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The Effectiveness of Sports Massage and Cold Water Immersion towards Fatigue Recovery and Post-Exercise Stress Levels of Sprinters at the Student Sports Education and Training Center (PPLP)

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ABSTRACT: The first objective of this research is to investigate the effectiveness of sport massage and cold water immersion in the post-exercise fatigue recovery of the PPLP sprinter athletes. Second, to determine the effectiveness of sports massage and cold water immersion in reducing post-exercise stress levels of the PPLP sprinter athletes. This research used an experimental method with a pretest-posttest-control group design. The research population was PPLP Bogor 100m sprint athletes, totaling 30 athletes and they were divided into 3 treatment groups: Sport Massage, Cold Water Immersion, and Control. The sampling technique was random sampling with certain criteria. The three groups received an exercise simulation with a duration of 60 minutes divided into 10 minutes of warm up, 45 minutes of exercise, and 5 minutes of cooling down. Before and after the treatment, pretest and posttest were conducted including the level of fatigue recovery (pulse rate, RPE, FAS) and post exercise stress level (Daily Wellness Questionnaire). The normality test used Shapiro Wilks and the data homogeneity test referred to the Levene test. Testing the effectiveness used one way ANOVA for normally distributed data and for the data that was not normally distributed using the Kruskal Wallis test. The data was then processed by using the statistical program SPSS 22. The results show that (1) there are differences in the effectiveness of sport massage and cold water immersion towards the level of post-exercise fatigue of PPLP sprinters. There are differences in treatment effectiveness between the three groups ($p < 0.05$) for pulse and RPE variables. In the Tukey post hoc test it is found that there is a difference in effectiveness between sport massage and the control group ($p < 0.05$) and between cold water immersion and the control group ($p < 0.05$). However, between sports massage and cold water immersion there is no significant difference in recovering fatigue levels. (2) There is no difference in the effectiveness of sport massage and cold water immersion towards the level of post- exercise stress reduction of PPLP sprinters with a significance value ($p > 0.05$). Hence, in recovering post-exercise fatigue, sports massage or cold water immersion recovery techniques can be used according to the needs of athletes compared to passive rest.

KEYWORDS: *Sport Massage, Cold Water Immersion, Recovery Rate, Stress Level*

INTRODUCTION

The race numbers in sports such as fast walking, running, throwing and jumping are called track and field means that the race is carried out on a running track which is divided based on the medium of the race. Running numbers are held on the track such as sprinting, middle distance, long distance running, fast walking, hurdling and steeplechase. Field numbers have a special area for each number according to the needs and activities of the sport. Derived from the word “athlon” into athletics which has the meaning of a race. Athletics is an activity that involves physical or physical exercise consisting of basic natural and logical movements in accordance with what is done in everyday life. Activities such as walking, running, jumping and throwing (Sukirno, 2011).

Training in sprinters is usually intense and physically demanding, as it requires high levels of speed and strength. The intensity of sprinter training varies depending on the athlete's goals, experience and fitness level. Training for sprinters there are types of exercises that are divided into two and commonly used in sports, namely anaerobic and aerobic. Anaerobic exercises include weightlifting, sprints, pull-ups, push-ups and some kinds of jumps. Anaerobic exercise is a form of physical activity with high intensity as one of the exercises. This type of exercise requires energy that at its source must be provided precisely and quickly in

a very short time. The 100-meter sprint exercise in less than 30 seconds uses the ATP-PC energy system. Sprinter training is classified as high-intensity training. Sprinters' training is classified as strenuous because sprint-specific power, technique and endurance are considered the main determinants underlying 100m sprint performance. The intensity of sprint training is determined by a series of components such as sprint training mode, strength training, plyometric training, duration, intensity, rest duration, rhythm of the training session, shoe surface.

