



The Synergistic Impact of Combined Massage and Stretching During Halftime on Accelerated Recovery in Football: A Quasi-Experimental Study on Lactic Acid Clearance, Pain Reduction, and Flexibility Improvement

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Abstract

Background. Soccer players frequently encounter performance declines early in the second half due to diminished muscle temperature and the accumulation of fatigue indicators, such as lactic acid.

Objectives. This study aimed to examine the efficacy of massage, stretching, and their combination in facilitating physical recovery during a halftime break in a match. It focused on how quickly lactic acid leaves the body, how much it reduces discomfort from exercise, and how it improves flexibility.

Materials and methods. This study employed a quasi-experimental design, involving 36 male soccer players from UNESA FC. These players were divided into four groups: sports massage (SM), muscle stretching (MS), combination (CMS), and control (CON). The participants engaged in maximum treadmill running (90–95% HR_{max}) followed by designated recovery procedures: SM, MS, CMS, and CON. Before, during, and after the intervention, lactic acid levels (measured with a lactate meter), range of motion (measured with a goniometer), and pain levels (measured with a visual analogue scale) were all checked. Subsequently, these measures underwent statistical analysis comprising paired t-tests, Wilcoxon tests, MANOVA, and Kruskal-Wallis tests.

Results. This study revealed that the CMS group had the most substantial decrease in lactic acid (12.68 ± 2.37 to 5.16 ± 1.04 mmol/L, $p = 0.000$), outperforming the SM, MS, and CON groups ($p < 0.005$). Furthermore, pain reduction scores were also found significant in the CMS (3.44 ± 2.35 to 1.67 ± 1.58) and MS (4.67 ± 1.11 to 1.33 ± 1.00) groups ($p < 0.05$). Similarly, flexibility improvement was superior in CMS (right ROM: $p = 0.007$; left ROM: $p = 0.003$), while CON showed no marked changes. The MANOVA test revealed significant intergroup differences in post-intervention outcomes ($p < 0.05$).

Conclusions. The findings of this study indicate that the combination of stretching and massage during halftime of a football match helps maximise healing by lowering lactic acid, relieving discomfort, and improving flexibility or range of motion. This approach lowers second-half performance drops and injury risks.

Keywords: football, massage, stretching, recovery.

Introduction

A football match consists of two halves of 45 minutes each, separated by a 15-minute break called halftime. The

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players use this break to mentally recover, to hydrate, and to receive tactical instructions to be applied in the second half. Additionally, the halftime break allows the players to recover from any injuries they may have sustained. However, during this 15-minute break, the muscle temperature decreases, which can have a negative impact on the players by affecting their performance in the early minutes of the second half

and making them more prone to injury (Christaras et al., 2023). Moreover, studies show that football players run less and with a lower intensity in the first 10–15 minutes of the second half compared to the same interval in the first half. In a recent study, Russell et al. (2016) reported this issue among the English Premier League players. In the first 15 minutes of the second half, they noted that the number of decelerations, the distance covered at high intensity, and the running speed of the players differed significantly from those in the first half. Other studies have reported that kicking accuracy decreased by 38.02% (Alkhalaf, 2023) and kicking speed decreased by 8.5% (Ferraz et al., 2011). They believed that fatigue experienced by the players was the potential factor of these declines. Other scholars argued that the decline in performance in the first few minutes after the break might be caused by less than optimal recovery in the first half, a lack of preparation for the second half, and other factors such as internal motivation and tactical instructions by the coach (Christaras et al., 2023).

Football is a sport that uses aerobic and anaerobic energy systems, with a greater emphasis on the anaerobic system (Bekris et al., 2016; Turna et al., 2023). Activities that rely on the anaerobic energy system use energy from both the anaerobic glycolysis system and ATP-PCr. These activities are carried out with high intensity in a short time (Kafrawi et al., 2024a). As a result of anaerobic exercise, heart rate and lactic acid levels will rise, delayed onset muscle soreness (DOMS) will happen later, and range of motion (ROM) and malondialdehyde (MDA) levels will drop (Almeida et al., 2019; Awang Daud et al., 2022; Pesenti et al., 2021; Rusdiawan et al., 2020a).

When the DOMS occurs, players feel pain and stiffness, which increases after exercise and causes a decrease in joint range of motion (ROM) (Peake et al., 2017). Additionally, accumulated lactic acid levels cause decreased muscle contraction abilities and fatigue (Sari et al., 2019). When the level increases, the pH will decrease, which causes enzyme performance to become slower. As a result, the ATP formation process is inhibited. This condition typically causes fatigue and hampers an individual to achieve their best performance (Hartono et al., 2019).

Fatigue is a decrease in the ability to maintain physical and mental activity during training or matches. It can occur during high-intensity training or competition due to a tight schedule. Frequently, it is one of the predicting factors of an athlete's decreased performance (Rampinini et al., 2011; Robineau et al., 2012). Thus, it is necessary to prevent the players from experiencing excessive fatigue, and one of the strategies is maximising recovery. Recovery is a process aimed at restoring the body's metabolic function to normal before the activity (Fahmi & Ashadi, 2019). In football, recovery from intensive training or competition is crucial for maintaining athlete performance. Faster recovery leads to greater advantage. This can be reached by neutralising the accumulation of lactic acid. In football, athletes who recover faster from intensive training or competition have a greater advantage (Marqués-Jiménez et al., 2017; Pinar et al., 2012).

Previous studies have widely discussed this topic and examined several methods to speed up recovery, such as muscle stretching and sports massage. Muscle stretching is defined as applying a force to a muscle structure to achieve changes in length in order to increase joint range of motion

(ROM), reduce muscle stiffness or pain, and also prepare for physical activity (Sands et al., 2013). This activity is generally prescribed to increase strength recovery, ROM, and DOMS after physical activity (Afonso et al., 2021). Muscle stretching can neutralise lactic acid, muscle spasms, and muscle pain (Zulaini et al., 2021). Muscle spasms that limit joint range of motion can also be overcome by doing muscle stretching (Zulaini et al., 2021). According to Herbert et al. (2011), there are some stretching models available to sports players, such as the four movements in Anderson's stretching model. However, these movements are unsuitable during a football match break because they require standing. Therefore, the present research proposes a series of ball stretches that can be performed while lying on the back or stomach to enhance player comfort.

Besides stretching, plenty of research offers massage as an alternative therapy because it expedites healing, diminishes pain intensity, and facilitates the restoration of damaged muscles (Kafrawi et al., 2024b). It is also effective in decreasing lactic acid concentrations (Welis et al., 2023) and beneficial when administered for durations of 10, 20, 30, or 60 minutes (Hunt et al., 2019; Piotrowska et al., 2021). Other research indicates that sports massage techniques may diminish lactic acid buildup (Budak, 2023) and enhance recovery by artificially stimulating the venous and lymphatic pump mechanisms, therefore expediting blood circulation (Davis et al., 2020). Massage is also advantageous in enhancing microcirculation, particularly in small blood vessels with diameters under 100 micrometers. It facilitates the transport of oxygen and nutrients to cellular tissues and the removal of metabolic waste. This process aids in eliminating lactic acid from tissues, enabling its diffusion into the bloodstream (Güven et al., 2019). This can happen because the lactic acid in the bloodstream is transported to the liver via the Cori cycle for conversion into glucose (Freire Jorge et al., 2017).

Although this sports massage model is beneficial, its implementation during the match break has some obstacles. For example, the players might feel pain, so the results may be less optimal. For this reason, this research proposes a combination of stretching massage models as an alternative to reduce pain during massage, namely the lower extremity body, with stretching techniques, massage, and stretching again.

Materials and Methods

This study employed a quasi-experiment research method, examining the influence of a variable on another variable through various cause-and-effect scenarios (McDonough, 2017). In this experiment, a "Purposive Randomized Control Group Pretest-Posttest Design" was used. The purpose was to identify changes caused by muscle stretching, sports massage, and the combination of sports massage and muscle stretching. Details of the research design are illustrated in Figure 1.

