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Sports performance

Effect of sports massage on recovery and post-fatigue physical performance in athletes: a comparative study

Efecto del masaje deportivo sobre la recuperación y el rendimiento físico post-fatiga en deportistas: estudio comparativo

Sánchez Rojas, Isabel Adriana[1], Pachón, Harol[1], Patiño, Carlos Iván[1], Argüello Gutiérrez, Yenny Paola[1]

[1] Universidad Santo Tomás

Contact address: isabel.sanchez@usta.edu.co
Isabel Adriana Sánchez Rojas
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ABSTRACT

Objective: to determine the effect of sports massage in three intervention groups on physical performance variables.

Method: a randomized repeated-measures design was conducted in 35 physically active participants assigned to passive rest, sports massage, or active recovery. Pain, perceived exertion, vertical jump, and maximal strength were assessed pre- and post-intervention. A mixed two-way ANOVA (time × group) was used for statistical analysis ($p \leq 0.05$).

Results: a significant time × group interaction was observed for pain ($F = 9.67$; $p < 0.001$) and perceived exertion ($F = 5.25$; $p=0.011$), showing greater reductions in the massage and active recovery groups compared with passive rest. No significant effects were found for vertical jump or maximal strength ($p >0.05$).

Conclusions: active recovery and massage significantly reduced post-exercise pain compared with passive rest, while active recovery showed greater effectiveness in reducing perceived fatigue. No significant effects were observed on neuromuscular performance variables.

Keywords: massage, sports massage, physical performance.

RESUMEN

Objetivo: determinar el efecto del masaje deportivo en tres grupos de intervención sobre variables de rendimiento físico.

Método: se realizó un diseño aleatorizado de medidas repetidas en 35 participantes físicamente activos, asignados a tres grupos: reposo pasivo, masaje deportivo o recuperación activa. Se evaluaron el dolor, la percepción subjetiva del esfuerzo, el salto vertical y la fuerza máxima antes y después de la intervención. El análisis estadístico se realizó mediante un ANOVA mixto de dos factores (tiempo × grupo), con un nivel de significancia de $p \leq 0.05$.

Resultados: se observó una interacción significativa tiempo × grupo para el dolor ($F = 9.67$; $p < 0.001$) y la percepción subjetiva del esfuerzo ($F = 5.25$; $p = 0.011$), evidenciando mayores reducciones en los grupos de masaje y recuperación activa en comparación con el reposo pasivo. No se encontraron efectos significativos en el salto vertical ni en la fuerza máxima ($p >0.05$).

Conclusiones: la recuperación activa y el masaje redujeron significativamente el dolor post-ejercicio frente al reposo pasivo, mientras que la recuperación activa mostró mayor eficacia en la disminución de la fatiga percibida. No se observaron efectos significativos en las variables de rendimiento neuromuscular.

Palabras clave: masaje, masaje deportivo, rendimiento físico.

INTRODUCTION

Sports massage is a therapeutic technique increasingly used in the world of sport and forms part of the recovery regimens of elite athletes, with the aim of reducing the mechanical stress suffered by muscles and other soft tissues as a result of activities carried out before, during and after sporting competitions. Additionally, regularly applied sports massage has demonstrated various benefits, such as the reduction of fatigue-related waste products, improved circulation, relaxation and reorganisation of collagen fibres, as well as relief from delayed onset muscle soreness (DOMS) (Buoite et al., 2025). During its application, sports massage involves a series of manipulations and pressures which can be applied to different parts of the body with the aim of preparing the musculoskeletal structures in advance for the load to which they will be exposed, reducing the incidence of injuries associated with overload and fatigue, as well as optimising the athlete's physical performance; It is worth noting that these effects are associated with the type and intensity of the techniques used, as well as the stage of competitive preparation during which the massage is applied (Arsovski, 2025), who suggests that massage is the most effective technique for preventing injuries and accelerating recovery following physical exertion, thereby improving perceived exertion.

There are various techniques used in sports massage, as well as different schools and approaches dedicated to updating and innovating in this field; however, among the most recognised and widely applied techniques are: friction, kneading, percussion and vibration. Now, superficial friction massage is a technique involving rapid, circular, repetitive movements performed with the fingertips or palms of the hands on the surface of the skin, in specific fields of the body. According to Trybulski (2025), the main aim of superficial friction massage is to improve blood and lymphatic circulation, stimulate muscle relaxation and relieve accumulated tension and stress. Furthermore, it can help reduce localised inflammation and aid the release of toxins. The benefits of this technique include improved flexibility and mobility, as well as relief from muscle and joint stiffness.