Several factors explain why sprinters' training is heavy. One of them is Speed Development which explains that maximum training speed can be divided into three training principles; endurance development, endurance training and sprinting. According to (Jalilvand, 2016) sprint-specific endurance refers to the deceleration phase of the sprint. A decrease in speed is usually accompanied by a decrease in stride rate. Sprint-related fatigue is linked to disturbances in the central nervous system and peripheral factors in skeletal muscles.

Based on one of the factors above, training for sprinters is classified as heavy and high-intensity training. According to Margono (2006), athletes who participate in sprints are very at risk of injury. Many studies have been conducted to find the cause, not only one cause but also various risk factors. Fatigue is one of the factors causing muscle overheat in sprinters in addition to inadequate warm-up, poor flexibility, overtraining, muscle imbalance, mineral deficiency, structural abnormalities, incorrect training methods, injury, and lack of a proper endurance program. Sprint-related fatigue is associated with disturbances in the central nervous system and peripheral factors in skeletal muscle. Available research suggests that leg stiffness affects elastic energy storage, which is critical for sprint-specific endurance, requiring rapid recovery.

Fatigue in athletes is a condition of decreased ability when performing a physical activity. Fatigue can result in increased stress levels for athletes. The main focus of athletes such as fatigue and injury factors and the risk of overtraining that must be avoided so that the goals of training can be carried out as well as possible. Fatigue is divided into two parts, namely fatigue which means central which occurs in the nerves due to the influence of central nervous system activity and fatigue which means peripheral which occurs in the muscles and affects the nervous system to contraction. Routine training with increased form and training load can be a cause of mental and physical fatigue. There is a gap between the definition of fatigue and the reality on the field, this is because the items that coaches typically measure for aspects of fatigue are often objective such as heart rate and lactic acidosis. However, there are items that require more attention and are subjective, such as mood, stress, and perceived exertion. This is supported by the theory that determining an athlete's fatigue level requires both objective and subjective factors. Sprint competitions put the sprinter's body under pressure. All of these components in a sprint race cause sprinters to experience stress. Recovery is important and very beneficial if done in the right way, so that the athlete's condition does not experience acute fatigue. The system of returning the body to its original condition is important in avoiding the very high risk of fatigue. The importance of recovery is to restore the condition of the body before the match begins, and also athletes and coaches who have an understanding of a program in training consisting of balanced training and rest in order to get the best results or achievements. Post-training recovery is an important component of the overall sports training paradigm, and is essential for high performance in athletes. If recovery rates are appropriate, then higher training volumes and intensities are possible without the detrimental effects of overtraining. Therefore, it is important for health and fitness professionals to understand the physiological concepts of recovery.

Opinions presented in research by (Haugen et al, 2019) The strategy for restoring an athlete's performance capacity depends on the optimal balance between training and recovery. While sleep and nutrition are fundamental to daily life recovery and the recovery process after physical exercise, several recovery strategies have been explored to improve recovery in athletes. In the community of leading sprinters, so-called tempo runs of 100-300 m with short recoveries and intensities of 60-70% of maximal running speed are commonly used between high-intensive training days to relax stiff muscles and improve cardiovascular fitness. A number of passive recovery modalities have also been applied by practitioners over the years, including massage, stretching, compression garments, cold water or contrast water immersion, cryotherapy, hyperbaric oxygen therapy, and electrostimulation. Recovery is needed after carrying out a training program with the aim of restoring the athlete's body condition. There are two types of recovery methods that are commonly known. Active recovery is light, low-intensity exercise. Active recovery refers to recovery from low-intensity activity training aimed at recovery. There are many different ways and techniques used in recovery. In (Parwata, 2015) so that athletes can use physiotherapy recovery techniques to help the recovery process, there are several recovery techniques or mechanisms of recovery techniques that can be applied in the field, including massage can be carried out for about 15 to 20 minutes before exercise, then continued with a general warm-up, 8 to 10 minutes post-exercise, 20 to 30 minutes after sauna or hot bath, or more. Hot sauna or heat therapy works through the endocrine system and nervous system, affecting local organs and tissues in the muscles. At 36^0 Celsius, warming up and then taking a hot shower or steam bath with a duration of 8 to 10 minutes relaxes the muscles. Cold or cryotherapy is a technique of immersion in cold water or bathing with

ice. Recovery is an important method of muscle recovery. During exercise the body experiences stress and muscle damage despite the fact that it helps build muscles. However, the body needs time to recover and grow stronger so we need fast and effective recovery methods. Recovery techniques commonly used in athletics are hydrotherapy, compression and massage.

