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Original Article

The Effect of Self-Myofascial Release Technique via Foam Roller on Delayed Onset Muscle Soreness Level

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Abstract

Exercise-induced muscle damage triggers an inflammatory response, leading to the clinical condition known as delayed-onset muscle soreness (DOMS). Various recovery strategies are being developed to mitigate the effects of DOMS. One increasingly popular approach is self-myofascial release (SMR). However, knowledge in this area remains limited, and further research is essential. The purpose of this study was to examine the changes in the intensity of DOMS over a 72-hour period post-exercise in individuals who performed SMR compared to those who did not. This cross-sectional study employed a fully experimental design with experimental and control groups. Participants in both groups (control: n=16; experimental: n=16) underwent a high-intensity interval training (HIIT) program to induce muscle damage. To assess the impact of SMR on DOMS, the experimental group was incorporated into a post-HIIT SMR intervention, while the control group did not receive any post-exercise intervention. Pain intensity was measured using a pain scale immediately before, immediately after, and at 24, 48, and 72 hours post-HIIT. Statistical analysis revealed significant effects for time, group, and the time-by-group interaction, with differences between the groups becoming particularly evident at 48 and 72 hours. Additionally, the experimental group showed a more controlled increase in pain intensity and a faster reduction in pain compared to the control group. These findings suggest that SMR is a viable strategy for alleviating exercise-induced muscle soreness and accelerating recovery. However, it is recommended that further studies explore the long-term effects of this method and its potential benefits across different types of exercise.

Keywords: DOMS, HIIT, SMR, Muscle soreness, Foam roller.

Introduction

Exercise-induced muscle damage is a common condition that occurs after high-intensity or unaccustomed training and is generally associated with microtraumas in the muscle cell membrane. This process leads to the disruption of muscle integrity and the release of intramuscular proteins into the bloodstream, resulting in decreased muscle strength, speed, and flexibility (Callegari et al., 2017). Muscle damage following exercise triggers an inflammatory response, leading to a clinical condition known as delayed onset muscle soreness (DOMS). DOMS manifests with symptoms such as muscle pain, stiffness, and tenderness, peaking between 12 and 72 hours post-exercise (Hody et al., 2019; Jamurtas et al., 2005).

Muscle damage induced by intense exercise and the associated oxidative stress and inflammation have been the focus of numerous studies (Bogdanis et al., 2013; Jamurtas, 2018; Tesema et al., 2019). In particular, high-intensity interval training (HIIT) is recognized as an effective method for enhancing physical performance by simultaneously improving both aerobic and anaerobic energy systems (Buchheit & Laursen, 2013; Gibala & McGee, 2008). However, intense exercise protocols such as HIIT may trigger muscle damage and the development of DOMS, potentially impairing athletic performance.

Although the exact mechanism of DOMS remains unclear, two primary hypotheses have been proposed. The first hypothesis links DOMS to the activation of B2-bradykinin receptors released during exercise, leading to mechanical hyperalgesia (Hody et al., 2019). The second hypothesis highlights the roles of cyclooxygenase-2 (COX-2) and glial cell-derived neurotrophic factor (GDNF). The reduction of DOMS severity through COX-2 inhibitors supports this hypothesis (Murase et al., 2013; Paulsen et al., 2010).

Various recovery strategies have been developed to alleviate muscle pain and fatigue following exercise. Methods such as cold water immersion, electrical muscle stimulation, massage, and self-myofascial release (SMR) using a foam roller are widely utilized to accelerate muscle recovery (Aboodarda et al., 2015; Cheatham et al., 2015; Devlin et al., 2014; Dupuy et al., 2018). In recent years, SMR has become an increasingly preferred technique among athletes due to its ease of application and cost-effectiveness (Cheatham et al., 2015; D’Amico & Gillis, 2019; Drinkwater et al., 2019; Dupuy et al., 2018; İlbak, 2024; Jo et al., 2018; Rey et al., 2019).

