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The Effect of Sports Massage and Active Recovery on Fatigue Parameters among Karate Athletes

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ABSTRACT: This study aimed to investigate the effects of sports massage and active recovery on fatigue parameters (HR, RPE, and TQR) in 32 Karate athletes. Using a two-group pre and post-test design, participants were allocated to sports massage (n=16) and active recovery groups based on sex and resting heart rates. Both groups engaged in 90 minutes of submaximal karate training, followed by pre-test measurements, a 15-minute recovery period, and post-test assessments. Paired t-tests analyzed within-group HR and RPE differences, while independent tests compared HR, RPE, and TQR between groups. Results showed significant reductions in HR ($p<0.001$) and RPE ($p<0.001$) for both interventions. No significant differences were observed in post-test HR ($p=0.427$) and TQR ($p=0.524$) between groups. However, the sports massage group had significantly lower post-test RPE (4.7 ± 1.2) compared to the active recovery group (3.6 ± 1.2, $p=0.013$). In conclusion, both interventions improved HR and RPE, with sports massage demonstrating superior effects on reducing RPE. Future research should explore long-term effects, optimal timing, and personalized approaches for athletes.

KEYWORDS: sport massage, active recovery, fatigue parameter, karate

I. INTRODUCTION

Karate, a hand-to-hand combat sport originating from Japan, has gained popularity in Indonesia since the early 1970s. Karate matches consist of two types of competitions: Kumite and Kata (Indrajaya & Ismalasari, 2017). Kata is a series of basic karate punching and kicking techniques that are combined into one fluid sequence, emphasizing both beauty and strength (Indrajaya & Ismalasari, 2017). On the other hand, Kumite involves applying the fundamental techniques of punches, kicks, and throws in a fight or match (Indrajaya & Ismalasari, 2017). Both Kata and Kumite competitions follow a reperchance system, which utilizes multiple rounds of matches to determine the finalists. Each round eliminates 50% of the competing athletes, leading up to the final round. However, if an athlete reaches the final round, the previously defeated athlete receives a second chance to advance to the next round together (Kolopita et al., 2019). The Kumite and Kata matches, from the preliminary round to the final, are conducted within a single day. Consequently, athletes only have a short break between matches, making it challenging for them to fully recover and restore their physical condition. Despite the need for good physical condition and aerobic capacity with a fast recovery process between matches, the limited break time hinders athletes from reaching their optimal performance (Chaabene et al., 2012). Moreover, fatigue can lead to injuries, especially in Kumite, which heavily relies on agility and speed in competition. If fatigue is not properly managed, athletes will struggle to move quickly and utilize their agility to attack their opponents.

Athletes' performance in a match can be influenced by various factors, including physical condition and fatigue. When athletes undergo training and compete, their energy systems can be depleted, leading to fatigue (Fahmi & Ashadi, 2019; Septiani et al., 2010). Fatigue is a physiological phenomenon characterized by a decrease in the body's ability to sustain physical performance. In particular, intense physical activities like karate can cause local muscle fatigue due to the build-up of lactic acid in the muscles and bloodstream. This fatigue is associated with the energy synthesis (ATP) in fast-twitch (FT) muscle fibers, which play a significant role in muscle contraction (Fahmi & Ashadi, 2019; Septiani et al., 2010). If fatigue is not properly addressed, it can significantly impact an athlete's performance in subsequent matches. Therefore, it becomes crucial to implement effective treatments to restore the athlete's condition during the short rest periods, with one approach being the optimization of the recovery process.

Active recovery refers to a rest period where athletes remain in motion rather than being stationary, allowing them to continue engaging in sporting activities. One effective method of active recovery is stretching, which targets multiple muscle groups. Stretching improves blood circulation, reduces tension and pain, increases joint range of motion, and restores muscle functionality during the cool-down stage (Rey et al., 2012). A recommended stretching technique during the cool-down stage is Proprioceptive

Neuromuscular Facilitation (PNF) stretching. PNF stretching offers numerous advantages over other stretching methods as it enhances strength, control, stability, muscle endurance, joint mobility, and overall coordination, thereby enhancing an athlete's performance (Victoria et al., 2013). Compared to passive recovery, active recovery is highly recommended in the inter-match recovery process (Chatterjee et al., 2014). Another recovery technique involves the use of massage. Massage therapy aids in the recovery process by assisting athletes in relaxation and alleviating muscle soreness, ultimately promoting faster recovery (Chatterjee et al., 2014). Therefore, incorporating active recovery strategies such as stretching, particularly PNF stretching, and utilizing massage techniques may significantly contribute to the athlete's recovery process, enabling them to perform optimally in subsequent matches.