Cold Water Immersion, a recovery technique and widely used by athletes in recovery using water media or commonly referred to as hydrotheraphy where the human body responds to immersion with changes in heart, peripheral resistance, and blood flow, as well as changes in skin, core and muscle temperature (Wilcock et al., 2006). Changes in blood flow and temperature can affect inflammation, immune function, muscle pain and feelings of fatigue. Research into the potential regenerative effects of immersion, recovery and performance is growing. The most common form of water immersion that is widely used is cold water immersion (CWI). Twelve minutes of CWI also increased total sprint work and peak power. The effectiveness of CWI in restoring simulated performance in running sports evaluated over a 48-hour period (Ingram et al., 2009). Cold Water Immersion is a method by means of soaking using cold temperature water with a vertical body position. (Tsafiq, 2018). Cold water immersion or commonly known as cold therapy is a recovery method that has a function in replacing nitrogen as a role in the use as anesthetic and analgesia in providing a mild effect on pain and reducing symptoms of inflammation that arise in the muscles.

Sport Massage is another recovery technique, a widely used recovery strategy among athletes. Sport massage can help lower pulse rate, RPE, and reduce stress levels through various physiological and relaxation mechanisms that can improve performance and overall health. In addition to the perceived benefits of massage on muscle soreness, several studies have shown positive effects on performance in repetitive sports. Moreover, increased blood flow is one of the main mechanisms proposed to enhance recovery. However, many studies have reported no increase in blood flow or lactate output during massage (Monedero & Donne, 2000). As recovery is a relatively new field of scientific research, athletes are encouraged to experiment with various recovery techniques to identify individualized recovery strategies that are beneficial. The opinion by Bambang Priyonoadi in Nopriansyah (2015) explains that sport massage is a therapy in the form of massage which is specifically recommended for sports players with a healthy body condition. Sport massage is one type of massage that can be used for a sportsman and has a purpose in maintaining fitness for the body, minimizing the risk of injury and handling after injury (Tsaqif, Muchammad, 2018). Sport massage is a method of massage and sequencing carried out on certain parts using methods with hands or special tools with the aim of blood circulation in launching it and can be an effort to relieve fatigue and goals with treatment efforts (Ningsih, 2017).

Preliminary studies have been conducted with four athletic national team athlete respondents who have been interviewed. The results of the interview explained that the toughest exercise for athletic athletes is technical training which requires them to work and practice optimally to get good technical movements. After technical training they explained that they usually do recovery to restore their condition. Five athletes argued that sport massage can recover quickly while, the other five athletes explained that ice bath, or cold water immersion also caused a fast recovery effect for their physical condition. This interview was conducted on Friday, December 23, 2022 when the athlete finished doing technical training in the morning at around 10.00 WIB. The observation used in this preliminary study is to observe athletes from several technical exercises performed at the Senayan athletic field with the number of athletes observed as many as ten athletes on the same day before the interview.