SMR is believed to alleviate muscle pain by enhancing fascial tissue elasticity and promoting blood circulation (Cheatham et al., 2015). It has been reported to increase blood flow to muscle tissues by promoting vasodilation through mechanical pressure, thereby accelerating the removal of metabolic waste products (Devlin et al., 2014; Dupuy et al., 2018). Several studies in the literature have investigated the effects of SMR on DOMS. For instance, Rey et al. (2019) reported that SMR applied after football training was more effective than passive recovery in reducing lower extremity muscle soreness while improving agility performance. Similarly, MacDonald et al. (2013) demonstrated that SMR not only alleviated muscle soreness but also enhanced joint range of motion. Additionally, Cheatham et al. (2015) indicated that SMR reduced edema, increased oxygen flow to muscles, and mitigated the adverse effects of DOMS by enhancing lactate clearance.

The aim of this study was to examine the changes in DOMS severity over 72 hours post-exercise in individuals who apply SMR and those who do not. The findings obtained will contribute to strengthening the scientific evidence regarding the efficacy of SMR and aid in determining effective recovery strategies for athletes.

Material and Methods

This study was approved by Inonu University Health Sciences Non-Interventional Clinical Research Ethics Committee (approval no: 2025/7431) and was conducted in accordance with the helsinki declaration.

Participant Group

The sample size of the study was determined using the G*Power 3.1.9.7 software (University of Düsseldorf, Düsseldorf, Germany). Based on repeated measures mixed ANOVA with a significance level of 0.05, a statistical power of 0.95, two groups, five measurement points, and an effect size of 0.25, it was calculated that a total of 32 participants would be required to ensure an adequate sample size in each group. Accordingly, 32 male combat athletes were included in the study and were equally divided into experimental and control groups (n=16 for each group).

Study Design

A true experimental design with experimental and control groups was used in this cross-sectional study. A HIIT program was applied to the participant groups to induce muscle damage. Modified Borg Scale was used to determine the level of exertion perceived by the participants during exercise. To determine the effects of SMR on DOMS, the experimental group underwent SMR after the HIIT program, while the control group did not receive any intervention after the HIIT program. To examine changes in the severity of DOMS in individuals who applied and did not apply SMR after exercise, pain intensity levels were monitored by administering a Pain Scale immediately before and after the HIIT program and at 24, 48, and 72 hours post-exercise. The flow chart of the research is shown in figure 1.