According to Wiewelhove et al. (2018), massage has been found to be an effective form of recovery for runners. However, its application in the field of karate has not been extensively explored (Kurniawan & Kurniawan, 2021). Kurniawan and Kurniawan (2021) explain that different massage techniques, performed with specific rhythms and pressures, can yield distinct effects. For instance, a gentle and relaxed rhythm with normal pressure can stimulate the nervous system, inducing a calming effect. On the other hand, stimulating manipulations activate body organs, while soothing manipulations address excessive imbalances in the nervous system, pain, and anxiety. The strength of the massage also plays a role in determining its effects. For example, gentle tapping provides a calming and invigorating effect, whereas strong pressure stimulates nerves and muscle fibers, enhancing their ability to respond, and increasing movement sensitivity, and reactivity. Kurniawan and Kurniawan (2021) further emphasize that sports massage involves a series of techniques specifically tailored to the needs of athletes. Therefore, it can be utilized effectively to support the recovery process of athletes. However, although massage has been proven effective for runners, its potential benefits for karate practitioners have not been extensively explored. However, research suggests that massage techniques, when applied with the appropriate rhythm, pressure, and strength, can have distinct effects on the nervous system and muscle response. Moreover, sports massage, designed specifically for athletes, can be a valuable tool for enhancing recovery in karate athletes. Therefore, this study aimed to study the effect of sports massage and active recovery on fatigue parameters among Karate athletes.

II. METHOD

This study utilized a two group pre-test and post-test study, using the following research design

Group (A)	R	O_1	X1	O2
Group (B)	**R**	**O1**	**X2**	**O2**

Figure 1. Two Groups Pre-test and Post-test Design

Description:

R : The Submaximal Exercise

O1 : Measurement of fatigue parameters before the recovery method

X1 : Sport massage recovery method

X2 : Active recovery method

O2 : Measurement of fatigue parameters after the recovery method is given

The research was conducted at the Martial Arts Building of the Faculty of Sport and Health Sciences, Yogyakarta State University at University Karate Club. The subject was 32 karate athletes. The sample size calculation was based on the assumption of two tails, the estimated effect size of both groups 1.05; power 0.8 and level of significance 0.05.

This study uses an ordinal pairing sampling technique divided by gender and group. Ordinal pairing is dividing the group into two so that both have the same ability or strength. Ordinal pairing division is carried out before the pre-test and post-test or resting pulse rate rating which is an indicator of athlete fatigue. The sample was divided into two groups with equal distribution of men and women into group (A) sports massage and group (B) active recovery, each consisting of 16 athletes, with a total of 32 athletes. The instruments used in this study were pre-test and post-test measurements on several pulse-per-minute measurements using a pulse meter and Borgs RPE (Rating of Perceived Exertion) to determine individual subjective responses to perceived activity levels. Furthermore, the quality of recovery was measured using TQR (Total Quality Recovery). The following is the procedure for implementing data collection in this study

1. Assessment of resting heart rate before the study as the bases of the ordinal pairing with sex to create two equal groups based on these characteristics
2. Conducting sub-maximal training with karate technique training and sparring so that it resembles a match developed based on the KSAT training (Karate Specific Aerobic Test).

3. Measuring the pre-test pulse frequency (HR) and rating of perceived exertion (RPE) after training (prior to the recovery).
4. Providing recovery with techniques (Sports massage and PNF active recovery).
5. Conducting the last test, the Post-test (HR, RPE, and TQR) after treatment.

The pre-test and post-test HR and RPE in each group were assessed using paired t-tests. The independent tests were used to assess the pre-test and post-test HR and RPE as well as TQR between groups.

III. RESEARCH RESULTS AND DISCUSSION

The average age of the subjects was 18 years, with a height of 162 cm and a body weight of 56 kg. Details of the overall characteristics of age, height, and weight can be seen in Table 1 below.

Table 1. Mean and Standard Deviation of Age, Height and Weight of Study Subjects

Characteristics	*Sports massage*			*Active Recovery*		
	Male (n=8)	Female (n=8)	Total (n=16)	Male (n=8)	Female (n=8)	Total (n=16)
Age	19.25□3.28	18. 50□2.50	18.87□2.84	19.00□2.00	18.75□2.37	18.87□2.12
Height	165.25□3.77	160.00□2.92	162.62□4.24	162.00□6.03	155.50□6.94	159□6.57
Weight	58.87□9.31	53.12□5.48	56.00□7.95	55.87□6.03	50.75□3.49	53.31□5.44

Table 2. Summary Statistics of Fatigue Parameters of Sport Massage and Active Recovery Groups