In both methods in this study, there are several advantages and disadvantages, namely, Cold Water Immersion can improve cardiovascular circulation for heart health, a strong immune system, mental health and high energy levels after participating in high intensity. The disadvantages of Cold Water Immersion are the shock of cold water that will respond automatically where the heart rate increases and lose control of breathing and arrhythmia or heart rhythm disturbances and hypothermia because the core temperature is too cold. As for sports massage, it can release and reduce tension in the muscles, improve circulation and encourage the removal of lactic acid during high intensity and reduce injuries. However, the side effects that can occur are nausea, headache, pain in the massaged muscle, bruising, bleeding in some cases, and skin irritation. The disadvantage that can be seen from cold water immersion, sports massage, fatigue levels and stress reduction levels is that in cold water immersion there is a response called the hunting response that can occur in preventing tissue damage due to anoxia in the tissue. In a cold condition, the hypothalamus which regulates skeletal muscles actively for vasoconstriction can be a cause of a person experiencing chills and increased body temperature, therefore requiring rapid control and observation in carrying out this treatment. Sport massage has a weakness if it is wrong in performing massage techniques on the body precisely in the muscles then the results felt by athletes do not become significant. Weaknesses in the level of fatigue and stress reduction include requiring sports activities that make athletes tired and stress that can change quickly and the condition of external factors that can affect the athlete.

Several reasons for comparing the two recovery methods between sports massage and cold water immersion were found in a preliminary study of national team athletics athletes while doing technical training in Senayan on December 23, 2022, 10 athletes were interviewed and observed about the choice of recovery method. A total of 4 athletes (40%) argue that they feel more efficient sport masage, 1 athlete (10%) chooses passive rest and 5 other athletes (50%) argue that cold water immersion is more efficient,

popular, and widely used. This is one of the reasons for choosing, in comparing the two methods. The benefits found in sport massage and cold water immersion are aimed at recovery in improving adaptation for athletes to physical stress for the body and mentally during competition and training, recovery programs for affected athletes can be applied to reduce fatigue and efforts to be made in reducing fatigue and stress levels.

The selection of respondents in this study were sprinters at PPLP Bogor and in accordance with the characteristics of athletes in sports that require fast recovery and athletes who already have a definite schedule in the training period. Based on this explanation, it is necessary to conduct a deeper research and study with the topic of comparing the effectiveness between the provision of sports massage and the cold water immersion method towards fatigue recovery and post-exercise stress levels of PPLP sprinters.

METHODS

Quasi experiment is a type of research that is a method in research that is commonly used in finding the effect of certain treatments on objects under controlled conditions and there is treatment, control and supervision (Sugiyono, 2018). Research with quasi-experimental type research and using cross sectional method which is a study as a type of research that is included in observational by analyzing variable data collected at a certain point in time from the entire population of samples or subsets that have been determined. The research design is pretest-posttest control group design. The population used in this study were a number of 100m sprint athletes at PPLP Bogor, totaling 32 athletes. The sampling technique is random sampling used in this study, namely random sampling by adjusting the needs of athletes and some considerations from the coach. So, with the sample size formula that the sample in this study was obtained totaling 30 sample participants. The 30 participants in the study were divided into 10 participants in each group. 10 participants in the sports massage manipulation group, 10 participants in the cold water immersion manipulation group, and 10 participants in the control group. This study has a specific criterion in representing the sample which is then used in research, the criteria for the sample are based on the inclusion and exclusion criteria as follows: 1) Inclusion Criteria, including PPLP Bogor sprint athletes number 100 m, adolescent individuals with an age range of 14 - 18 years, willing to become respondents. 2) Exclusion criteria, including being injured, being sick, allergic or sensitive to cold temperatures. The data collection technique in this research is a questionnaire. Instruments in data collection for fatigue level recovery using Fatigue Assessment Scale (FAS), Rating Perceived Exertion (RPE), and Pulse Rate. Data collection instruments for stress levels used the Daily Wellness Questionare. Validity and Reliability of the FAS measuring instrument is classified as good and can be used with validity values > 0.59 - 0.68 and Reliability 0.74 - 0.80 which means this measuring instrument is very reliable (Zhang M., et al, 2015). The validity and reliability of the RPE measuring instrument is classified as good and can be used with a validity value of 0.88 and reliability of 0.84-0.91 which means that this measuring instrument is highly reliable (Lea, J.W.D et al, 2022). The validity and reliability of the Daily Wellness Questionaire (DWQ) measuring instrument is 0.75 as a reliability coefficient which has Acceptable internal consistency and can be considered reliable. The validity value or coefficient value> 0.3 is considered valid. data analysis techniques in this study are divided based on each treatment group, namely, the sports massage group, the cold water group and the control group. Data analysis techniques include prerequisite tests (normality and homogeneity tests), hypothesis testing using the one way anova test on normally distributed data, while the Kruskal Wallis test is used on non-normally distributed data.