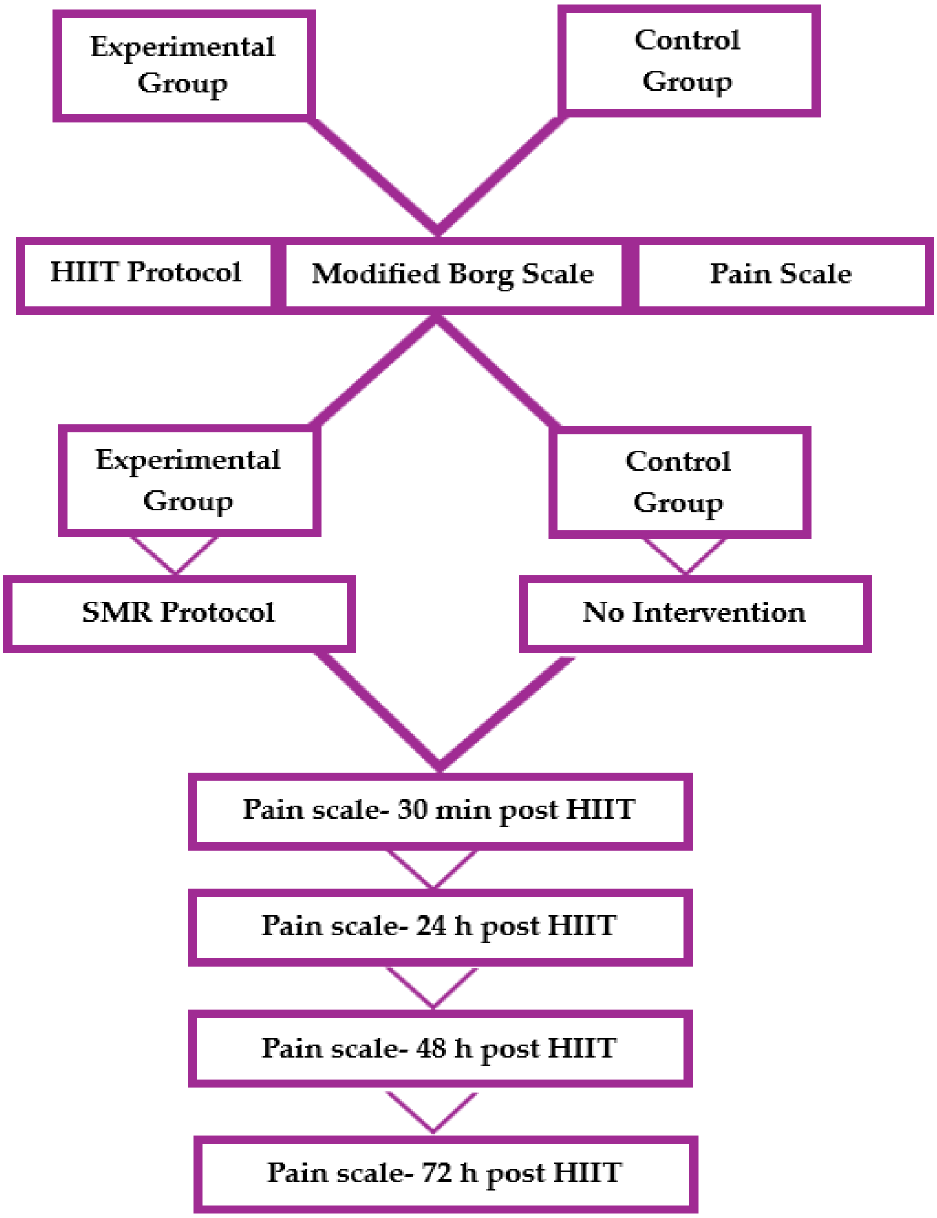

Figure 1. The flow chart of the research.

HIIT Protocol

A HIIT exercise protocol was applied in this study to induce muscle damage. The literature indicates that exercises such as "Squat Jumps, Split Squat, Jump on Box, and Drop Jump" are frequently used in HIIT protocols (Curitianu et al., 2022; Machado et al., 2017, 2018). Therefore, these four exercises were included in this study. Additionally, Machado et al. (2017) stated in a review study that for intermediate and advanced athletes, a HIIT session should last 15-20 minutes, with maximum intensity for each set and a work-to-rest ratio of 1:1 (30 seconds for both work and rest periods). Accordingly, in this study, following a 5-minute dynamic warm-up period, a protocol consisting of 30 seconds of maximal effort followed by 30 seconds of passive recovery was applied for a total of 16 sets (4 sets per exercise).

SMR Protocol

In the SMR protocol, participants performed SMR exercises targeting the hamstring, quadriceps, gluteus, and gastrocnemius muscle groups, consisting of three sets of 20-second repetitions with a 1-minute passive rest between sets (Bradbury-Squires et al., 2015). The application did not include rhythm restrictions (Healey et al., 2014); participants were instructed to apply pressure using their body weight while rolling between the two end-points of the selected muscle group. The SMR intervention was performed immediately after the HIIT protocol. Foam Roller Plus (FRP; Perform Better, Inc., Cranston, RI, USA) was used in this study. The Foam Roller Plus is a highly dense cylindrical foam roller with a polyvinyl chloride core and neoprene cover.