Study participants

This study involved 36 football players from UNESA FC as the sample. The sample size was determined using the Slovin formula with a 5% margin of error. The samples were then divided into 4 groups of equal size using the simple random sampling method so that each sample had

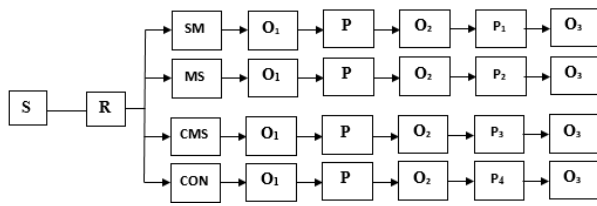


Fig. 1. Research design

Note: S: Research sample. R: Randomisation. SM: Sports Massage group. MS: Muscle Stretching group. CMS: Combination of Sports massage and Stretching group. CON: Control Group (sit down and rest). O1: Pre-test (ROM and lactic acid levels test). O2: Post-test 1 (Exercise pain, ROM and lactic acid levels test). O3: Post-test 2 (Exercise pain, ROM and lactic acid levels test). P: Doing maximum intensity treadmill running (90%-95% HR Maks). P1: Sport massage. P2: Muscle stretching. P3: Combination of Sports Massage and Stretching. P4: No treatment (just sit down and rest)

the same opportunity to enter the group (Firmansyah & Dede, 2022; Ramadhani Khija & Ludovick Uttoh, 2015). After that, the selected samples were given informed consent and signed a willingness to receive treatment as well as tests and measurements of lactic acid, pain, and range of motion (ROM). As the study involved human subjects, it complied with the Declaration of Helsinki. In particular, it has been granted ethical approval by the Universitas Negeri Semarang Health Research Ethics Committee, under reference number 068/KEPK/FK/KLE/2024, which is in line with the Declaration of Helsinki.

Study organisation

As mentioned earlier, this study involved four groups: the Sports Massage (SM), Muscle Stretching (MS), Combination of Sports Massage and Stretching (CMS), and Control (CON) groups. The night before the pretest, the samples were asked to fast but were allowed to drink water as needed. During the pretest, they were requested to come at 07:00 am to undergo a health check. Following the health check, we administered a pretest to each group, collecting data on pain, range of motion, and lactic acid levels. After the pretest, they ran on a treadmill with maximum intensity (90-95% of maximum HR). Five minutes after the treadmill session, the research samples underwent posttest 1, which involved pain, range of motion, and lactic acid level measurements. Next, different treatments were given depending on the sample's group. For example, sports massage treatment was given to the SM group, muscle stretching was given to the MS group, and a combination of both was given to the CMS group for 10 minutes. On the other hand, no treatment was given to the CON group as they served as the control group. Then, the samples were measured again (posttest 2) to check their pain, ROM, and lactic acid levels after the treatment. Table 1 below explains how sports massage, stretching, and a combination of massage and stretching are implemented in this experiment.

Measurement

This study aimed to measure several indicators, such as exercise pain, ROM, and lactic acid levels. When measuring

lactic acid and ROM, the data were collected 3 times: pretest, posttest 1, and posttest 2. Meanwhile, exercise pain examination was only carried out 2 times during posttest 1 and posttest 2. The pretest was carried out before exercise by requesting the research samples to run on a treadmill until their heart rates reached maximum intensity (95%). On the other hand, posttest 1 was carried out after exercise, and posttest 2 was carried out after a sports massage, stretching, or control (without recovery treatment).

After the data collection, lactic acid was quantified via a Roche Cobas Accutrend Plus GCTL Meter. The acid was utilised by extracting blood from the sample fingertips and thereafter applying it to the apparatus (Rusdiawan et al., 2020; Rusdiawan & Habibi, 2020b). To measure pain after running, a visual analog scale was used (Delgado et al., 2018; Han et al., 2011). Meanwhile, ROM was measured using a goniometer on the left and right knee joints expressed in angular units (Shah, 2008) knee flexion and extension range of motion (ROM).

Statistical analysis.

The data were then processed using the Microsoft Office Excel 2016 and SPSS Series 23 programs with a significance level 0.05. It involved several data analyses. First, a descriptive statistical test was used to determine the mean and standard deviation of the dependent variable in each group during the pretest and posttest. After that, a normality test was carried out as a prerequisite to determine the appropriate statistical test. In this study, the data were considered normal if $p > 0.05$. The homogeneity test was also administered to ensure variance between similar groups, with homogeneous criteria if $p > 0.05$. Following that, the paired t-test was performed to test the effect of treatment by comparing pretest and posttest values, where the value is considered significant if $p < 0.05$. Additionally, the Manova test was done to test the mean difference between groups on all variables, where the value is considered significant if $p < 0.05$. Finally, the study employed the Post Hoc test to determine the difference in treatment between groups if the Manova results show a significant difference ($p < 0.05$).

Results

This section outlines whether certain types of massage or stretching can lower pain during massage. To achieve the goal, this study involved 36 football players from UNESA FC with the mean \pm SD of their physical characteristics included age 21.56 ± 1.29 years, weight 64.56 ± 3.85 kg, height 172.79 ± 2.81 cm, and training experience 14.52 ± 2.86 years. The results of these statistics are shown in Table 2.

Table 2 shows that lactic acid levels increased in all groups after high-intensity exercise, followed by a decrease after treatment. The highest decrease in lactic acid levels occurred in the CMS group, with an average change from 12.68 ± 2.37 mmol/L at posttest 1 to 5.16 ± 1.04 mmol/L at posttest 2. In addition, exercise-related pain also decreased in all groups after treatment, with the MS group experiencing the largest decrease, from 4.67 ± 1.11 to 1.33 ± 1.00 . In terms of range of motion (ROM), there was a substantial increase after treatment, especially in the CMS group for the right and left ROM. This increase indicates that the combination