RESULTS

The characteristics of respondents in this quasi-experimental study follow the inclusion and exclusion criteria that have been determined before data collection. The following can be described the characteristics of the subjects in this quasi-experimental study in table 1.

Table 1. Characteristics of Research Subjects Based on Age, Height, Weight and Body Mass Index

Groups	Total	Age (mean±SD)	Height (mean±SD)	Weight (mean±SD)	BMI (mean±SD)
SM	10	16.90±1.10	169.40±5.62	56.90±3.66	19.85±1.36
CWI	10	15.80±1.13	168.50±7.30	59.30±6.29	20.85±1.16
Control	10	15.70±1.25	162.60±3.71	55.20±4.91	20.87±1.61
Total	**30**				

The table above presents data or characteristics of respondents in the study. Based on the characteristics of the average age of the three groups is 16 years old. The highest average height was in the sports massage group with 169.4 cm. The highest average body

weight is in the cold water immersion group with a value of 59.3 kg and the lowest BMI is in the sports massage group with a value of 19.8.

Table 2 below will explain the characteristics of quasi-experimental research subjects based on gender.

Table 2. Characteristics of Research Subjects based on Gender

Groups	Gender		Total (%)
	Male (n/%)	Female (n/%)	
SM	4 (40)	6 (60)	
CWI	7 (70)	3 (30)	
Control	3 (30)	7 (70)	
Total	15 (50)	15 (50)	100

Characteristics based on gender. The most male gender is in the cold water immersion group as many as 7 athletes and the most female gender is in the control group as many as 7 athletes.

Descriptive data including pretest and posttest regarding pulse rate, FAS, RPE and DWQ can be explained in the table below:

Table 3. Descriptive Data of Pretest, Post-test and Difference in Pulse Rate (DN), FAS, RPE and DWQ by Groups

Groups	Test	Parameters (mean±SD)			
		DN	FAS	RPE	DWQ
SM	Pretest	109.20 ± 13.44	24.40 ± 4.35	3.60 ± .96	30.20 ± 6.05
	Post-test	80.00 ± 13.54	21.50 ± 4.47	.750 ± .54	26.80 ± 4.35
	Selisih	29.20 ± .1	2.90 ± .12	2.85 **±** .42	3.40 ± 1.7
CWI	Pretest	111.60 ± 12.38	23.00 ± 3.83	4.10 ± 1.10	30.40 ± 3.30
	Post-test	68.70 ± 6.49	21.60 ± 4.16	0.40 ± .39	26.70 ± 4.57
	Selisih	42.90 ± 5.89	1.40 ± .33	3.70 **±** 0.71	3.70 ± 1.27
Control	Pretest	113.20 ± 21.05	24.80 ± 4.89	4.40 ± 1.17	31.10 ± 5.23
	Post-test	100.40 ± 17.22	22.90 ± 4.63	1.90 ± 0.87	29.80 ± 6.07
	Selisih	12.80 **±** 3.83	1.92 ± .26	2.50 ± .30	1.30 **±** .84

Descriptive data based on the sport massage, cold water immersion and control groups resulted in the following data values. There is a difference in value in the data above before getting treatment and after getting treatment both in the parameters of pulse rate difference, fatigue assessment scale, rating perceived exrcertion and daily wellness questionnaire. The most difference in pulse rate is in the cold water immersion group, the difference in FAS is most in sport massage, the most RPE difference is in cold water immersion, and the most difference in DWQ is in the cold water immersion group..