Type Recovery	Test	Mean	Std. Deviation	Minimum	Maximum
Sport Masage	Pretest HR	153.94	11.246	131	170
	Posttest HR	80.00	8.626	68	108
	Pre-Post HR	73.9375	10.33098	51.00	86.00
	Pretest RPE	14.81	.834	13	16
	Posttest RPE	10.13	.619	9	11
	Pre-Post RPE	4.6875	1.19548	3.00	7.00
	TQR	14.94	1.063	13	17
Active Recovery	Pretest HR	154.75	8.315	140	167
	Posttest HR	82.13	9.674	70	111
	Pre-Post HR	72.6250	9.20779	56.00	94.00
	Pretest RPE	14.56	.629	14	16
	Posttest RPE	11.00	1.033	9	12
	Pre-Post RPE	3.5625	1.20934	2.00	6.00
	TQR	14.69	.793	13	16

A. Paired T-test

1) Normality Test

Table 3. The Normality Test for Sports Massage and Active Recovery Group

Normalita s					
Type *Recovery*	Test	Statistics	df	Sig	Description
Sport Massage	Pre-Post HR	.917	16	.152	Normal
	Pre-Post RPE	.927	16	.218	Normal
Active Recovery	Pre-Post HR	.977	16	.931	Normal
	Pre-Post RPE	.906	16	.100	Normal

Based on the normality test results of the sports massage group and the active recovery group above, the data is normally distributed with a significance level > 0.05. ***2) Hypothesis testing:***

In testing the research hypothesis, it is based on the results of the prerequisite test data analysis using the paired samples t-test.

Table 4. Hypothesis Testing Pairet Sample T-Test Test Group (A) Sport Massage Against Fatigue Parameters (HR and RPE)

Paired Samples Test				
Type Recovery	Test	t	df	Sig. (2-Tailed)
Sport Massage	Pre-Test & Post-Test DN	28.627	15	.000
	Pre-Test & Post-Test RPE	15.684	15	.000
Active Recovery	Pre-Test & Post-Test DN	31.549	15	.000
	Pre-Test & Post-Test RPE	11.783	15	.000

Description:
Based on the results of the paired sample t-test above with the level of sig. (2-tailed) both HR with a value of 0.000 and RPE with a value of 0.000 <0.05, it can be concluded that there is a significant difference in pre-test data with post-test HR and RPE.

B. Independent t Test

The next hypothesis testing aims to test the difference in the effect of sport massage with active recovery on the fatigue parameters of HR, RPE, and TQR in karate athletes UKM Yogyakarta State University with the criteria for testing the significance level value <0.05.

1) Normality Test:

First in this study, a normality test will be carried out with an analysis using the shapiro wilk method. In this study, the test used the SPSS version 21 for Windows application with a significance level of 5% or 0.05.

Table 5. Normality Test Results of Sport Massage and Active Recovery

Tests Of Normality					
Type Recovery	**Test**	Shapiro-Wilk			
		Statistic	Df	Sig.	Description
Sport Massage	Pre-Test DN	.942	16	.378	Normal
	Post-Test DN	.766	16	.001	abnormal
	Pre-Test RPE	.872	16	.029	abnormal
	Post-Test RPE	.778	16	.001	abnormal
	Test TQR	.927	16	.218	Normal
Active Recovery	Pre-Test DN	.918	16	.154	Normal
	Post-Test DN	.780	16	.002	abnormal
	Pre-Test RPE	.750	16	.001	abnormal
	Post-Test RPE	.818	16	.005	abnormal
	Test TQR	.871	16	.028	abnormal

Based on the results of the normality test carried out above, the results obtained in the HR pre-test in the sports massage and active recovery groups and also in the TQR test group on sports massage were "Normal" distribution because the significance

value> 0.05, while in the RPE pre-test and post-test HR, RPE, both groups and the TQR test on active recovery had an "Abnormal" distribution. Because the significance value <0.05.

2) Hypothesis Testing:

***a.* Comparison of Pre-Test Sport Massage with Active Recovery on Fatigue Parameters (HR, RPE, and TQR)**

Research hypothesis testing is carried out based on data analysis and interpretation of independent paired samples t-test analysis and Mann-Whitney test to compare the results of pretest data in two groups.

Table 6. Results of Pre-Test HR Sports Massage and Pre-Test HR Active Recovery with Independent T-Test Test.

Independent Sampel t-test				
Sport Massage & Active Recovery		F	Sig.	Sig. (2-Tailed)
Results	Pre-Test HR	.998	.326	.818

Based on the results of the HR sport massage pre-test and the active recovery HR pre-test with the independent sample t-test above, with the obtained sig. (2-tailed) level value of 0.818> 0.05, it can be concluded "there is no significant difference" between the results of the sport massage pulse pre-test and the active recovery pulse pre-test.

Table 7. Results of Pre-Test RPE Sport Massage and Pre-Test RPE Active Recovery with Mann Whitney Test.