Modified Borg Rating of Perceived Exertion Scale (0-10 RPE)

The Modified Borg Rating of Perceived Exertion Scale allows individuals to rate their perceived exertion during exercise on a scale from 0 to 10. This scale is widely used in clinical settings such as COPD, cardiac rehabilitation, and chronic disease management. Additionally, it is a practical and reliable method for determining exercise intensity in both athletes and sedentary individuals. The 0-10 scale is defined as follows: 0: No exertion (rest); 1: Extremely light exertion; 2: Light exertion; 3: Moderate exertion; 4: Somewhat hard exertion; 5: Hard exertion; 6-7: Very hard exertion; 8-9: Extremely hard exertion; 10: Maximal effort (Borg, 1985). The Modified Borg Rating of Perceived Exertion Scale is shown in Figure 2.

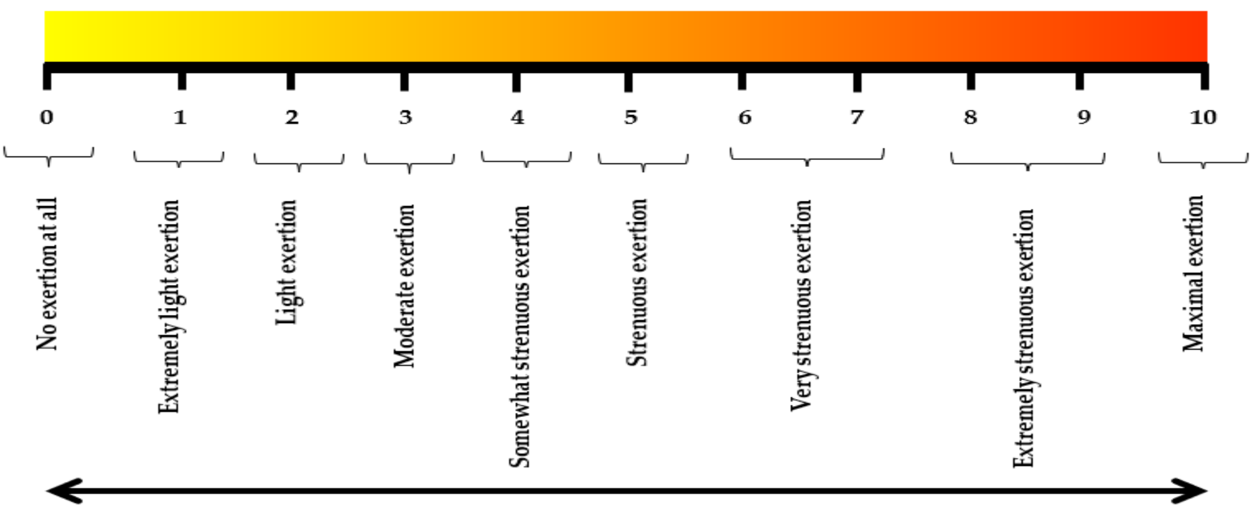

Figure 2. The modified borg rating of perceived exertion scale.

Pain Assessment Protocol

The Numeric Rating Scale (NRS) was used for the pain assessment protocol. The NRS is a widely used method that allows individuals to quantitatively express the intensity of pain they experience. By converting subjective pain perception into numerical data, this scale plays a significant role in clinical decision-making processes and is frequently preferred in both research and clinical applications. The NRS is typically presented as a horizontal or vertical line ranging from 0 to 10. In this scale, "0" indicates no pain, while "10" represents unbearable pain. Participants were asked to mark the point on the scale that best reflected their current pain intensity. The clinical interpretation of the scale is as follows: 0 points: No pain; 1-3 points: Mild pain; 4-6 points: Moderate pain; 7-10 points: Severe pain (Hennessy et al., 2015). The Numeric Rating Scale is presented in Figure 3.