The data normality test uses the Shapiro-Wilk method with a significance level of 0.05. The results of the normality test are presented in Table 4:

Table 4. Normality Test Results

Variables	Groups	Shapiro Wilk		
		Statistic	Df	Sig
DN	SM	.906	10	.254
	CWI	.921	10	.365
	Control	.923	10	.387
FAS	SM	.965	10	.842
	CWI	.907	10	.264
	Control	.941	10	.568
RPE	SM	.366	10	.000
	CWI	.878	10	.124
	Control	.366	10	.000

DWQ	SM	.960	10	.791
	CWI	.891	10	.173
	Control	946	10	.621

In the data above the pulse rate, FAS, and DWQ variables have a significance value (p> 0.05) so that the data can be said to be normally distributed. RPE data in the sports massage group and control group have a significance value (p < 0.05) so that the data can be said to be not normally distributed. For normally distributed data using the One Way Anova hypothesis test and for data that is not normally distributed using the Kruskal Wallis test.

The homogeneity test uses the Levene Test with a significance level of 0.05. The results of the homogeneity test are presented in Table 5:

Table 5. Homogeneity Test Pretest - Posttest

Variables	Statistic	df1	df2	Sig
DN Pre	2.80	2	27	.078
DN Post	3.11	2	27	.061
FAS Pre	1.18	2	27	.320
FAS Post	.26	2	27	.769
RPE Pre	.36	2	27	.699
RPE Post	7.81	2	27	.002
DWQ Pre	1.69	2	27	.203
DWQ Post	.26	2	27	.105

Based on the homogeneity data above the significance value> 0.05, the data is homogeneous. RPE Post data <0.05, which means that the data is not homogeneous or data where the test is carried out to determine whether the variances of two or more distributions are equal.

Hypothesis Test 1

The following table shows the results of hypothesis testing using one way anova for the variables of pulse fatigue level and FAS.

Table 6. One way Anova for fatigue level variables pulse rate (DN) and FAS

Variables	Sum of Squares	Mean Square	F	Sig.
DN	5162.46	2581.23	14.82	.001
FAS	12.20	6.10	.31	.735

The results of the One Way Anova Test, the DN variable has a significance value (p < 0.05) and shows there is a significant difference (p < 0.05) between treatment groups so it needs to be continued with the Tukey Post Hoc test, while for the FAS variable has a significance value (p> 0.05) which indicates there is no significant difference.

The Kruskal Wallis test was then conducted for the RPE fatigue level variable and is shown in the following table:

Table 7. Kruskal Wallis Test

Variabel	Chi-Square	Df	Asymp.Sig
RPE	14.94	2	.001

The test results on the RPE variable show a significance value (p < 0.05) between groups so that there are significant differences between groups. So that the results of RPE can be explained that based on measurements through athlete perceptions, there are differences in the effectiveness of sports massage and cold water immersion on post-training fatigue recovery in PPLP sprinters.

Hypothesis Test 2

The following is a table of hypothesis test results using one way anova for the stress reduction level variable.

Table 8. One way Anova for DWQ stress level variable

Variable	Sum of Squares	Mean Square	F	Sig.
DWQ	62.06	31.03	.69	.510

In the DWQ variable results, with a significance value (P> 0.05), there is no significant difference between treatment groups or there is no difference in the effectiveness of sports massage and cold water immersion on reducing post-training stress levels in PPLP sprinters.

Tukey's Post Hoc Test

a. Pulse Rate/DN

Following up on the results of the data test with one way anova and getting a significance value <0.05, the next step is to test the pulse fatigue level variable in the following table:

Table 9 Tukey's Post Hoc Test for DN fatigue level variable

	Groups	SM	CWI	Control
DN	SM	-	0,154	0,005
	CWI	-	-	0,000
	Control	-	-	-

The results of Tukey's post Hoc test for the pulse rate variable showed that there was a significant difference in pulse rate parameters between the Sport Massage, Cold Water Immersion and Control groups. However, between the sport massage and cold water immersion groups there is no significant difference. Based on the results of the analysis that there is no significant difference because both have almost the same effectiveness value so there is no significant difference.