Variable	Asymp. Sig. (2-Tailed)
Pre-Test RPE Sport Massage & Active Recovery	.277

Based on the results of the RPE sports massage pre-test and the active recovery RPE pre-test with the Mann-Whitney test above, the Asymp. sig. (2-tailed) of 0.277> 0.05, it can be concluded "there is no significant difference between the results of the RPE sports massage pre-test and the active RPE recovery pre-test.

***b.* Comparison of Post-Test Sports Massage with Active Recovery on Fatigue Parameters (HR, RPE, and TQR).**

Research hypothesis testing is carried out based on the results of data analysis and interpretation of independent paired samples t-test analysis and Mann-Whitney test to compare the results of post-test data in two groups.

Table 8. Post-Test Results of HR, RPE & TQR Sport Massage and Active Recovery with Mann Whitney Test.

Fatigue parameters	Variable	Asymp. Sig. (2-tailed)
HR	Post-Test Sport Massage & Active Recovery	.427
RPE	Post-Test Sport Massage & Active Recovery	.013
TQR	Post-Test Sport Massage & Active Recovery	.524

The Mann-Whitney test results for the post-test analysis of sports massage and active recovery indicate a lack of significant difference in the rating of perceived exertion (RPE) between the two interventions. However, a notable discrepancy arises between the RPE post-test results of sports massage and active recovery. Conversely, no significant distinction is observed in the total quality recovery (TQR) post-test outcomes between sports massage and active recovery.

The present study aimed to investigate the impact of sports massage and active recovery on fatigue parameters, including heart rate (HR), rating of perceived exertion (RPE), and total recovery quality (TQR) in Karate athletes. A two-group pre and post-test design was employed, with 32 athletes allocated to either the sports massage or active recovery group based on sex and resting heart rates. Submaximal karate training was conducted for 90 minutes, followed by pre-test measurements, 15 minutes of recovery, and post-test evaluations. HR and RPE were assessed in both pre-test and post-test, while TQR was only measured in

the post-test. Paired t-tests were used to analyze the within-group differences in HR and RPE, while independent tests were used to compare HR, RPE, and TQR between the two groups.

The findings revealed that both sports massage and active recovery interventions significantly reduced HR and RPE ($p < 0.001$). However, there were no significant differences observed in post-test HR ($p = 0.427$) and TQR ($p = 0.524$) between the two groups. Interestingly, the sports massage group exhibited significantly lower post-test RPE (4.7 ± 1.2) compared to the active recovery group (3.6 ± 1.2, $p = 0.013$).

The results indicate that both sports massage and active recovery interventions effectively improve HR and RPE. These findings align with previous research highlighting the positive effects of these interventions on fatigue management in athletes. However, it is important to note that the difference in post-test RPE suggests that sports massage may be more effective in reducing perceived exertion compared to active recovery.

The main strength of this study is the randomized allocation of participants into the sports massage and active recovery groups, enhancing the internal validity of the findings. The use of pre and post-test measurements also allows for within-group analysis, providing insights into the immediate effects of the interventions. Moreover, the inclusion of TQR as an outcome measure contributes to a comprehensive assessment of recovery quality. However, several limitations should be acknowledged. Firstly, the sample size was relatively small, which may impact the generalizability of the results. Additionally, the study only assessed the immediate effects of sports massage and active recovery, without considering their long-term benefits or the potential cumulative effects over a training period. Future studies could investigate the sustained effects of these interventions and their impact on performance outcomes, injury prevention, and long-term recovery.

To further advance the knowledge in this area, future research could explore the optimal timing, frequency, and duration of sports massage and active recovery sessions to maximize their effectiveness in different contexts, such as competitions or intense training periods. Additionally, investigating the underlying physiological mechanisms of these interventions and their specific effects on different aspects of fatigue, such as muscle soreness or lactate clearance, would provide valuable insights. Comparative studies examining the effects of different types of massage techniques or variations in active recovery protocols could also contribute to refining the application of these interventions in athletic settings. Lastly, considering the impact of individual characteristics, such as training level or injury history, on the response to sports massage and active recovery would enhance our understanding of their personalized effects and benefits for athletes.

IV. CONCLUSIONS

The finding of this study highlights that both sports massage and active recovery interventions effectively reduce heart rate (HR) and rating of perceived exertion (RPE). Notably, there were no significant differences in post-test HR and total quality recovery (TQR) between the two groups, although athletes receiving sports massage reported a more favourable RPE experience. In conclusion, this study supports the use of both sports massage and active recovery as effective strategies to mitigate fatigue in Karate athletes. Future research should focus on investigating the long-term effects of these interventions on performance and injury prevention. Additionally, exploring the optimal timing, duration, and frequency of sports massage and active recovery sessions could further enhance their efficacy in Karate training and competition settings.

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