Table 1. Implementation of treatment

Treatment	Procedure
Exercise	The exercise in this study was done by running on a treadmill. The duration of the run was determined by each participant's performance until their heart rate reached 95% of their maximum heart rate.
Sports Massage	Sports massage was given to the lower extremities of the participants. The massage techniques were effleurage, petrissage, shaking, tapotement, and walking. Each technique was performed with six repetitions, with the opening and closing done by effleurage.
Stretching	<p>This stretching was done passively with the assistance of another person. The procedures were described as follows:</p> <p>The assistant's left hand held the upper thigh, and the right hand was attached to the sole of the participant's right foot. Then, it was pushed and held in a count of 1-6, 1-8, and vice versa.</p> <p>The participant's right leg was bent, with the left hand holding the knee and the right hand holding the sole of the participant's foot. The participant pushed with a count of 1-6, 1-8, and vice versa.</p> <p>The participant's right leg was lifted 30° and placed on the assistant's thigh. Then, the left hand pressed the knee down, and the right hand pushed with a count of 1-6, 1-8, and vice versa.</p> <p>The participant's leg was raised by 60°. The left hand pressed the knee, and the right hand held the sole of the foot. Then, it was pushed with a count of 1-6, 1-8, and vice versa.</p> <p>The right leg was lifted 120° with the left hand, and the right hand held the participant's left foot and vice versa.</p> <p>The participant's right leg was raised 90°, clamped with both of the masseur's knees. Additionally, the right arm was placed on the participant's sole and pressed with the addition of the masseur's body weight. This position was held for a count of 1-6, 1-8, and vice versa.</p> <p>Both knees were bent and pushed until they touched the participant's chest. This position was held for a count of 1-6.</p> <p>The left hand held the upper thigh above the knee, and the right arm was attached to the participant's right sole. Then, it was pushed and held for a count of 1-6, 1-8, and vice versa.</p> <p>The participant's right leg was bent, while the left hand held the knee, and the right hand held the participant's sole. They were push for a count of 1-6, 1-8, and vice versa.</p> <p>The participant's right leg was raised 30° and placed on the assistant's thigh. Then, the left hand pressed the knee down, and the right hand pushed for a count of 1-6, 1-8, and vice versa.</p> <p>The player's legs were raised by 60° while the left hand pressed the knee. Then, the right hand held the sole of the foot, then was pushed for a count of 1-6, 1-8, and vice versa.</p> <p>The right leg was lifted 120° with the left hand. The right hand held the player's left leg and vice versa.</p> <p>The participant's right leg was lifted 90° and clamped with both assistant's knees. The right arm was placed on the participant's soles and pressed with the addition of the assistant's body weight held for a count of 1-6, 1-8, and vice versa.</p> <p>Both knees were bent and pushed until they touched the participant's chest. Then, this position was held for a count of 1-6.</p>
Combination of massage and stretching	<p>The procedures of combined massage and stretching are described as follows:</p> <p>Participants were in a supine position, where both legs were raised with the ankle grip and shaken rhythmically up and down.</p> <p>Both legs were pulled up at a 90° angle, while both knees were straightened. The soles of both feet were pushed down with body weight, counting 1-6. After that, release the soles and then push again, counting 1-7, release and push again, and counting 1-8.</p> <p>Both legs are extended with both legs open, stretched to a count of 1-6, released, counted again 1-7, released, and counted again 1-8.</p> <p>Both legs were spread apart and stretched with a count of 1-6 off, a count of 1-7 off, and a count of 1-8.</p> <p>With both knees bent simultaneously, the knees were pushed forward for a count of 1-6, released for a count of 1-7, and then pushed again for a count of 1-8.</p> <p>The front, inner, and outer upper legs were massaged by several techniques, such as effleurage, shaking, and hitting with light pressure. The tempo was quick and finished with more effleurage.</p> <p>The front and back lower legs were massaged by effleurage. Meanwhile, the tibial and the back parts were treated with effleurage, petrissage, shaking, and tapotement, followed by petrissage of the soles of the feet.</p> <p>The player was positioned in a prone position. The upper back was cooled down by effleurage, petrissage, shaking, and tapotement and effleurage.</p> <p>The lower cooling-down massage targeted the gastrocnemius through a combination of effleurage, petrissage, shaking, and rhythmic light strokes.</p> <p>Then, the soles of the feet were massaged with effleurage, petrissage, shaking, and effleurage.</p> <p>Both legs were straightened and extended again with a count of 1-6 and 1-8.</p>

of massage and stretching is effective in restoring muscle flexibility. These results also provide a comprehensive picture of the effect of treatment on the recovery of football players' physical conditions.

After describing the participants' characteristics, a difference test was required before and after treatment

(pretest-posttest). If the variables were normally distributed, a paired t-test was employed. On the other hand, a Wilcoxon test was done for non-normally distributed variables. The objective of this test was to assess the impact of the administered treatments, such as sports massage, stretching, and a combination of massage and stretching, on each group.

Table 2. Descriptive statistics of lactic acid, exercise pain, and ROM

Group		Variable	Mean ± SD	Min	Max
SM	Lactic Acid	Pretest	5.91 ± 2.25	3.40	9.60
		Posttest 1	11.79 ± 2.37	9.30	15.90
		Posttest 2	7.21 ± 2.87	3.10	12.40
		Δ Pretest - Posttest 1	-5.88 ± 2.31	-9.20	-2.60
		Δ Pretest - Posttest 2	-1.30 ± 2.88	-5.20	3.00
		Δ Posttest 1 - Posttest 2	4.58 ± 1.04	2.80	6.20
MS	Lactic Acid	Pretest	3.23 ± 2.1	1.50	7.10
		Posttest 1	11.38 ± 2.35	9.50	16.30
		Posttest 2	6.69 ± 2.13	4.50	10.50
		Δ Pretest - Posttest 1	-8.14 ± 2.1	-9.90	-3.10
		Δ Pretest - Posttest 2	-3.45 ± 2.28	-8.90	-0.50
		Δ Posttest 1 - Posttest 2	4.69 ± 2.00	0.70	7.60
CMS	Lactic Acid	Pretest	5.50 ± 1.01	3.30	6.70
		Posttest 1	12.68 ± 2.37	10.60	17.60
		Posttest 2	5.16 ± 1.04	4.20	7.40
		Δ Pretest - Posttest 1	-7.18 ± 2.12	-11.30	-4.70
		Δ Pretest - Posttest 2	0.34 ± 1.10	-1.10	2.00
		Δ Posttest 1 - Posttest 2	7.52 ± 1.50	5.30	10.20
CON	Lactic Acid	Pretest	4.26 ± 2.43	1.40	10.00
		Posttest 1	9.99 ± 3.40	3.50	14.60
		Posttest 2	8.40 ± 3.00	3.10	12.60
		Δ Pretest - Posttest 1	-5.73 ± 2.67	-10.40	-0.60
		Δ Pretest - Posttest 2	-4.14 ± 2.35	-8.50	-0.20
		Δ Posttest 1 - Posttest 2	1.59 ± 0.82	0.40	2.60
SM	ROM Dextra	Pretest	112.22 ± 4.41	105.00	120.00
		Posttest 1	107.78 ± 2.64	105.00	110.00
		Posttest 2	118.33 ± 4.33	110.00	125.00
		Δ Pretest - Posttest 1	4.44 ± 4.64	-5.00	10.00
		Δ Pretest - Posttest 2	-6.11 ± 4.17	-10.00	0.00
		Δ Posttest 1 - Posttest 2	-10.56 ± 4.64	-15.00	-5.00
MS	ROM Dextra	Pretest	111.11 ± 6.51	100.00	120.00
		Posttest 1	104.44 ± 4.64	100.00	110.00
		Posttest 2	114.44 ± 4.64	110.00	120.00
		Δ Pretest - Posttest 1	6.67 ± 6.12	-5.00	15.00
		Δ Pretest - Posttest 2	-3.33 ± 6.12	-15.00	5.00
		Δ Posttest 1 - Posttest 2	-10.00 ± 2.50	-15.00	-5.00
CMS	ROM Dextra	Pretest	112.78 ± 8.33	95.00	120.00
		Posttest 1	107.22 ± 2.64	105.00	110.00
		Posttest 2	117.22 ± 2.64	115.00	120.00
		Δ Pretest - Posttest 1	5.56 ± 8.82	-15.00	15.00
		Δ Pretest - Posttest 2	-4.44 ± 9.17	-25.00	5.00
		Δ Posttest 1 - Posttest 2	-10.00 ± 3.54	-15.00	-5.00
CON	ROM Dextra	Pretest	115.00 ± 4.33	110.00	120.00
		Posttest 1	109.44 ± 8.82	100.00	125.00

Table 2 (continued)