On the other hand, the superficial kneading technique is characterised by rapid, rhythmic movements using the palms and fingers to apply pressure to the body's superficial tissues. This type of massage involves compressive movements, stretching and gentle pressure. According to Vázquez (2009), superficial kneading massage aids the elimination of waste products; it can also improve blood and lymphatic circulation, promote the release of endorphins (hormones associated with well-being), reduce anxiety and stress, and promote muscle relaxation and relieve accumulated muscle tension. This is supported by Franklin et al. (2014), who state that massage promotes vasodilation and hyperaemia, as well as producing histamines and reducing oedema, thereby facilitating physical and mental relaxation.

With regard to percussion and vibration as techniques characteristic of classical massage, evidence has demonstrated positive effects associated with the stimulation of muscle and tendon receptors, which can be activated or induce a relaxing effect depending on the depth, intensity and speed of execution of these techniques (Budak et al., 2024). However, techniques such as percussion require specific clinical considerations, particularly in individuals with coagulation disorders, heart disease or respiratory conditions, amongst other conditions, which must be carefully assessed by the practitioner prior to application. In line with the above, the overall effects of massage include a reduction in pain sensitivity, improved skin trophism, reduced pain and muscle fatigue, as well as optimised recovery times (Arias et al., 2026).

As for sports massage, some studies, such as those by (Delextrat et al., 2013; Rodríguez, 2018), assert that massage improves an athlete's physical performance regardless of their sporting discipline; effects reported in their research include the reduction of muscle fatigue and the relief of tension accumulated during training and competitions; on the other hand, they argue that sports massage can help increase muscle flexibility and range of motion, which in turn leads to improved efficiency of movement and precision in sporting actions.

Finally, the mechanisms of action derived from massage highlighted include biomechanical factors associated with reduced muscle tension and increased range of motion; physiological mechanisms such as increased blood flow and increased activity of the parasympathetic nervous system; at the neurological level, a reduction in neuromuscular excitability and pain; and, finally, psychological mechanisms which are linked to increased relaxation and reduced anxiety (Monteiro et al., 2025). Therefore, the aim of this research is to identify the effect of massage on athletes' recovery and its impact on physical performance, in comparison with other recovery strategies.

METHOD

Study design

The study adopted an experimental design with randomised allocation using permuted blocks. The sample consisted of 35 participants, divided into three intervention groups. The experimental protocol was structured based on the study by Rinder & Sutherland (1995), who assessed the effect of massage on the quadriceps muscle following the induction of muscle fatigue in healthy women. In that study, the intervention lasted a total of 10 minutes and included friction and kneading techniques.

In line with this methodological framework, the experimental group, termed the "massage group", received treatment to the mid-thigh immediately following the fatigue protocol. Localised longitudinal massage was applied for 10 minutes, comprising 5 minutes of superficial friction performed with the fingertips and 5 minutes of superficial kneading. The intervention was carried out with the participant in the supine position on a massage table, ensuring standardised conditions throughout the procedure. The second group, termed *the "active recovery* group", performed 10 minutes of constant pedalling at a free cadence; the bicycle was set to no resistance in order to avoid further muscular overload in the subjects. The third group, termed *the "control* group", was placed in a controlled environment free from potential interruptions, distractions and external stimuli, where they remained seated for the same 10-minute period.

Population and sample

The population was selected using a non-probabilistic sampling method and participants were randomly assigned to the groups. The following inclusion criteria were selected: i) athletes currently active at Santo Tomás University representing their teams; ii) proven participation in the most recent inter-university championship of the Colombian Association of Universities (ASCUN); as ex , participants were excluded if they had suffered musculoskeletal injuries in the previous 6 months, had not participated in training sessions with their respective team, or were under the influence of thyroid and/or anabolic supplements.