b. RPE

Tukey's Post Hoc test was also conducted for the RPE variable in measuring fatigue levels as it had a significance value of <0.05. Table 10 follows:

Table 10. Tukey's Post Hoc Test for RPE fatigue level variables

	Groups	SM	CWI	Control
RPE	SM	-	0,956	0,001
	CWI	-	-	0,000
	Control	-	-	-

The results of Tukey's post Hoc test for RPE variables showed that there was a significant difference in RPE parameters between the Sport Massage, Cold Water Immersion and Control groups. However, between the Sport Massage and Cold Water Immersion groups there was no significant difference based on athletes' perceptions of the level of fatigue they felt and could also occur because the design of high-intensity training activities did not make athletes feel tired.

DISCUSSION

Based on the results of the data obtained and have been processed with the SPSS software application, the discussion will be explained below. Subject characteristics based on the age of the participants are in the range of 14 to 18 years, with a height from an average of 162 cm to 170 or more, which has an average body weight of 55 kg to 59 kg or more, and has a fairly good BMI from a scale of 19 - 21 and above which can be said to still be in Normal BMI especially for sprinter athletes. Based on gender, it is divided into 15 female athletes and 15 male athletes with a total of 30 athletes in this study.

The next descriptive data is descriptive data of pretest and post-test and the difference between the two values. The parameters used are the mean or average value and standard deviation on each variable. The difference in pulse rate between the sports massage, cold water immersion, and control groups with the most difference is in the cold water immersion group with a value of 42.90 with SD 5.89 compared to other groups. The difference in FAS fatigue level measurements between the sports massage group, cold water immersion, and the control group with the most difference is in the sports massage group with a value of 2.90 with SD .12 compared to other groups. The difference in RPE fatigue level measurements between the sports massage, cold water immersion, and control groups with the most difference being in the cold water immersion group with a value of 3.70 with SD .71

compared to other groups. The difference in measurement of the level of stress reduction DWQ between the sports massage group, cold water immersion, and the control group with the most difference is in the cold water immersion group with a value of 3.70 with SD 1.27 compared to other groups. Based on this data, the level of fatigue and the level of stress reduction of each variable experienced a difference in value change.

Data normality test on pulse rate, FAS and DWQ variables has a significance value ($p > 0.05$) which has data with normal distribution. Data normality on RPE variables in the sports massage group and control group has a significance value ($p < 0.05$) so that the data is not normally distributed.

In the data homogeneity test using the Levene test resulted in data for the RPE data variable ($p < 0.05$) so that the data was not homogeneous, while the data on other variables, namely pulse rate, FAS, and DWQ had homogeneous data. Normally distributed data and homogeneous data can be continued with one way anova data processing while for data that is not normally distributed can use the Kruskall Wallis test.

In the hypothesis test in answering the research question that there is a difference in the effectiveness of sport massage and cold water immersion on post-training fatigue recovery in PPLP sprinter athletes through one way anova testing with a significance value (0.001), so that the Tukey Post Hoc test is carried out for pulse rate variables which gives the result that there is a significant difference in pulse rate parameters between the sport massage group and the control group with a significance value (0.005), the cold water immersion group with the control group with a significance value (0.000), but between the sport massage and cold water immersion groups (0.154) there is no significant difference. The RPE variable uses the Kruskall Wallis test with a significance value of (0.001), and continued with Tukey post hoc which explains there is a significant difference in RPE parameters between the Sport Massage treatment group, Cold Water Immersion and the control group. The significance value of the sport massage group and the control group (0.001), the cold water immersion group (0.000), and the sport massage and cold water immersion group (0.956) which means that between the Sport Massage and Cold Water Immersion groups there is no significant difference based on the athlete's perception of the level of fatigue. In the results of the one way anova test on the variable level of DWQ stress reduction, it gives a significance value (0.510) which means there is no significant difference between treatment groups.