Group	Variable	Mean \pm SD	Min	Max
	Posttest 2	108.89 \pm 6.01	100.00	120.00
	Δ Pretest - Posttest 1	5.56 \pm 6.82	-5.00	15.00
	Δ Pretest - Posttest 2	6.11 \pm 5.46	0.00	15.00
	Δ Posttest 1 - Posttest 2	0.56 \pm 7.68	-10.00	15.00
SM	ROM Sinistra			
	Pretest	111.39 \pm 2.20	110.00	115.00
	Posttest 1	108.61 \pm 3.77	105.00	115.00
	Posttest 2	116.67 \pm 5.59	105.00	125.00
	Δ Pretest - Posttest 1	2.78 \pm 2.32	0.000	5.00
	Δ Pretest - Posttest 2	-5.28 \pm 5.65	-15.00	5.00
	Δ Posttest 1 - Posttest 2	-8.06 \pm 5.83	-20.00	0.00
MS	ROM Sinistra			
	Pretest	110.56 \pm 3.91	105.00	115.00
	Posttest 1	110.56 \pm 7.68	100.00	125.00
	Posttest 2	115.00 \pm 5.59	105.00	120.00
	Δ Pretest - Posttest 1	0.00 \pm 9.68	-20.00	10.00
	Δ Pretest - Posttest 2	-4.44 \pm 7.26	-15.00	5.00
	Δ Posttest 1 - Posttest 2	-4.44 \pm 5.83	-15.00	5.00
CMS	ROM Sinistra			
	Pretest	113.89 \pm 3.33	110.00	120.00
	Posttest 1	104.44 \pm 5.27	95.00	110.00
	Posttest 2	117.22 \pm 2.64	115.00	120.00
	Δ Pretest - Posttest 1	9.44 \pm 5.27	0.00	15.00
	Δ Pretest - Posttest 2	-3.33 \pm 5.00	-10.00	5.00
	Δ Posttest 1 - Posttest 2	-12.78 \pm 6.18	-25.00	-5.00
CON	ROM Sinistra			
	Pretest	117.78 \pm 4.41	110.00	125.00
	Posttest 1	108.33 \pm 4.33	100.00	115.00
	Posttest 2	108.33 \pm 6.12	100.00	120.00
	Δ Pretest - Posttest 1	9.44 \pm 5.27	5.00	20.00
	Δ Pretest - Posttest 2	9.44 \pm 4.64	5.00	15.00
	Δ Posttest 1 - Posttest 2	0.00 \pm 6.61	-10.00	10.00
SM	Exercise pain			
	Posttest 1	2.56 \pm 2.01	0	5
	Posttest 2	0.78 \pm 0.97	0	2
	Δ Posttest 1 - Posttest 2	1.78 \pm 1.64	0	4
MS	Exercise pain			
	Posttest 1	4.67 \pm 1.11	3	6
	Posttest 2	1.33 \pm 1.00	0	3
	Δ Posttest 1 - Posttest 2	3.33 \pm 1.32	2	5
CMS	Exercise pain			
	Posttest 1	3.44 \pm 2.35	0	6
	Posttest 2	1.67 \pm 1.58	0	4
	Δ Posttest 1 - Posttest 2	1.78 \pm 1.30	0	4
CON	Exercise pain			
	Posttest 1	3.89 \pm 2.47	0	7
	Posttest 2	3.56 \pm 2.01	0	6
	Δ Posttest 1 - Posttest 2	0.33 \pm 1.32	-2	2

Note: Δ is the difference

Table 3 below presents the results of the paired t-test and Wilcoxon test for each variable.

Table 3 shows that lactic acid levels in all groups significantly decreased after the intervention, with a p-value < 0.05

in the paired test and Wilcoxon t-test. Among the examined groups, the CMS group was reported to have the most significant decrease between Posttest 1 and Posttest 2, with a p-value of 0.000. This decrease indicates the effectiveness of

Table 3. Effect of maximum running exercise and recovery on lactic acid levels, ROM and exercise-induced pain

Group	Variable	p (sig)			
		Lactic Acid	ROM Dextra	ROM Sinistra	Exercise Pain
SM	Pretest - Posttest 1	0.008 [†]	0.033 [†]	0.007 [†]	
	Pretest - Posttest 2	0.260	0.015 [†]	0.023 [†]	
	Posttest 1 - Posttest 2	0.000 ^{††}	0.007 [†]	0.003 ^{††}	0.027 [†]
MS	Pretest - Posttest 1	0.000 ^{††}	0.023 [†]	0.760	
	Pretest - Posttest 2	0.008 [†]	0.131	0.104 [†]	
	Posttest 1 - Posttest 2	0.008 [†]	0.000 ^{††}	0.054	0.007 [†]
CMS	Pretest - Posttest 1	0.000 ^{††}	0.136	0.011 [†]	
	Pretest - Posttest 2	0.376 [*]	0.161	0.840	
	Posttest 1 - Posttest 2	0.000 ^{††}	0.007 [†]	0.007 [†]	0.003 ^{††}
CON	Pretest - Posttest 1	0.000 ^{††}	0.040 ^{††}	0.007 [†]	
	Pretest - Posttest 2	0.001 ^{††}	0.010 ^{††}	0.000 [†]	
	Posttest 1 - Posttest 2	0.000 ^{††}	0.834 [*]	1.000	0.471 [*]

(*) using the Paired t test; (without*) using the Wilcoxon test; (†)significantly different

combining massage and stretching in accelerating the recovery of lactic acid levels.

Meanwhile, the changes in dextra and sinistra ROM were measured to evaluate muscle flexibility after intervention. In this sense, the SM group showed significant improvement after intervention with $p = 0.015$ from pretest to posttest 2. The left ROM showed a similar improvement, with a p-value of 0.023 in the same generation. In addition, the CMS group was reported to gain optimal results with $p < 0.007$ in various pre- and posttest comparisons. The next variable measured in this study was pain caused by exercise (exercised-induced pain). This variable indicated a notable reduction in both the MS and CMS groups, with a significant decline in pain from posttest 1 to posttest 2. The yielding p-values for both groups were 0.007 and 0.003, respectively. These findings indicate that muscle stretching techniques and a combination of massage and stretching effectively alleviate pain following high-intensity exercise.

Although the findings indicate a positive trend across the groups, the combination of massage and stretching (CMS group) yielded superior outcomes in diminishing lactic acid levels, enhancing range of motion, and alleviating exercise-related discomfort during massage. The substantial decrease in lactic acid levels within the CMS group suggests that the combination of these strategies may represent the most efficacious method for physical recovery among football players.

Other advanced analyses were conducted in this research, involving the MANOVA and Kruskal-Wallis tests. As shown in Table 4, no significant difference is found between any of the groups for the lactic acid level variable (Δ Pretest lactic acid - Posttest 1 lactic acid) and the ROM Dextra variable (Δ Pretest ROM Dextra - Posttest 1 ROM Dextra). This is because the significance value for both variables was more than 0.05 ($p > 0.05$). Apart from these two variables, the results of the MANOVA and Kruskal-Wallis tests for the other two show a significant difference ($p < 0.05$).

Table 5 illustrates the differences in lactic acid, ROM, and exercise pain levels across the groups using the Mann-

Table 4. Manova and Kruskal Wallis test results

	Variable	p (sig)
Lactic acid	Δ Pretest - Posttest 1	0.119
	Δ Pretest - Posttest 2	0.001 [†]
	Δ Posttest 1 - Posttest 2	0.000 [†]
Exercise pain	Δ Posttest 1 - Posttest 2	0.005 ^{††}
ROM Dextra	Δ Pretest - Posttest 1	0.601 [*]
	Δ Pretest - Posttest 2	0.001 [†]
	Δ Posttest 1 - Posttest 2	0.003 ^{††}
ROM Sinistra	Δ Pretest - Posttest 1	0.009 [†]
	Δ Pretest - Posttest 2	0.000 [†]
	Δ Posttest 1 - Posttest 2	0.000 [†]

(*) using the Kruskal-Wallis test; (without*) using the MANOVA test; (†)significantly different

Whitney and Bonferroni tests. The results of the Bonferroni test showed that the lactic acid levels of the control group (CON) experienced the slightest decrease in lactic acid levels compared to the SM, MS, and CMS treatment groups ($p < 0.005$). Further, the lactic acid levels of the CMS group decreased better than the SM, MS, and CON groups, with significance values $p = 0.003$, $p = 0.005$, and $p = 0.000$, respectively. Meanwhile, the SM group did not experience a greater decrease in lactic acid levels than the MS group ($p = 1.000$).