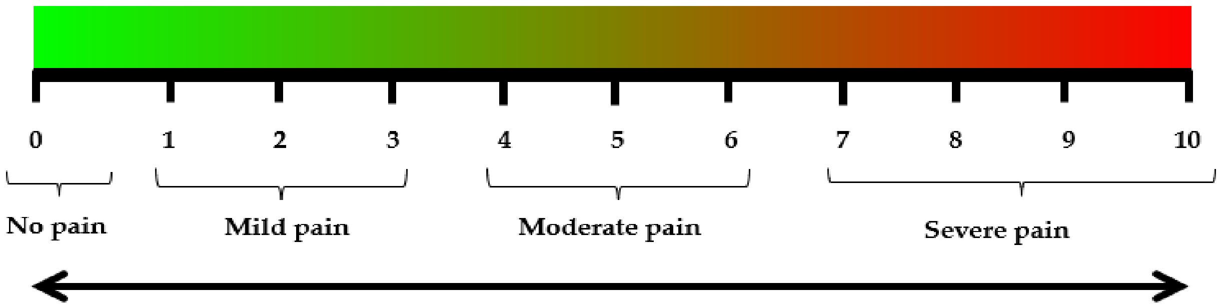

Figure 3. The numeric rating scale.

Statistical Analyses

All statistical analyses were performed using GraphPad Prism software (version 9.5.1; San Diego, CA, USA). The normality of the variables was assessed using the Shapiro-Wilk test, and the data were found to follow a normal distribution ($p > 0.05$). Descriptive statistics for the dependent variables, categorized by time and group, are presented in Table 1. Differences in perceived difficulty levels between groups were analyzed using an independent samples t-test, with the results displayed in Table 2. Changes in pain intensity over time, group effects, and time-group interactions were evaluated using a two-way ANOVA, with results presented in Table 3. Changes in pain intensity over time within the control group were analyzed using a one-way ANOVA and are reported in Table 4. Similarly, changes in pain intensity within the experimental group were examined using a one-way ANOVA, with results provided in Table 5. Differences in pain intensity between groups over time were analyzed using a two-way ANOVA. For all analyses, the statistical significance level was set at $p < 0.05$.

Results

The research results are presented in tables and figures below.

Table 1. Descriptive statistics of dependent variables according to time in groups.

Variable	Time	X±SD	
		Control Grup	Experimental Group
Perceived Difficulty	Immediately after HIIT	9.56±0.13	9.50±0.12
Pain Intensity	Baseline	0.62±0.12	0.56±0.12
	30 min post HIIT	2.37±0.50	1.50±0.51
	24 h post HIIT	6.25±0.77	4.75±0.57

	48 h post HIIT	9.68±0.47	5.25±1.03
	72 h post HIIT	8.12±0.79	4.75±0.57

X: Mean; SD: Standard Deviation.

The descriptive statistics of the dependent variables over time for each group are presented in Table 1. Regarding the perceived level of difficulty, it is observed that both groups reported a high level of perceived difficulty following HIIT. In terms of pain intensity, the difference between the groups at baseline gradually became more pronounced over time after HIIT, with a particularly notable increase in pain intensity in the control group.

Table 2. T test results of the comparison of the perceived difficulty levels of the groups.

Grup	X±SD	Mean Difference	Standard Error of Difference	t	DF	p	R^2
Control Grup	9.56±0.13	-0.06250	0.1819	0.3437	30	0.7335	0.003922
Experimental Group	9.50±0.12						

Table 2 presents the results of the independent samples t-test comparing the perceived difficulty levels between the groups. Accordingly, no significant difference was found between the groups in terms of perceived difficulty ($p > 0.05$). The small mean difference (-0.06250) and the very low effect size ($R^2 = 0.003922$) indicate that the levels of perceived exertion after HIIT were similar for both groups.

Table 3. ANOVA results evaluating the relationships between time, group and time and group in terms of the dependent variable.

