Syamsudin *et al.*, 2021). At present, it has not been reported that HIIT is able to improve the performance of karate athletes such as the muscle strength of karate athletes.

This study aims to analyze the potential of HIIT training methods to increase muscle strength and explosive power of karate athletes.

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Material & methods

Study Design

This experimental research used a pre and post control group design. The research subjects were selected using a purposive sampling technique and then the subjects were divided into 2 groups, namely the control group (K1) with aerobic exercises such as jogging and the treatment group (K2) with the HIIT method.

Subjects

A total of 24 healthy men participated in this study (subject characteristics are shown in table 1). The inclusion criteria in this study were the age range of 20 to 5 years, with a normal BMI. The exclusion criteria in this study were subjects under 20 years of age. The drop-out criterion in this study was consuming performance-supporting drugs. research subjects received instructions on research procedures and signed a written consent to become research subjects.

Procedure

Before the research began, the researcher gave an explanation of the purpose and intent of the research as well as filled out and submitted an informed consent form by the research sample. The sample was divided into 2 groups, namely group 1 with a total of 12 people, and group 2 with a total of 12 people. Group 1 (K1) was the control group and group 2 (K2) was the treatment group. The treatment was given in 17 meetings which were held 3 times in 1 week. Before being given treatment, pre-test data were collected for muscle strength, after being given treatment for 17 meetings, data were collected for post-test muscle strength. Muscle strength was measured using a leg dynamometer.

Exercise Program

Table 1. Exercise Program

Stage	Duration	Activity
Warming up	5 minutes	Jogging at a speed of approximately 4 km/hour
Interval training round 1	4 minutes	20 seconds of sprinting at a speed of approximately 10 km/hour, then jogging at a speed of 4 km/hour. Repeat this combination for 8 times
Recovery	3 minutes	Jogging at a speed of 4 km/hour
Round 2 interval training	4 minutes	20 seconds of sprinting at a speed of approximately 10 km/hour, then jogging at a speed of 4 km/hour. Repeat this combination for 8 times
Recovery	3 minutes	Jogging at a speed of 4 km/hour
Round 2 interval training	4 minutes	20 seconds of sprinting at a speed of about 10 km/hour, then jogging at a speed of 4 km/hour. Repeat this combination for 8 times
Recovery	3 minutes	Jogging at a speed of 4 km/hour
Cooling Down	5 minutes	Walk. Cool down until your pulse is below the fat burning zone

Statistical analysis

Statistical analysis in this study used the IBM SPSS version 26 application, descriptive tests were carried out to obtain the mean, standard deviation, and standard error. Furthermore, the normality test was carried out using the Shapiro-Wilk method, if the data were normally distributed, the difference test was performed using a paired t-test, but if the data were not normally distributed, the difference was performed using the Wilcoxon signed-rank test.

Results

The data on the characteristics of the research subjects are shown in table 1.

Table 2. characteristics of research subjects

Data	Group	n	X̄±SD	Shapiro-Wilk	p
Age	K1	12	22±1.67	0.023	0.502
	K2	12	23±1.80	0.539	
Height	K1	12	166±4.51	0.531	0.241
	K2	12	169.5±4.35	0.286	
Weight	K1	12	62.8±8.3	0.805	0.188
	K2	12	61.9±8.74	0.911	
BMI	K1	12	22.70±3.15	0.204	0.294
	K2	12	21.4±2.79	0.390	

In the t-test, there was no significant difference in the characteristics of each group ($p \geq 0.05$).

Table 3. Results of the normality test for muscle strength

Data	Group	Shapiro-Wilk	
		n	P
Muscle strength (Pre-test)	K1	12	0.121
	K2	12	0.077
Muscle strength (Post-test)	K1	12	0.145
	K2	12	0.151

Based on the normality test in Table 2, the data is normally distributed (p>0.05).

The results of the analysis of muscle strength between the pre-test and post-test in each group are presented in Figure 1.