For the exercise pain variable, the MS group had a significant effect compared to the CON group. However, when compared to the SM and CSM groups, the results were not significant. This means stretching can reduce pain better than the CON group but not better than the SM and CSM groups. Finally, in the ROM variable, both dextra and sinistra ROM showed that the provision of sports massage, stretching, and a combination of sports massage with stretching had a significant effect on improving ROM after maximum

Table 5. Differences in lactic acid, ROM, and exercise pain in the SM, MS, CMS and CON group

Dependent Variable	Group	p (sig.)			
		Pre-post1	Pre-post2	Post1-post2	
Lactic acid	SM	CMS	-	1.000	0.003 [†]
		MS	-	0.511	1.000
		CON	-	0.114	0.003 [†]
	CMS	MS	-	0.010 [†]	0.005 [†]
		CON	-	0.002 [†]	0.000 [†]
		MS	CON	-	1.000
Exercise Pain	SM	CMS	-	-	1.000
		MS	-	-	0.259
		CON	-	-	0.378
	CMS	MS	-	-	0.259
		CON	-	-	0.378
		MS	CON	-	-
ROM Dextra	SM	CMS	-	0.272 [*]	0.243 [*]
		MS	-	0.215 [*]	0.701 [*]
		CON	-	0.001 [†]	0.004 [†]
	CMS	SM	-	0.927 [*]	1.000 [*]
		CON	-	0.008 [†]	0.002 [†]
		SM	CON	-	0.005 [†]
ROM Sinistra	SM	CMS	0.323	1.000	0.865
		MS	1.000	1.000	1.000
		CON	0.323	0.000 [†]	0.047 [†]
	CMS	MS	0.032 [†]	1.000	0.035 [†]
		CON	1.000	0.002 [†]	0.000 [†]
		MS	CON	0.032 [†]	0.001 [†]

(*) using the Mann Whitney Test; (without*) using the Bonferroni test; (†)significantly different

intensity running activity ($p < 0.005$). However, the SM group did not outperform the MS group, and vice versa.

Discussion

The study investigates the impact of sports massage, muscle stretching, and a combination of both on the physical recovery of football players during match breaks. In particular, it focuses on lactic acid levels, pain after exercise, and range of motion (ROM). Since blood circulation plays a crucial role in muscle rehabilitation, effective oxygen and nutrient delivery through haemoglobin in red blood cells is essential for muscle health and function (Yoon et al., 2024). Many scholars argue that sports massage and stretching influence recovery by regulating blood flow and velocity, a key factor in muscle healing (González-Alonso, 2012; Joyner & Casey, 2015). The regulation of blood flow to skeletal muscle is crucial to satisfy the oxygen requirements of contracting skeletal muscle and to extend exercise duration.

At the systemic level, one of the main factors that affects this whole response is the production of cardiac output, which is caused by a rise in heart rate and stroke volume. This output

meets the oxygen needs of active muscles and the perfusion pressure of other organs. In humans, these requirements may be adjusted by muscular stretching flexibility exercises, as well as variations in external temperature and pressure (Rowell, 2004).

Having more lactic acid in the body after intense exercise is normal because metabolic products build up during anaerobic activity (Rusdiawan et al., 2020). When lactate levels increase, blood pH decreases. This increase affects enzyme reactions and ATP production, leading to fatigue. Since intracellular acidosis influences muscle fatigue, reducing lactic acid levels to normal is necessary to reduce fatigue (de Lima et al., 2018; Theofilidis et al., 2018). In maximal exercise for 30-120 seconds, lactate levels can reach 15-25 mM, measured after 3-8 minutes of exercise. Generally, high levels of lactic acid indicate ischemia and hypoxia (Rusdiawan & Habibi, 2020a; Goodwin et al., 2007).

In this study, the combination of sports massage and stretching (CMS group) was documented as the most significant intervention that reduced lactic acid levels. It was more significant than sports massage only (SM group) or stretching only (MS group). This is in line with previous findings showing that massage helps accelerate blood and lymphatic circulation while stretching helps restore muscle length and prevent stiffness. Both contribute to the acceleration of lactic acid removal from muscles (Ferreira et al., 2011; Greenwood et al., 2008; Menzies et al., 2010).

Although exercise in the long term will increase muscle flexibility and reduce the risk of injury (Warneke et al., 2023), acutely, high-intensity exercise can reduce Range of Motion (ROM) (Jamurtas et al., 2005; Nosaka et al., 2002). Such decrease is caused by increased delayed onset muscle soreness and decreased range of motion (ROM) associated with connective tissue damage (Leite et al., 2023). Further, high-intensity exercise may trigger muscle pain, as expressed by Stožer, Vodopivec and Bombek (2020). If a person is unaccustomed to a specific exercise or if the intensity is greater than normal intensity or duration. High-intensity eccentric exercise most often causes exercise-induced muscle damage (EIMD). This is likely due to the recruitment of fewer motor units during eccentric exercise compared to other modes of contraction, leading to a higher force per active motor unit and increased mechanical stress (Stožer et al., 2020).

An effective recovery strategy is essential to maintain optimal performance and prevent overtraining or injury, enabling athletes to continue the next match in a stable condition with good performance (Dakić et al., 2023). In this study, the CMS group showed the most optimal results in all measured variables, indicating that the combination method is more effective than either method alone. Massage and stretching have complementary mechanisms in muscle recovery: massage facilitates recovery by increasing blood circulation, while stretching helps reduce muscle tension and increase flexibility. This combination appears to have a greater cumulative effect on post-workout recovery than either method alone (Weerapong, Hume, & Kolt, 2005a; Yoon et al., 2024).

Previous research suggests that muscular stretching can reduce muscle injury and exhaustion at the onset and conclusion of training and competition. However, the effectiveness of this technique varies depending on the

timing, methodology, and duration of the stretching. Both static and active stretchings significantly reduce lactate levels (Pinar et al., 2012). Sports massage is a technique for muscle rehabilitation that includes pressure application, diminishes passive muscular stiffness, elevates arterial pressure, and facilitates rapid muscle recovery (Weerapong, Hume, & Kolt, 2005b). Moreover, changes in heart rate and blood pressure following massage stimulate parasympathetic nerve activity, restoring the aroused body to a state of equilibrium (Jo et al., 2018).

In neurological models, massage is thought to improve pain relief and speed up muscle recovery by changing pain control mechanisms like mechanoreceptor and nociceptor sensitisation and diffuse pain inhibitory regulation (Aboodarda et al., 2015; Kent-Braun et al., 2012). It is believed to facilitate cellular gas exchange by exerting external pressure on the muscles to enhance blood circulation. Hence, massage is considered helpful in getting rid of any leftover oxidation in the muscles after exercise by improving blood flow to the limbs and small blood vessels (Barber et al., 2020; Kalichman & Ben David, 2017; Pointon & Duffield, 2012). The primary benefits of massage include alleviation of muscular discomfort, enhancement of parasympathetic nerve blood flow and circulation, and mitigation of inflammatory responses and associated trigger points, and physiological research indicates its efficacy in muscle recovery (Okamoto et al., 2013).

The combination of sports massage and stretching may provide a synergistic impact on the recovery process. Sports massage alleviates muscular tension and enhances circulation while stretching increases flexibility and range of motion. The increased blood flow from massage and the increased range of motion from stretching may help get rid of lactic acid faster, speed up the recovery of muscle function, and ease pain after long-term physical activity.

Current studies indicate that sports massage can beneficially influence an athlete's psychological preparedness, improve athletic performance, and facilitate recovery from training and competition (Brummitt, 2008). A thorough analysis indicated that massage may enhance skeletal muscle recovery following intense exercise, perhaps by augmented blood flow, less muscular spasm, and reduced inflammation (Best et al., 2008). Moreover, stretching has had a positive impact on muscle recovery, with research demonstrating that physical relaxation strategies, such as stretching, might mitigate occupational stress among healthcare professionals (Zhang et al., 2021).

Conclusions

In conclusion, the study found that a combination of sports massage and muscle stretching during a match break can accelerate the physical recovery of football players. This approach is better for reducing lactic acid levels, increasing range of motion, and reducing post-exercise pain rather than using massage or stretching alone. The treatment also helps reduce muscle fatigue and increases flexibility. The findings suggest that coaches and medical teams should consider this strategy to maximise player recovery, maintain optimal performance, and reduce injury risk due to muscle fatigue and strain. This strategy is particularly beneficial in sports requiring high energy and intense activity, like football.

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Conflict of interest

All researchers declare that there is no conflict of interest in this research.