Dependent variable	Independent variable	Sum of squares (SS)	df	Mean squares	F	p
Pain Intensity	**Time**	1156	4	288.9	685.9	0.0001
	Grup	160.0	1	160.0	666.7	0.0001
	Time*Grup	87.50	4	21.88	73.32	0.0001

Table 3 presents the ANOVA results regarding the changes in pain intensity over time, group differences, and the time*group interaction. The high sum of squares for the time factor (SS = 1156, F = 685.9, $p < 0.01$) indicates that pain levels changed significantly over time. The significant group effect (SS = 160.0, F = 666.7, $p < 0.01$) shows that the experimental group generally reported lower pain levels. The significant time*group interaction (SS = 87.50, F = 73.32, $p < 0.01$) suggests that pain intensity evolved differently over time between the groups.

Table 4. ANOVA results of pain intensity of the control group by time.

Time	X±SD	Mean Difference	p
Baseline	0.62±0.12	-1.750	0.0001
30 min Post HIIT	2.37±0.50		
Baseline	0.62±0.12	-5.625	0.0001
24 h Post HIIT	6.25±0.77		
Baseline	0.62±0.12	-9.063	0.0001
48 h Post HIIT	9.68±0.47		
Baseline	0.62±0.12	-7.375	0.0001
72 h Post HIIT	8.12±0.79		

30 min Post HIIT	2.37±0.50	-3.875	0.0001
24 h Post HIIT	6.25±0.77		
30 min Post HIIT	2.37±0.50	-7.313	0.0001
48 h Post HIIT	9.68±0.47		
30 min Post HIIT	2.37±0.50	-5.625	0.0001
72 h Post HIIT	8.12±0.79		
24 h Post HIIT	6.25±0.77	-3.438	0.0001
48 h Post HIIT	9.68±0.47		
24 h Post HIIT	6.25±0.77	-1.750	0.0001
72 h Post HIIT	8.12±0.79		
48 h Post HIIT	9.68±0.47	1.688	0.0001
72 h Post HIIT	8.12±0.79		

Table 4 presents a comparison of pain intensity at different time points within the control group. Significant differences were found between baseline and all subsequent time points ($p < 0.01$), with pain intensity peaking at 48 hours. Although a slight decrease was observed at 72 hours, the pain level remained high.

Table 5. ANOVA results of pain intensity of the experimental group by time.

Time	X±SD	Mean Difference	p
Baseline	0.56±0.12	-0.9375	0.0001
30 min Post HIIT	1.50±0.51		
Baseline	0.56±0.12	-4.000	0.0001
24 h Post HIIT	4.75±0.57		
Baseline	0.56±0.12	-5.188	0.0001
48 h Post HIIT	5.25±1.03		
Baseline	0.56±0.12	-4.000	0.0001
72 h Post HIIT	4.75±0.57		
30 min Post HIIT	1.50±0.51	-3.063	0.0001
24 h Post HIIT	4.75±0.57		
30 min Post HIIT	1.50±0.51	-4.250	0.0001
48 h Post HIIT	5.25±1.03		
30 min post HIIT	1.50±0.51	-3.063	0.0001
72 h Post HIIT	4.75±0.57		
24 h Post HIIT	4.75±0.57	-1.188	0.0001
48 h Post HIIT	5.25±1.03		
24 h Post HIIT	4.75±0.57	0.000	0.9999
72 h Post HIIT	4.75±0.57		
48 h Post HIIT	5.25±1.03	1.188	0.0001
72 h Post HIIT	4.75±0.57		

Table 5 examines the changes in pain intensity over time within the experimental group. Compared to baseline, a significant increase was observed at 30 minutes ($p < 0.01$). This increase persisted at 24 and 48 hours ($p < 0.01$). However, by 72 hours, pain levels showed a significant decrease, with a notable difference between 48 and 72 hours ($p < 0.01$).

Table 6. Comparison of pain intensity between groups according to time.