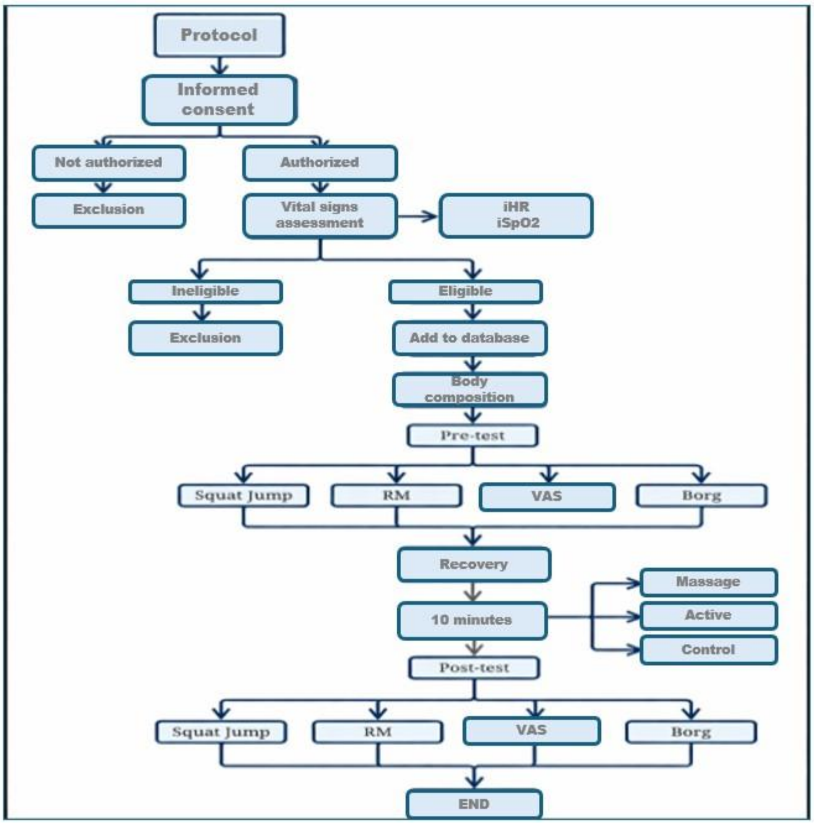
Procedure

The subjects were summoned in the morning to sign the informed consent form; once this was completed, baseline haemodynamic variables were recorded: initial heart rate (HRi) and initial oxygen saturation (SpO_2). Subsequently, body composition was measured using a bioimpedance scale (InBody® 330); therefore, as part of the methodological rigour, each participant was asked to arrive with an empty bladder, having consumed neither caffeine nor water, and to refrain from physical exercise for 24 hours prior to the physical tests. The pre-test of the protocol was then carried out, beginning with the measurement of the Squat Jump (SJ) test, taken from the battery of tests by Bosco (1994), using the Microgate Optogait® (2020); the participant was positioned between the Optogait® panels following the assessor's instructions: i) hands on hips; ii) on the assessor's command, the participant performs a 90-degree squat, held until the assessor signals the moment to jump; iii) during the flight phase, the participant must remain upright with knees extended; iv) upon landing, both feet must touch the ground simultaneously and in a stable manner; v) the test is performed twice, and the best result of the two attempts is recorded, taking into account the jump height.

Following the strength test, the Maximum Repetition (RM) protocol for squats was carried out, based on the protocol by Brzycki (1993), which consists of: i) a specific warm-up; ii) the participant performs 12 squats on the Smith® machine; iii) a 2-minute recovery period is allowed, after which the assessor specifies the load to be set on the machine based on the participant's fitness level; iv) the participant must perform as many squats as possible, bearing in mind that the maximum is 10, and may not stop for more than 3 seconds during the test; v) once the user has completed the first attempt, they have a 3-minute recovery period, during which the assessor uses the Brzycki index multiplied by the number of repetitions to estimate the RM; after this time, a second attempt is made under the same conditions as the first. Once completed, a 3-minute recovery period is allowed and the load is adjusted to proceed to the final attempt to estimate the RM. Once the physical tests were completed, the participant was asked to report their perceived exertion using the modified Borg scale from 6 to 20, as well as their pain assessment following the tests using the Visual Analogue Scale (VAS). After the tests, the participants were sent to the corresponding intervention groups (massage, active recovery and control) to undergo the 10-minute intervention. Once this time had elapsed, the same tests were performed in the order initially specified. The flowchart corresponding to the intervention protocol is presented below, showing the step-by-step procedure for carrying out the intervention.

Figure 1.