References

- Christaras, M., Michailidis, Y., Mandroukas, A., Vardakis, L., Christoulas, K., & Metaxas, T. (2023). Effects of a Short Half-Time Re-Warm-Up Program on Matches Running Performance and Fitness Test Performance of Male Elite Youth Soccer Players. *Applied Sciences*, 13(4), 2602. <https://doi.org/10.3390/APP13042602>
- Russell, M., Sparkes, W., Northeast, J., Cook, C. J., Love, T. D., Bracken, R. M., & Kilduff, L. P. (2016). Changes in acceleration and deceleration capacity throughout professional soccer match-play. *Journal of Strength and Conditioning Research*, 30(10), 2839-2844. <https://doi.org/10.1519/JSC.0000000000000805>
- Alkhalwaleh, I. I. M. (2023). The Effect of Mental Fatigue on the Accuracy of the Direct Free Kick in Terms of Some Kinematic Variables for Football Players. *Asian Journal of Sports Medicine*, 14(2). <https://doi.org/10.5812/asjasm-134232>
- Ferraz, R., van den Tillaar, R., Ferraz, S., Santos, A., Mendes, R., Marinho, D. A., Cretu, M., & Marques, M. C. (2011). A pilot study on the influence of fatigue on kicking velocity in the soccer players. *Journal of Physical Education and Sport*, 11(2), 68-71.
- Bekris, E., Mylonis, L., Gioldasis, A., Gissis, I., & Kombodietta, N. (2016). Aerobic and anaerobic capacity of professional soccer players in annual macrocycle. *Journal of Physical Education and Sport*, 16(2), 527-533. <https://doi.org/10.7752/jpes.2016.02083>
- Turna, B., Yildirim, S., Bayazit, B., Akyüz, Ö., & Köse, M. (2023). The Aerobic and Anaerobic Performance of Elite Soccer Players: Pre-Season Assessment. *Journal of Pharmaceutical Negative Results*, 13(November 2022), 2022. <https://doi.org/10.47750/pnr.2022.13.S08.277>
- Kafrawi, F. R., Nurhasan, Wahjuni, E. S., Rusdiawan, A., Bekti, A. P., & Ayubi, N. (2024a). Sports massage has the potential to reduce ischemic muscle pain and increase range of motion after exercise. *Fizjoterapia Polska*, 2024(1), 60-65. <https://doi.org/10.56984/8ZG2EF85A3>
- Almeida, M., Bottino, A., Ramos, P., & Araujo, C. G. (2019). Measuring Heart Rate During Exercise: From Artery Palpation to Monitors and Apps. *International Journal of Cardiovascular Sciences*, 32(4), 396-407. <https://doi.org/10.5935/2359-4802.20190061>
- Awang Daud, D. M., Ahmady, F., Baharuddin, D. M. P., & Zakaria, Z. A. (2022). Oxidative Stress and Antioxidant Enzymes Activity after Cycling at Different Intensity and Duration. *Applied Sciences (Switzerland)*, 12(18). <https://doi.org/10.3390/app12189161>

- Pesenti, F. B., Souza, G. M., Hsiao, J. C. C., do Santos, A. L. L., de Santana, J. G., & de Souza Guerino Macedo, C. (2021). Strategies to control delayed onset muscle soreness and fatigue in paracanoe athletes. *Revista Brasileira de Ciencias Do Esporte*, 43(August). <https://doi.org/10.1590/rbce.43.e002321>
- Rusdiawan, A., & Habibi, A. I. (2020a). Efek pemberian jus semangka kuning terhadap tekanan darah, kadar asam laktat, dan daya tahan anaerobic setelah aktivitas anaerobic. *Jurnal SPORTIF: Jurnal Penelitian Pembelajaran*. https://doi.org/10.29407/JS_UNPGRI.VI.13712
- Peake, J. M., Neubauer, O., Gatta, P. A. D., & Nosaka, K. (2017). Muscle damage and inflammation during recovery from exercise. *Journal of Applied Physiology*, 122(3), 559-570. <https://doi.org/10.1152/jappphysiol.00971.2016>
- Sari, R., Harahap, N., Siregar, N., & Rispani, M. (2019). The Effect of Massage to Decrease Lactic Acid Levels after Anaerobic Physical Activity. *The 9th Annual International Seminar On Trends In Science And Science Education (AISTSSE)*. <https://doi.org/10.4108/eai.18-10-2018.2287364>
- Hartono, S., Widodo, A., Wismanadi, H., & Hikmatyar, G. (2019). The effects of roller massage, massage, and ice bath on lactate removal and delayed onset muscle soreness. *Sport Mont*, 17(2), 111-114. <https://doi.org/10.26773/smj.190620>
- Rampinini, E., Bosio, A., Ferraresi, I., Petruolo, A., Morelli, A., & Sassi, A. (2011). Match-related fatigue in soccer players. *Medicine and Science in Sports and Exercise*, 43(11), 2161-2170. <https://doi.org/10.1249/MSS.0B013E31821E9C5C>
- Robineau, J., Jouaux, T., Lacroix, M., & Babault, N. (2012). Neuromuscular fatigue induced by a 90-minute soccer game modeling. *Journal of Strength and Conditioning Research*, 26(2), 555-562. <https://doi.org/10.1519/JSC.0B013E318220DDA0>
- Fahmi, H., & Ashadi, K. (2019). The Comparison of Sport Massage and Hydrotherapy Cold Water to Physiological Recovery. *JUARA: Jurnal Olahraga*, 4(2), 196-209. <https://doi.org/10.33222/juara.v4i2.566>
- Marqués-Jiménez, D., Calleja-González, J., Arratibel, I., Delextrat, A., & Terrados, N. (2017). Fatigue and Recovery in Soccer: Evidence and Challenges. *The Open Sports Sciences Journal*, 10(1), 52-70. <https://doi.org/10.2174/1875399X01710010052>
- Pinar, S., Kaya, F., Bicer, B., Erzeybek, M. S., & Cotuk, H. B. (2012). Different recovery methods and muscle performance after exhausting exercise: Comparison of the effects of electrical muscle stimulation and massage. *Biology of Sport*, 29(4), 269-275. <https://doi.org/10.5604/20831862.1019664>
- Sands, W. A., McNeal, J. R., Murray, S. R., Ramsey, M. W., Sato, K., Mizuguchi, S., & Stone, M. H. (2013). Stretching and its effects on recovery: A review. *Strength and Conditioning Journal*, 35(5), 30-36. <https://doi.org/10.1519/SSC.0000000000000004>
- Afonso, J., Clemente, F. M., Nakamura, F. Y., Morouço, P., Sarmento, H., Inman, R. A., & Ramirez-Campillo, R. (2021). The Effectiveness of Post-exercise Stretching in Short-Term and Delayed Recovery of Strength, Range of Motion and Delayed Onset Muscle Soreness: A Systematic Review and Meta-Analysis of Randomized Controlled Trials. *Frontiers in Physiology*, 12(May). <https://doi.org/10.3389/fphys.2021.677581>
- Zulaini, Harahap, N. S., Siregar, N. S., & Zulfahri. (2021). Effect Stretching and Recovery on Delayed Onset Muscle Soreness (DOMS) after Exercise. *Journal of Physics: Conference Series*. <https://doi.org/10.1088/1742-6596/1811/1/012113>
- Herbert, R. D., de Noronha, M., & Kamper, S. J. (2011). Stretching to prevent or reduce muscle soreness after exercise. *Cochrane Database of Systematic Reviews*. <https://doi.org/10.1002/14651858.CD004577.PUB3>
- Kafrawi, F. R., Nurhasan, Wahjuni, E. S., Rusdiawan, A., Bekti, A. P., & Ayubi, N. (2024b). Sports Massage Has The Potential To Reduce Ischemic Muscle Pain And Increase Range Of Motion After Exercise. *Polish Journal of Physiotherapy*, 24(1), 60-65. <https://doi.org/doi.org/10.56984/8ZG2EF85A3>
- Welis, W., Darni, & Mario, D. T. (2023). Sports Massage: How does it Affect Reducing Lactic Acid Levels in Athletes? *International Journal of Human Movement and Sports Sciences*, 11(1), 20-26. <https://doi.org/10.13189/saj.2023.110103>
- Hunt, E. R., Confides, A. L., Abshire, S. M., Dupont-Versteegden, E. E., & Butterfield, T. A. (2019). Massage increases satellite cell number independent of the age-associated alterations in sarcolemma permeability. *Physiological Reports*, 7(17), e14200. <https://doi.org/10.14814/PHY2.14200>
- Piotrowska, A., Pilch, W., Tota, Ł., Maciejczyk, M., Mucha, D., Bigosińska, M., Bujas, P., Wiecha, S., Sadowska-Krępa, E., & Pałka, T. (2021). Local Vibration Reduces Muscle Damage after Prolonged Exercise in Men. *Journal of Clinical Medicine*, 10(22), 5461. <https://doi.org/10.3390/JCM10225461>
- Budak, H. (2023). The Effect of Passive Rest and Sports Massage Recovery Methods on Blood Lactate Clearance After High-Intensity Exercise. *Akdeniz Spor Bilimleri Dergisi*, 6(2), 406-418. <https://doi.org/10.38021/asbid.1230326>
- Davis, H. L., Alabed, S., & Chico, T. J. A. (2020). Effect of sports massage on performance and recovery: a systematic review and meta-analysis. *BMJ Open Sport & Exercise Medicine*, 6(1), e000614. <https://doi.org/10.1136/bmjsem-2019-000614>
- Guyen, G., Hilty, M. P., & Ince, C. (2019). Microcirculation: Physiology, Pathophysiology, and Clinical Application. *Blood Purification*, 49(1-2), 143. <https://doi.org/10.1159/000503775>
- Freire Jorge, P., Wieringa, N., de Felice, E., van der Horst, I. C. C., Oude Lansink, A., & Nijsten, M. W. (2017). The association of early combined lactate and glucose levels with subsequent renal and liver dysfunction and hospital mortality in critically ill patients. *Critical Care*, 21(1), 1-11. <https://doi.org/10.1186/s13054-017-1785-z>
- McDonough, K. (2017). Experimental research methods. *The Routledge Handbook of Instructed Second Language Acquisition*, May, 562-576. <https://doi.org/10.4324/9781315676968>
- Firmansyah, D., & Dede (2022). Teknik Pengambilan Sampel Umum dalam Metodologi Penelitian: Literature Review.