Time	Grup	X±SD	Mean Difference	t	DF	p
	Control grup	0.62±0.12	0.06250	0.3236	60.00	0.7473

Baseline	Experimental group	0.56±0.12				
30 min Post HIIT	Control grup	2.37±0.50	0.8750	4.531	60.00	0.0001
	Experimental group	1.50±0.51				
24 h Post HIIT	Control grup	6.25±0.77	1.688	8.739	60.00	0.0001
	Experimental group	4.75±0.57				
48 h Post HIIT	Control grup	9.68±0.47	3.938	20.39	60.00	0.0001
	Experimental group	5.25±1.03				
	Control grup	8.12±0.79	3.438	17.80	60.00	0.0001
72 h Post HIIT	Experimental group	4.75±0.57				

Table 6 examines whether pain intensity differed between the groups at each time point using an independent samples t-test. While no significant difference was found between the groups at baseline (p = 0.7473), at 30 minutes post-HIIT, pain intensity in the control group was significantly higher (t = 4.531, p < 0.001). Similarly, at 24, 48, and 72 hours, the pain levels in the control group were significantly higher than those in the experimental group (t-values of 8.739, 20.39, and 17.80, respectively, all p < 0.001).

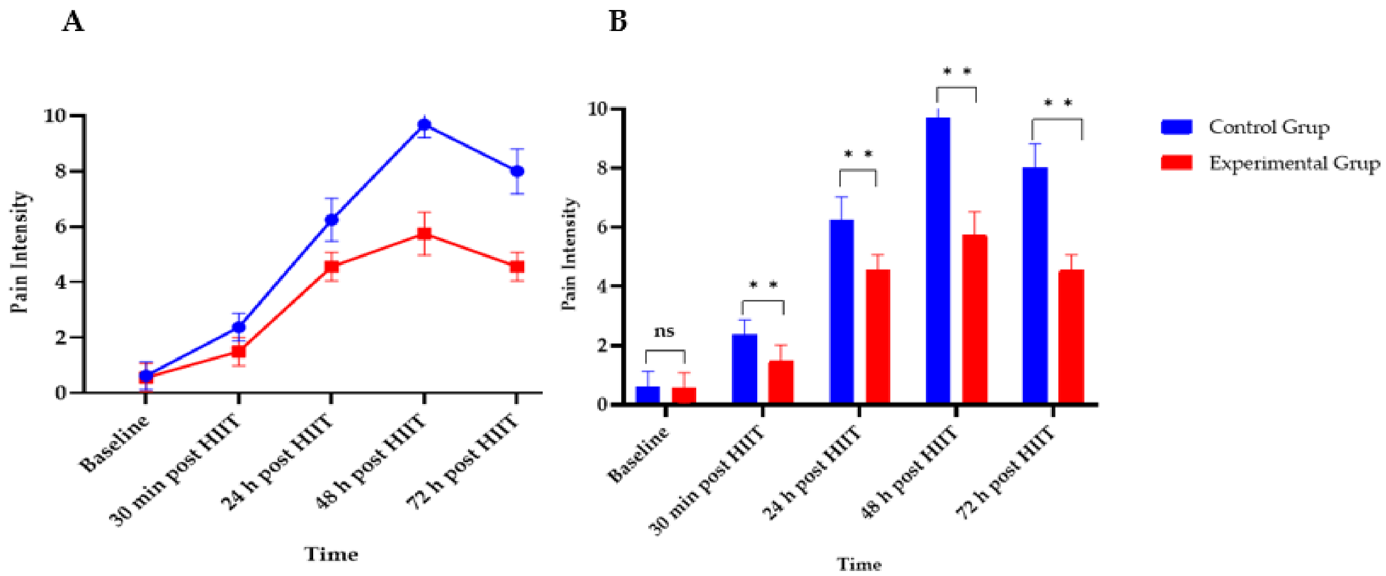

Figure 4. The relationships between time, group and time and group in terms of the dependent variable

Figure 4 shows that pain intensity increased more gradually and decreased more rapidly in the experimental group after HIIT. The main effects of time, group, and the time-group interaction were found to be statistically significant, with a noticeable difference between groups particularly at the 48-hour and 72-hour time points.