Flowchart for the intervention protocol



Ethical considerations

To comply with the ethical standards applicable to research involving human subjects, reference is made to the 1964 Declaration of Helsinki, which establishes the right to self-determination and the right to decide whether or not to participate, taking into account the benefits and risks of participating in the research; Additionally, Resolution 008430/93 was taken into account, which classifies this type of research as low-risk, given that the physical tests do not have implications for the subjects' lives. Finally, to ensure the protection of participants' personal data, they voluntarily signed the relevant informed consent form, in which, pursuant to Resolution 54004/12 Habeas Data, it is stated that the data will be used for academic purposes and that participants' personal information will not be disclosed. Finally, this research was approved by the institutional ethics committee of the University of Santo Tomás, administrative act (BOG-2023-EF020) of 2023.

Statistical analysis

G*Power software (Heinrich-Heine-Universität Düsseldorf, Germany) was used to estimate the sample size, configured for a Student's *t-test* for paired samples (pre–post design) with a two-tailed test. A moderate effect size (dz = 0.50) was assumed, based on previous studies on supervised physical exercise interventions and their impact on physiological variables such as $VO_{2máx}$, heart rate and blood glucose. A significance level of $\alpha = 0.05$ and a statistical power of $1–\beta = 0.80$ were set. With these parameters, a minimum sample size of 34 participants was estimated; therefore, the study met the standards set for this research.

The data were described using measures of central tendency and dispersion (mean ± standard deviation) for the physical performance variables assessed in each intervention group. Prior to inferential analysis, the assumption of normality was verified using the Shapiro–Wilk test of, confirming a normal distribution of the data ($p > 0.05$). To determine the comparative efficacy of the different intervention strategies on physical recovery and post-fatigue perceived exertion, a comprehensive two-phase analysis was conducted. Firstly, the descriptive variations in intra- and inter-group means were examined. Subsequently, to address the limitations of analyses focused solely on isolated pre-post comparisons, a rigorous inferential statistical model was applied using a two-factor repeated measures mixed-design analysis of variance (ANOVA): Time (Pre vs. Post; within-subjects factor) and Intervention (Control, Massage Group, Active Recovery; between-subjects factor) (Hopkins et al., 2009).

RESULTS

The results obtained for each of the variables analysed are reported below in terms of measures of central tendency (mean and standard deviation), beginning with the body composition of the population.

Table 1.

Body composition of the participants

	Age	Weight	Height	BMI	GBD	GBI	GT	GPD	GPI	AI	AE	TM	RCC	MC	AF
Average	21.09	64.54	169.3	22.52	0.49	0.52	4.89	1.77	1.76	23.74	14.02	1494	0.82	33.99	6.26
D.E.	2.02	11.08	10.7	2.7	0.44	0.45	3.04	0.78	0.78	5.4	3.02	248.4	0.05	7.73	0.8

Note: SD = Standard Deviation; weight is reported in kilograms; height is reported in centimeters; BMI = Body Mass Index; RFA = Right Arm Fat (kg); LFA = Left Arm Fat (kg); TBF = Trunk Fat (kg); RLF = Right Leg Fat (kg); LLF = Left Leg Fat (kg); IC = Intracellular Water (L); EC = Extracellular Water (L); RM = Metabolic Rate (kcal); WHR = Waist-to-Hip Ratio; BM = Body Mass (kg); PA = Phase Angle

Based on the reported data, it can be seen that the participants' body composition is within normal ranges and consistent with their height and weight; the cellular integrity indicated by the levels of intracellular and extracellular water is consistent with the phase angle values, the average of which (6.26) reflects the integrity of cell membranes and adequate fluid and electrolyte balance.

Table 2.

Descriptive statistics (Mean ± Standard Deviation) of the study variables according to intervention group and time of Assessment

Variable	Time point / Variation	Control (n = 11)	Massage group (n = 12)	Active Recovery (n = 12)
Visual analogue scale	Pre	6.91 ± 0.94	7.25 ± 1.22	6.17 ± 1.40
	Post	6.45 ± 0.82	4.67 ± 1.87	3.58 ± 1.44
	Mean difference	-0.45	-2.58	-2.58
Subjective perception of exertion	Pre	15.00 ± 1.73	14.00 ± 2.73	14.33 ± 3.17
	Post	12.82 ± 2.09	9.83 ± 3.13	8.83 ± 4.28
	Mean difference	-2.18	-4.16	-5.5
Vertical jump	Pre	33.16 ± 4.59	30.55 ± 7.24	29.18 ± 9.87
	Post	31.99 ± 5.65	29.16 ± 7.74	32.25 ± 10.18
	Mean difference	-1.17	-1.39	3.07
Maximum force	Pre	90.45 ± 21.28	75.25 ± 16.41	77.42 ± 32.79
	Post	89.64 ± 21.75	75.58 ± 17.69	79.50 ± 37.95
	Mean difference	-0.82	0.33	2.08

The descriptive statistics, which summarise the means and standard deviations for each dependent variable according to the intervention group and measurement time point, are detailed in Table 2. Upon examining the baseline values (Pre-measurements), it can be seen that the three groups began the protocols with highly comparable perceptual levels and performance metrics, which provided the design with an ideal homogeneous starting point for testing the isolated effect of the therapies.