- Jurnal Ilmiah Pendidikan Holistik (JIPH)*, 1(2), 85-114.
<https://doi.org/10.55927/jiph.v1i2.937>
- Ramadhani Khija, & Ludovick Uttoh, M. K. T. (2015). Teknik Pengambilan Sampel. *Ekp*, 13(3), 1576-1580.
- Rusdiawan, A., & Habibi, I. (2020b). Efek pemberian jus semangka kuning terhadap tekanan darah, kadar asam laktat, dan daya tahan anaerobik setelah aktivitas anaerobik The impact of yellow watermelon juice intake after performing anaerobic activity on blood pressure, lactic acid levels. *Jurnal Sportif: Jurnal Penelitian Pembelajaran*, 6(2), 316-331.
- Delgado, D. A., Lambert, B. S., Boutris, N., McCulloch, P. C., Robbins, A. B., Moreno, M. R., & Harris, J. D. (2018). Validation of Digital Visual Analog Scale Pain Scoring With a Traditional Paper-based Visual Analog Scale in Adults. *Journal of the American Academy of Orthopaedic Surgeons Global Research and Reviews*, 2(3).
<https://doi.org/10.5435/JAAOSGlobal-D-17-00088>
- Han, G., Cho, M., Nam, G., Moon, T., Kim, J., Kim, S., Hong, S., & Cho, B. (2011). The effects on muscle strength and visual analog scale pain of aquatic therapy for individuals with low back pain. *Journal of Physical Therapy Science*, 23(1), 57-60. <https://doi.org/10.1589/jpts.23.57>
- Shah, N. (2008). Increasing knee range of motion using a unique sustained method. *North American Journal of Sports Physical Therapy: NAJSPT*, 3(2), 110-113.
- Yoon, N.-Y., Uh, S.-W., Nam, S.-K., & Lee, J.-H. (2024). The Effects of Flexibility Exercise, Cold Compresses, and Massage on Muscle Recovery in Elite Athletes: Focusing on Literature Review. *Annals of Applied Sport Science*, 12(1), 0-0. <https://doi.org/10.61186/aassjournal.1224>
- González-Alonso, J. (2012). Human thermoregulation and the cardiovascular system. *Experimental Physiology*, 97(3), 340-346. <https://doi.org/10.1113/expphysiol.2011.058701>
- Joyner, M. J., & Casey, D. P. (2015). Regulation of increased blood flow (Hyperemia) to muscles during exercise: A hierarchy of competing physiological needs. *Physiological Reviews*, 95(2), 549-601.
<https://doi.org/10.1152/physrev.00035.2013>
- Rowell, L. B. (2004). Ideas about control of skeletal and cardiac muscle blood flow (1876-2003): Cycles of revision and new vision. *Journal of Applied Physiology*, 97(1), 384-392.
<https://doi.org/10.1152/jappphysiol.01220.2003>
- Rusdiawan, A., Mar, A., & Prihatiningsih, S. (2020). The Changes in pH Levels, Blood Lactic Acid and Fatigue Index to Anaerobic Exercise on Athlete After. *Malaysian Journal of Medicine and Health Sciences*, 16(10), 50-56.
- de Lima, F. D. R., Brietzke, C., Franco-Alvarenga, P. E., Asano, R. Y., Viana, B. F., Santos, T. M., & Pires, F. O. (2018). Traditional models of fatigue and physical performance. *Journal of Physical Education (Maringá)*, 29(1), 1-12.
<https://doi.org/10.4025/jphyseduc.v29i1.2915>
- Theofilidis, G., Bogdanis, G. C., Koutedakis, Y., & Karatzafiri, C. (2018). Monitoring exercise-induced muscle fatigue and adaptations: Making sense of popular or emerging indices and biomarkers. *Sports*, 6(4), 1-15.
<https://doi.org/10.3390/sports6040153>
- Goodwin, M. L., Harris, J. E., Hernández, A., & Gladden, L. B. (2007). Blood lactate measurements and analysis during exercise: A guide for clinicians. *Journal of Diabetes Science and Technology*, 1(4), 558-569.
<https://doi.org/10.1177/193229680700100414>
- Ferreira, J., Da Silva Carvalho, R., Barroso, T., Szmuchrowski, L., & Śledziewski, D. (2011). Effect of Different Types of Recovery on Blood Lactate Removal After Maximum Exercise. *Pjst*, 18(2), 105-111.
<https://doi.org/10.2478/v10197-011-0008-4>
- Greenwood, J. D., Moses, G. E., Bernardino, F. M., Gaesser, G. A., & Weltman, A. (2008). Intensity of exercise recovery, blood lactate disappearance, and subsequent swimming performance. *Journal of Sports Sciences*, 26(1), 29-34.
<https://doi.org/10.1080/02640410701287263>
- Menzies, P., Menzies, C., McIntyre, L., Paterson, P., Wilson, J., & Kemi, O. J. (2010). Blood lactate clearance during active recovery after an intense running bout depends on the intensity of the active recovery. *Journal of Sports Sciences*, 28(9), 975-982.
<https://doi.org/10.1080/02640414.2010.481721>
- Warneke, K., Wirth, K., Keiner, M., & Schiemann, S. (2023). Improvements in Flexibility Depend on Stretching Duration. *International Journal of Exercise Science*, 16(4), 83. <https://doi.org/10.70252/LBOU2008>
- Jamurtas, A. Z., Theocharis, V., Tofas, T., Tsiokanos, A., Yfanti, C., Paschalis, V., Koutedakis, Y., & Nosaka, K. (2005). Comparison between leg and arm eccentric exercises of the same relative intensity on indices of muscle damage. *European Journal of Applied Physiology*, 95(2-3), 179-185.
<https://doi.org/10.1007/S00421-005-1345-0/TABLES/2>
- Nosaka, K., Newton, M., & Sacco, P. (2002). Delayed-onset muscle soreness does not reflect the magnitude of eccentric exercise-induced muscle damage. *Scandinavian Journal of Medicine & Science in Sports*, 12(6), 337-346.
<https://doi.org/10.1034/J.1600-0838.2002.10178.X>
- Leite, C. D. F. C., Zovico, P. V. C., Rica, R. L., Barros, B. M., Machado, A. F., Evangelista, A. L., Leite, R. D., Barauna, V. G., Maia, A. F., & Bocalini, D. S. (2023). Exercise-Induced Muscle Damage after a High-Intensity Interval Exercise Session: Systematic Review. *International Journal of Environmental Research and Public Health*, 20(22), 7082. <https://doi.org/10.3390/IJERPH20227082>
- Stožer, A., Vodopivec, P., & Bombek, L. K. (2020). Pathophysiology of exercise-induced muscle damage and its structural, functional, metabolic, and clinical consequences. *Physiological Research*, 69(4), 565-598.
<https://doi.org/10.33549/physiolres.934371>
- Dakić, M., Toskić, L., Ilić, V., Đurić, S., Dopsaj, M., & Šimenko, J. (2023). The Effects of Massage Therapy on Sport and Exercise Performance: A Systematic Review. *Sports*, 11(6). <https://doi.org/10.3390/sports11060110>
- Weerapong, P., Hume, P. A., & Kolt, G. S. (2005a). The mechanisms of massage and effects on performance, muscle recovery and injury prevention. *Sports Medicine*, 35(3), 235-256.
<https://doi.org/10.2165/00007256-200535030-00004>
- Weerapong, P., Hume, P. A., & Kolt, G. S. (2005b). Effects of Exercise During Pregnancy on Maternal Heart Rate and Heart Rate Variability. *Sport Med*, 8(7), 611-617.
<https://doi.org/10.1016/j.pmrj.2015.11.006>
- Jo, E., Juache, G. A., Saralegui, D. E., Weng, D., & Falatoonzadeh, S. (2018). The acute effects of foam rolling on fatigue-related impairments of muscular performance. *Sports*, 6(4). <https://doi.org/10.3390/sports6040112>
- Aboodarda, S., Spence, A., & Button, D. C. (2015). Pain pressure threshold of a muscle tender spot increases