In line with research by Kurniawan (2021) argues that sports massage with several movements can stimulate vegetative nerves or the autonomic nervous system in all parts of the body and affect the body. The implementation in this manipulation is distinguished based on the place or part that is massaged. Abdominal shaking is only a small intensity vibration using the shaking technique. Some limbs that are shaken are required to be in a state of comfort or relaxation. Having the purpose of manipulation to relax the muscles, increase tissue flexibility, get calm the nervous tension in the area of massage so that there is a significant difference from the group that gets treatment or massage manipulation after high intensity training. The same as getting a cold water immersion treatment that is explained by doing water immersion with cold temperature is a method of immersion in cold water with a vertical position (Tsaqif, 2018). Cold water immersion is a recovery method where a part of the body is immersed in cold temperature water with a constant temperature (Akhsan, 2018). Cold therapy and cold water immersion is the use of cold water to treat symptoms of inflammation and pain (Rijal, 2019). Implemented either after training to soak in cold temperature water breaks the lactic acid that accumulates in the body from physical activity that has been done. So that it has an impact on the central autonomic nervous system that can recover effectively, therefore there is a significant difference between groups that do cold therapy treatment and not.

The most important thing to consider after training or competition is recovery. Rest helps the whole body adjust when after physical activity. Increasing recovery time as a means of helping athletes maintain fitness and performance status and can increase their likelihood of participation and competition. Therefore, the three groups were given different treatments with the control group using passive rest, the sports massage group with treatment, and the cold water immersion group with cold water immersion, this was done in this study to determine effective recovery by resting.

On the variable level of stress reduction with the daily wellness questionnaire measuring instrument, there is no difference in effectiveness between sports massage and cold water immersion in reducing the level of stress after training PPLP athletes among the three groups. The DWQ measuring instrument is a measuring tool used by the body's response to intense physical exercise which includes changes in mood, sleep quality, energy levels, muscle soreness and stress as measured by the Daily wellness questionnaire. One of the reasons why there was no significant difference in stress levels in the sprinters was because this tool was only used once on the same day, and should have been used the day after to get maximum results on other variable components. There was no significant difference in stress levels between the groups because the intensity of the training was not too high for them so the stress levels were also affected by that.

According to research conducted by Parwata (2015) fatigue is basically reduced productivity reduced work capacity and reduced endurance and is explained in a state of fatigue, the state of subjective fatigue dominates. Therefore, the possibility that can occur that athletes in perceiving the level of stress reduction is still subjective in assessing and training intensity designed is not a stressor for them because stress does not always have a negative connotation. The impact of stress can be both positive and negative. In determining the state of the athlete, it is necessary to have a certain level of sports stress and gain performance in order to achieve success in sports. On the other hand, excessive levels of stress can affect performance and damage parts of the body. This ability to adapt to stress can be improved by developing systematic practices. Performance and Avoidance or the result of overload. The lack of difference in effectiveness in reducing stress levels may be due to athletes being well adapted to their usual training or activities.

The opinion expressed by Jarvis (in Walerinczyk & Stolarski, 2021) explains that one of the goals of sports psychology is to improve athletic performance, and not only about performance but sport is seen as a place or laboratory in research on efficiency under high pressure and the strong emotions that accompany it. So stress can occur and not in athletes who want to improve their performance and how athletes manage high pressure and emotions in high intensity training.

CONCLUSIONS

Based on the results of research and discussion, it can be concluded that there are differences in the effectiveness of sports massage and cold water immersion on post-training fatigue recovery in PPLP sprinters. 1) There is a difference in the effectiveness of sports massage and cold water immersion on post-training fatigue recovery in PPLP sprinter athletes. In the pulse rate and RPE variables, there is a significant difference between the Sport Massage, Cold Water Immersion and Control groups. However, between the sport massage and cold water immersion groups there is no significant difference. 2) There is no difference in the effectiveness of sport massage and cold water immersion on the recovery of post-training stress levels in PPLP sprinters. It is interpreted that there is no significant difference between Sport Massage, Cold Water Immersion and Passive Rest on reducing post-training stress levels.

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