Analysis of the behaviour of the means over time reveals markedly different trajectories depending on the variable and the group. On the visual analogue scale, the Control Group showed a marginal decrease of just 0.45 points following passive rest. In contrast, both the Massage Group and the Active Recovery Group experienced a decrease, with both recording an identical drop of 2.58 points in their averages. With regard to the subjective perception of exertion, all groups reported a decrease following the cessation of the stimulus. The Active Recovery group showed a reduction in their perception of exertion of 5.50 points on average, followed by the Massage Group (-4.16 points) and the Control Group (-2.18 points).

Regarding vertical jump, a decrease was observed in the Control Group (-1.17 cm) and in the Massage Group (-1.39 cm). Meanwhile, the group undergoing Active Recovery recorded an increase in the average height of their jump of +3.07 cm compared to their baseline value. Finally, the maximum strength indicator showed descriptive variations ranging from -0.82 to +2.08 kg across the three cohorts, maintaining levels similar to the initial values.

To establish population validity for these differences and formally test the main working hypothesis, the statistical analysis focused on the assessment of the main effects and the interaction effect of the mixed ANOVA, the full results of which are presented in Table 3. This approach allows for the quantification of the general effect of the passage of time, the baseline differences between interventions and, most importantly, whether the recovery slopes differ statistically significantly depending on the assigned strategy.

The model yielded conclusive findings in the perceptual and psychological domains. For the visual analogue scale, a very strong main effect of time was observed, indicating that pain decreased across the board. However, a highly significant Time × Intervention interaction of strong magnitude was confirmed ($F(2, 32) = 9.67$, $p < .001, \eta^2 = 0.377$). Multiple pairwise comparison tests (post-hoc analysis) revealed that both sports massage and active recovery produced a significantly greater analgesic effect than the control group, although the model failed to detect significant differences in efficacy between massage and light-to-moderate exercise.

In line with the above, the subjective perception of exertion also showed a very marked main effect of time and exhibited a significant overall interaction effect (F(2, 32) = 5.25, p = .011,η^2 = 0.247). In this metric, pairwise comparisons identified Active Recovery as the only modality capable of showing a statistically significant difference from the control group in its rate of clearance of perceived fatigue. The Massage Group settled at a midpoint in the reduction of perceived exertion, without exceeding the threshold for statistical significance in its direct comparison with passive rest.

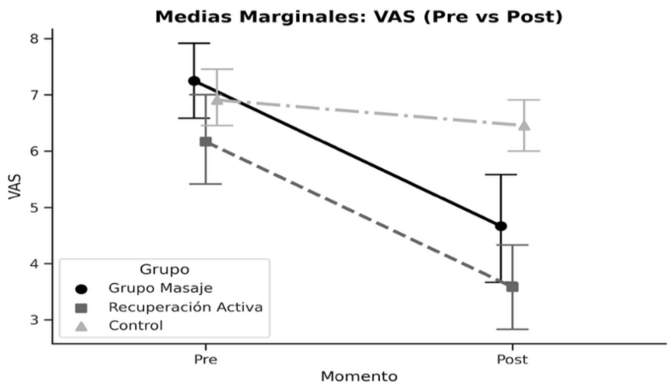
Table 3.
Results of the mixed ANOVA for main and interaction effects

Variable	Effect assessed	Degrees of Freedom	F-statistic	p-value	Effect Size (η2)
Visual analogue scale	Main effect: Time	1.32	69.41	< .001*	0.684
	Main effect: Intervention	2, 32	7.04	.003*	0.306
	Interaction: Time × Intervention	2, 32	9.67	< .001*	0.377
Subjective perception of effort	Main effect: Time	1, 32	89.76	< .001*	0.737
	Main effect: Intervention	2, 32	2.4	0.107	0.13
	Interaction: Time × Intervention	2, 32	5.25	.011*	0.247
Vertical jump	Main effect: Time	1.32	0.03	0.855	0.001
	Main effect: Intervention	2, 32	0.4	0.672	0.025
	Interaction: Time × Intervention	2, 32	2.53	0.096	0.136
Maximum force	Main effect: Time	1.32	0.35	0.559	0.011
	Main effect: Intervention	2, 32	1.01	0.376	0.059
	Interaction: Time × Intervention	2, 32	0.87	0.43	0.051

Note: * Statistically significant at a level of p <= .05.