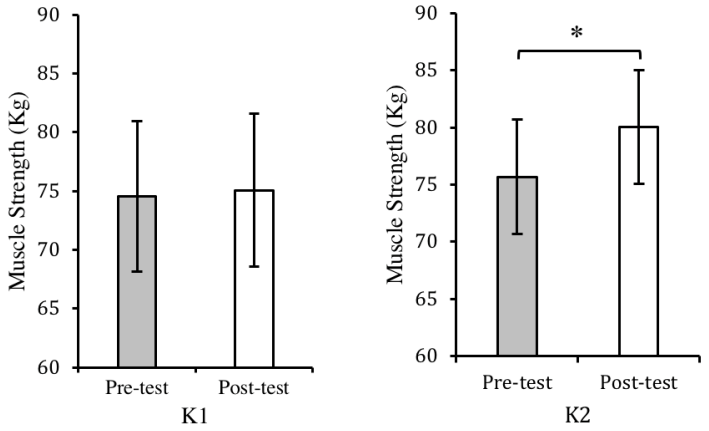

Figure 1. The K2 group that was given the HIIT training method was able to increase muscle strength significantly (*p<0.05) compared to the K1 group as the control group. Data is presented as Mean and Std Error. P-values were obtained using a paired t-test to compare the pre-test and post-test of each group..

Table 4. Results of Muscle Strength

Different Test Method	Group	p-value
Paired t-test	K1 (pre-test and post-test)	0.375
	K2 (pre-test and post-test)	0,000*

Information: * There was a significant difference in the paired test (p <0.05)

Discussion

The purpose of this study was to analyze the effect of the HIIT method on the muscle strength of karate athletes. Our results show that the control group did not significantly increase muscle strength, while the treatment group that was given the HIIT training method was able to increase muscle strength significantly.

Karate is a martial sport that has also become an achievement sport (Turelli *et al.*, 2020; Ritter *et al.*, 2022). Karate is a martial art that uses physical techniques such as punches, kicks, blocks and dodges with sturdy horses (Frigout, Tasseel-Ponche and Delafontaine, 2020). Karate is also a sport that has its own characteristics of motion and technique (Yudhistira and Tomoliyus, 2020; Stefano *et al.*, 2022). One of the most important components of physical conditioning in karate is muscle strength. We observed that the HIIT method given 17 times was able to increase the muscle strength of karate athletes. Our findings are supported by a study that reported that the HIIT method was very effective 3 sessions per week for 6 weeks to reduce the negative reaction phenomena caused by glycogen depletion, accumulation of muscle metabolites, and neuromuscular tension. On the other hand, strength stimulates protein synthesis which has the potential to increase muscle hypertrophy and increase maximal strength (Ayubi *et al.*, 2022, 2023). Several other studies have reported that HIIT methods that last for 3-15 weeks result in slight muscle hypertrophy (Hayes *et al.*, 2021; Hirsch *et al.*, 2021). In this context, an interesting aspect of HIIT is that this type of training method can promote physiological adaptation. The increase in muscle strength observed in the HIIT method can be related to the intensity of the exercise performed (Ozaki *et al.*, 2015). Previous studies reported that the increase in strength after high-intensity exercise is due to large motor unit recruitment and reaching levels above maximum contraction resulting in recruitment in type II muscle fibers. (Kyröläinen, Avela and Komi, 2005; Molinari *et al.*, 2022).

In summary, our research findings report that HIIT methods can improve muscle strength. We are aware of some limitations in this study. We have not investigated and analyzed the physiological and biomolecular aspects of increasing muscle strength due to the HIIT method. We hope that further studies will analyze the effect of the HIIT method on a biomolecular basis.

Conclusion

The HIIT training method which is carried out 17 times which is carried out 3 times in 1 week has the potential to increase the muscle strength of karate athletes. Since muscle strength is a component of physical condition that is very necessary for karate athletes, it is highly recommended to apply the HIIT method in compiling a training program.

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