Discussion

This study investigated the changes in DOMS over a 72-hour period following a HIIT protocol in individuals who either performed or did not perform SMR. No significant difference was found between groups in perceived exertion levels after the HIIT protocol, indicating that the protocol's intensity was perceived consistently across participants and that adequate standardization was achieved.

The findings revealed that participants in the experimental group experienced a more controlled increase and a faster decrease in muscle soreness. Significant main effects were observed for time, group, and time*group interactions, with the most prominent group differences emerging at the 48th and 72nd hours. These results suggest that SMR supports muscle recovery and contributes to the alleviation of DOMS.

Exercise-induced microtrauma in muscle fibers initiates an inflammatory response, which triggers the recruitment of immune cells to the damaged area and promotes tissue regeneration. This process results in the development of DOMS (Jang, 2007; Lee et al., 2022). DOMS typically peaks between 24 and 72 hours post-exercise and resolves within five to seven days (Kim et al., 2012; Oh, 2013).

SMR techniques, particularly foam rolling, have been shown to reduce muscle pain and restore muscle function when applied after exercise (İlbak & Eken, 2023; Michalak et al., 2024). These techniques are effective in releasing adhesions in soft tissue, improving flexibility, proprioceptive awareness, and joint position sense (2015; Kim et al., 2017). Additionally, SMR has been associated with decreased muscle pressure, increased pain threshold, and enhanced muscular performance (Mohr et al., 2014).

Previous studies have largely focused on comparing pain responses to SMR at specific time points during recovery; however, there is a lack of research examining pain changes throughout the entire post-exercise recovery period (Lee et al., 2020). The originality of this study lies in its comprehensive analysis of DOMS severity across multiple time points, thereby addressing a gap in the existing literature.

In the control group, muscle soreness peaked at 48 hours and showed only a limited decrease by the 72nd hour. In contrast, the experimental group showed a significant increase in soreness at 30 minutes post-exercise, which persisted through 24 and 48 hours, but significantly decreased by 72 hours. This pattern suggests that recovery began earlier in the experimental group. When comparing groups over time, no significant differences were observed at baseline; however, the control group reported significantly higher pain levels at 30 minutes, as well as at 24, 48, and 72 hours post-exercise.

These effects may be explained by the mechanical pressure applied during SMR, which promotes vasodilation within muscle tissue, enhances the delivery of oxygen and nutrients, supports the removal of inflammatory agents, and reduces osmotic pressure within the muscle—thereby alleviating pain. Furthermore, SMR may inhibit pain perception via modulation of afferent signals in the spinal nervous system, particularly through the activation of large-diameter nerve fibers that dampen nociceptive input (Lee et al., 2020).

Future researchers are encouraged to investigate the effects of the duration and frequency of SMR over different time periods. This study focused solely on a 72-hour period, and therefore, it did not provide information regarding the long-term effects of SMR. Consequently, conducting more comprehensive studies on the return of the recovery process after the reduction of muscle soreness and the long-term muscle recovery outcomes would be beneficial. Additionally, the pain levels perceived by the participants were obtained through subjective measurements. Future research should aim to use more objective measurement techniques to minimize individual differences in pain tolerance and perception, thereby enabling a more reliable assessment of pain and recovery processes.

Conclusions

This study demonstrated that DOMS, which occurs after HIIT, can be significantly reduced through SMR, thereby accelerating the recovery process. Participants in the experimental group experienced a more controlled increase in soreness with a significant reduction by the 72nd hour. In contrast, those in the control group who did not perform

SMR reported prolonged and more intense soreness. These findings indicate that SMR is an effective recovery strategy for supporting post-exercise muscle repair and sustaining athletic performance.

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Informed Consent Statement: Informed consent was obtained from all participants involved in the study.

Conflict of Interest: The authors declare no conflicts of interest regarding this study.

Data Availability Statement: Data supporting this study is available from the authors upon reasonable request.

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