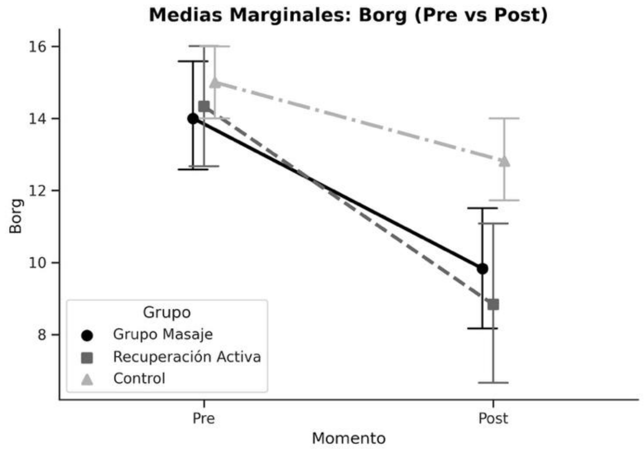
Moving into the biomechanical and neuromuscular sphere, the analysis of variance on the vertical jump was absent of a main effect of time, confirming that simply waiting does not naturally restore jumping ability. However, the model identified a marked statistical trend towards significance in its interaction (p = .096), which is of particular relevance in sports science as it is supported by a partial effect size categorised as moderate-high (η^2 = 0.136). This supports the descriptive observation that Active Recovery exerts a protective effect on the recruitment of fast motor units compared to the decline observed in the massage or control groups. Meanwhile, the estimated maximum strength showed a complete absence of main or interaction effects (p = .430,η^2 = 0.051), reaffirming that the metabolic and neural pathways governing maximum-intensity lifts are not significantly modulated by short-term external mechanical intervention.

Figure 2.
Marginal means of pain progression on the visual analogue scale



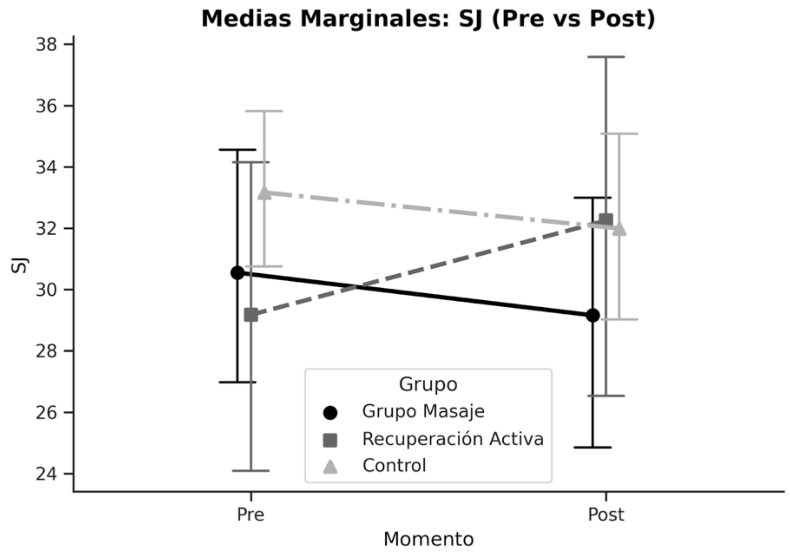
A pronounced drop in the slopes is observed in the Massage and Active Recovery Group compared to the slight decrease in the Control Group

Figure 3.
Marginal means of subjective perception of exertion



Active recovery exhibits the steepest downward slope, indicating greater effectiveness in eliminating residual fatigue.

Figure 4.
Marginal means of vertical jump



The unique upward trajectory of the Active Recovery group stands out, which clinically diverges from the sustained decline in the other experimental groups.