- following local and non-local rolling massage. *BMC Musculoskeletal Disorders*, 16(1), 1-10.
<https://doi.org/10.1186/s12891-015-0729-5>
- Kent-Braun, J. A., Fitts, R. H., & Christie, A. (2012). Skeletal Muscle Fatigue. *Comprehensive Physiology*, 2(2), 997-1044. <https://doi.org/10.1002/CPHY.C110029>
- Barber, S., Pattison, J., Brown, F., & Hill, J. (2020). Efficacy of Repeated Cold Water Immersion on Recovery After a Simulated Rugby Union Protocol. *Journal of Strength and Conditioning Research*, 34(12), 3523-3529.
<https://doi.org/10.1519/JSC.0000000000002239>
- Kalichman, L., & Ben David, C. (2017). Effect of self-myofascial release on myofascial pain, muscle flexibility, and strength: A narrative review. *Journal of Bodywork and Movement Therapies*, 21(2), 446-451.
<https://doi.org/10.1016/j.jbmt.2016.11.006>
- Pointon, M., & Duffield, R. (2012). Cold water immersion recovery after simulated collision sport exercise. *Medicine and Science in Sports and Exercise*, 44(2), 206-216.
<https://doi.org/10.1249/MSS.0B013E31822B0977>
- Okamoto, T., Masuhara, M., & Ikuta, K. (2013). Acute Effects of Self-Myofascial Release Using a Foam Roller on Arterial Function. *Journal of Strength and Conditioning Research*, 28(1), 69-73.
<https://doi.org/10.1519/JSC.0b013e31829480f5>
- Brummitt, J. (2008). The Role of Massage in Sports Performance and Rehabilitation: Current Evidence and Future Direction. *North American Journal of Sports Physical Therapy*, 3(1), 7-21. <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC2953308/pdf/najspt-03-007.pdf>
- Best, T. M., Hunter, R., Wilcox, A., & Haq, F. (2008). Effectiveness of sports massage for recovery of skeletal muscle from strenuous exercise. *Clinical Journal of Sport Medicine*, 18(5), 446-460.
<https://doi.org/10.1097/JSM.0B013E31818837A1>
- Zhang, M., Murphy, B., Cabanilla, A., & Yidi, C. (2021). Physical relaxation for occupational stress in healthcare workers: A systematic review and network meta-analysis of randomized controlled trials. *Journal of Occupational Health*, 63(1), 1-16.
<https://doi.org/10.1002/1348-9585.12243>

Синергетичний вплив комбінованого методу масажу та стретчингу під час перерви між таймами на прискорене відновлення у футболі: Квазіекспериментальне дослідження щодо кліренсу молочної кислоти, зменшення болю та поліпшення показників гнучкості

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Авторський вклад: А – дизайн дослідження; В – збір даних; С – статаналіз; D – підготовка рукопису; E – збір коштів

Реферат. Стаття: 14 с., 5 табл., 1 рис., 67 джерел.

Історія питання. Футболісти часто стикаються зі зниженням результативності на початку другого тайму через зменшення температури м'язів і накопичення індикаторів втоми, як-от молочна кислота.

Мета дослідження. Мета цього дослідження полягала у вивченні ефективності масажу, стретчингу та їх комбінації у сприянні фізичному відновленню під час перерви між таймами в матчі. Дослідження було зосереджено на швидкості виведення молочної кислоти з організму, ступені зменшення дискомфорту від фізичних навантажень та поліпшенні показників гнучкості.

Матеріали та методи. У цьому дослідженні застосовано квазіекспериментальний дизайн, до якого було залучено 36 футболістів-чоловіків з футбольного клубу UNESA FC. Цих гравців було розділено на чотири групи: спортивний масаж (СМ), розтягування м'язів (РМ), комбінація спортивного масажу і розтягування м'язів (КМР) та контрольна (КОН). Учасники виконували біг на біговій доріжці з максимальною інтенсивністю (90–95 % від максимальної частоти серцевих скорочень), після чого проходили визначені процедури відновлення: СМ, РМ, КМР та КОН. На етапах перед початком, під час та після завершення інтервенції проведено контроль рівнів молочної кислоти (вимірювали за допомогою лактометра), діапазону рухів (вимірювали за допомогою гоніометра) та рівнів інтенсивності болю (вимірювали за допомогою візуальної аналогової шкали). Згодом отримані показники піддавали статистичному аналізу, що включав t-критерій для парних вибірок, критерій Вілкоксона, багатовимірний дисперсійний аналіз (MANOVA) та критерій Краскела-Волліса.

Результати. Це дослідження показало, що у групі, де застосовувалася практика комбінованого методу, спостерігалось найзначніше зниження рівня молочної кислоти (з $12,68 \pm 2,37$ до $5,16 \pm 1,04$ ммоль/л, $p = 0,000$), що перевищувало показники груп СМ, РМ та КОН ($p < 0,005$). Крім того, показники зменшення болю також виявилися значущими в групах КМР ($3,44 \pm 2,35$ до $1,67 \pm 1,58$) та РМ ($4,67 \pm 1,11$ до $1,33 \pm 1,00$) ($p < 0,05$). Аналогічним чином, покращення гнучкості

було вищим у групі КМР (правий діапазон рухів: $p = 0,007$; лівий діапазон рухів: $p = 0,003$), тоді як у контрольній групі не спостерігалось виражених змін. Тест MANOVA виявив істотні міжгрупові відмінності в результатах постінтервенційного періоду ($p < 0,05$).

Висновки. Результати представленої дослідження свідчать, що поєднання стретчингу та масажу під час перерви між таймами футбольного матчу сприяє максимізації відновлення організму за рахунок зниження рівня молочної кислоти, полегшення дискомфорту та поліпшення показників гнучкості або амплітуди рухів. Такий підхід знижує рівень спаду результативності у другому таймі та ризику травмування.

Ключові слова: футбол, масаж, стретчинг, відновлення.

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