DISCUSSION

The results of this study show that sports massage significantly reduced pain perception and subjective perception of exertion, but did not produce immediate improvements in physical performance as assessed by the standing jump (SJ) and maximum resistance (RM) tests. This finding is consistent with recent systematic reviews which, whilst supporting the efficacy of massage in reducing delayed-onset muscle soreness (DOMS) and improving the athlete's general well-being, do not show consistent effects on strength, power or endurance immediately following the intervention (Davis et al., 2020; Dakic et al., 2023).

However, active recovery strategies are more effective than passive rest in modulating post-fatigue perceptual variables, particularly in reducing pain and the subjective perception of exertion. Although no statistically significant effects were observed on neuromuscular performance variables, activity recovery showed a favourable trend in preserving vertical jump height, suggesting potential functional benefits that should be explored with larger sample sizes (Zhang et al., 2024).

The analgesic effect and the reduction in perceived fatigue can be explained, in part, by the modulation of motor neuron excitability via the H-reflex. Techniques such as friction and superficial kneading, which according to Del Tío (2019) have a limited impact on muscle mass but promote relaxation, could influence the response of this reflex. According to Ruiz (2002), *"the H-reflex consists of a monosynaptic reflex resulting from submaximal stimulation of the IA afferent fibres of a peripheral nerve and the response recorded in a muscle innervated by the stimulated nerve*". The application of intermittent pressure during massage can generate a negative reflex arc, in which interneurons block motor neuron stimulation in response to the activation of cutaneous mechanoreceptors (Marroyo, 2022). This mechanism reduces the amplitude of the H-reflex, decreases neuronal excitability and tone, and its magnitude will depend on the intensity of the massage.

In contrast, the active recovery group showed significant improvements in physical performance tests. Low-intensity cycling allowed for the maintenance of muscle activation, promoting lactate clearance and functional recovery following exertion, which is consistent with research indicating that low-load active exercise accelerates neuromuscular recovery and preserves optimal tone for a second exertion (Dupont et al., 2004; Karangmalang, 2024). This type of cyclic activity has also been described as effective in reducing post-exercise pain and DOMS through increased clearance of blood lactate, whilst maintaining motor end-plate function (Dupont et al., 2004). In fact, Martín (1998) found significant reductions in l e lactate concentration, in both absolute and relative terms, in a group undergoing active recovery, whilst the groups receiving massage or rest showed no significant changes, enabling the former to maintain superior performance in a second test. These results help to explain the pattern observed in this study.

It follows from the above that it is important to integrate both strategies into a more comprehensive recovery protocol. Various authors suggest that the combination of massage and active exercise could optimise the reduction of pain and fatigue, whilst preserving or improving physical performance, in line with the athlete's needs and the competitive calendar (Fateev, 2023; Raja & Ismail, 2026).

However, the interpretation of the findings must be contextualised within the characteristics of the design. Although the sample size was determined by a priori calculation and allowed for adequate statistical power ($1–\beta = 0.80$), this was estimated based on a specific expected effect size; therefore, smaller effects on performance variables may not have been detected. Furthermore, the absence of objective physiological measurements such as lactate concentration, electromyography or mean propulsive velocity limits the ability to corroborate the proposed metabolic and neuromuscular mechanisms. Finally, the assessment focused exclusively on immediate effects, which prevents establishing whether massage could generate delayed benefits in the 24–48 hours following the session, as suggested by some research. (Weerapong et al., 2005).

Overall, the findings support the view that sports massage is effective in reducing pain and the perception of exertion, whilst active recovery offers immediate benefits for physical performance. When combined and applied strategically, this approach could represent an optimal, evidence-based option for sports recovery.

PRACTICAL APPLICATIONS

Based on the results obtained, the combination of active recovery and massage could be considered a complementary strategy within post-exercise recovery protocols. Whilst active recovery showed favourable effects on immediate physical performance, massage demonstrated benefits in reducing the perception of pain and exertion. However, these findings are limited to the acute effects assessed in the present study; therefore, further research is required to analyse their medium- and long-term impact, as well as their possible relationship with structural variables or injury prevention.

CONCLUSIONS

Sports massage was effective in reducing pain and perceived exertion, although it had no immediate impact on power and strength tests. In contrast, active recovery significantly improved short-term physical performance. These findings support the application of a combined and personalised recovery model, in which massage is used to alleviate discomfort and perceived stress, and active recovery to optimise neuromuscular performance. Furthermore, the importance of designing evidence-based protocols tailored to the individual athlete's context is emphasised.

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CONFLICTS OF INTEREST

The authors declare that they have no academic or commercial conflicts of interest that could lead to bias in the research results.

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