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Post-exercise foam rolling as a recovery strategy for performance outcomes in martial arts athletes: a pilot study from Latvian and Polish cohorts

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Authors' contribution:
A. Study design/planning
B. Data collection/entry
C. Data analysis/statistics
D. Data interpretation
E. Preparation of manuscript
F. Literature analysis/search
G. Funds collection

Abstract

Background. This pilot study examined the feasibility and preliminary effects of a two-week post-exercise foam rolling intervention on delayed-onset muscle soreness (DOMS) and kicking performance (TAIKT) in martial arts athletes.
Material and methods. Martial arts athletes from Latvia (n=10) and Poland (n=8) were allocated to either a foam rolling or a control condition and completed a two-week intervention while continuing regular training. DOMS and TAIKT were assessed before and after the intervention. Absolute change scores (post-pre) were calculated and compared between groups using parametric or nonparametric tests.
Results. DOMS decreased following foam rolling in both cohorts (Latvia: U=25, p=0.009; Poland: t(6)=2.80, p=0.03). TAIKT improved significantly after foam rolling (Latvia: t(8)=-6.39, p<0.001; Poland: t(6)=-8.76, p<0.001).
Conclusions. These findings support the feasibility of post-exercise foam rolling as a recovery strategy in martial arts athletes. However, results should be interpreted cautiously given the pilot design, small sample sizes, and ongoing training during the intervention. Larger, controlled studies are required.

Keywords: kicking performance, foam rolling, delayed-onset muscle soreness, recovery strategy, martial arts

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Introduction

Recovery strategies such as foam rolling (FR) are commonly applied to alleviate delayed-onset muscle soreness (DOMS), reduce fatigue, improve flexibility, and support post-exercise recovery [1-3]. DOMS can adversely affect athletic performance by impairing muscle and connective tissue function, thereby altering joint mechanics and neuromuscular control. These changes can lead to reduced range of motion, diminished strength and power, disrupted muscle recruitment patterns, impaired proprioception, and an increased risk of injury, ultimately limiting training capacity and sports performance [4]. Combat sports such as taekwondo and mixed martial arts (MMA) involve explosive offensive actions, including rapid kicking and striking sequences that place high demands on speed, strength, and movement coordination. Successful performance requires not only physical capabilities but also tactical decision-making, concentration, and technical proficiency during bouts that fluctuate between brief high-intensity exchanges and lower-intensity phases [5-8]. Previous research highlights the critical role of lower-limb muscle characteristics in martial arts performance [9]. Enhancements in kicking effectiveness have been associated with higher knee extension velocities and shorter ground contact time. Equally important is the capacity to perform quick directional changes and execute movements efficiently under dynamic conditions. During striking actions, force production originates from interaction with the ground and is transferred through the lower extremities to the upper body, enabling athletes to generate powerful, rapid attacks [10].

The application of FR as a post-exercise recovery method has become increasingly common in athletic practice [3]. Although literature generally suggests that active recovery strategies are more effective than passive rest after exercise [11], the benefits of massage-based interventions appear to vary with individual responses and the techniques employed. Consequently, previous studies have reported inconsistent or inconclusive findings regarding the effects of massage on recovery processes and performance outcomes [12]. Martial arts athletes are exposed to distinct physical and cognitive demands, including repeated high-intensity training loads and sustained tactical focus, which increase the need for effective post-exercise recovery strategies to support performance, reduce injury risk, and promote muscle recovery [11]. Therefore, further investigation is warranted to clarify the role of FR and to determine optimal application protocols within combat sports settings.

Aim of the work

The present pilot study aimed to examine the feasibility and preliminary effects of a two-week post-exercise FR intervention on DOMS and kicking performance in Latvian and Polish martial arts athletes.

Material and methods

The participants included 10 well-trained ITF taekwondo athletes from Riga, Latvia (5 females, 5 males), and 8 MMA athletes from Biała Podlaska, Poland (1 female, 7 males), who volunteered to participate (Table 1). Eligibility criteria included participation in national or international competitions, a minimum of five years of training experience, and at least four training sessions per week. Athletes were excluded if they reported medication use, cardiovascular or neurological disorders, or current musculoskeletal injuries. The Latvian cohort was younger (14-21 years) than the Polish cohort (19-25 years), with corresponding differences in anthropometric characteristics. Latvian athletes (14-21 years; M=16.10, SD=2.64) had a mean height of 171.35 cm (SD=6.08) and body mass of 64.42 kg (SD=8.63), whereas Polish athletes (19-25 years; M=22.12, SD=2.41) had a mean height of 175.25 cm (SD=5.28) and body mass of 72.53 kg (SD=4.48). Body height and mass were measured using standardized equipment (Seca 213 and 813, Hamburg, Germany). Sample size was determined by athlete availability, consistent with the exploratory nature of this pilot study. The intervention was conducted in October 2025 in Latvia and November 2025 in Poland, with the Latvian athletes completing the protocol immediately prior to a national competition. A pre-post design with a two-week interval was used. Quadriceps muscle soreness was assessed using a visual analog scale (VAS), and kicking performance was evaluated using a modified taekwondo anaerobic intermittent kick test (TAIKT) [13].

Table 1. Sample characteristics of the Latvian and Polish athletes (n=18)

Parameter	Latvian		Polish	
	CG (n=5)	FR (n=5)	CG (n=4)	FR (n=4)
Age (years)	16.4±2.6	15.8±2.95	22.25±2.21	22±2.94
Height (cm)	171.1±6.15	171.6±6.72	176.25±2.06	174.25±7.58
Weight (kg)	62.82±6.91	66.02±10.66	73.95±4.44	71.12±4.66
Body Mass Index (kg/m^2)	21.43±1.73	22.31±2.44	23.84±1.11	23.47±1.11

Notes: cm – centimeter, kg – kilogram, CG – control group, FR – foam rolling group.

FR was performed using a compact roller (Sveltus, Le Chambon-Feugerolles, France) and applied to the quadriceps, hamstrings, adductors, and gastrocnemius muscles [14]. For each muscle group, athletes completed three 30-second bouts separated by 30-second rest periods, using slow, controlled rolling movements from proximal to distal positions. The selected muscles and rolling volume reflected the functional demands of lower-limb actions in martial arts and followed previously established protocols [14]. Participants in the control group (CG) remained seated for 20 minutes as a passive recovery period.

Training sessions were conducted four times per week for two weeks, each lasting 90 minutes. Sessions included a standardized warm-up, technical and kicking drills, sparring, and plyometric exercises involving box jumps from 60 cm [15]. Quadriceps muscle soreness was evaluated using a 10-cm VAS, ranging from no soreness (0) to severe soreness (10) [16]. Athletes performed a 90° squat hold for 3 seconds before rating soreness intensity.

Kicking performance was assessed using a modified TAIKT [13], consisting of six 5-second maximal kicking bouts separated by 10-second active recovery. Athletes alternated legs while performing roundhouse (bandal-chagi) kicks toward a standardized target. Kicks were directed at a fixed stand bag, and accuracy was assessed by two international referees, who recorded the number of valid strikes during the test.

Training intensity was maintained at approximately 85% of predicted maximal heart rate, as monitored by pulse oximetry and estimated using age-based equations [17]. Data were analyzed using Microsoft Excel 2016 and JASP (version 0.18.3). Descriptive statistics included mean (M), standard deviation (SD), effect sizes (Cohen's *d*), and confidence intervals (CIs). Normality was evaluated using the Shapiro-Wilk test. Analyses were performed separately for the Latvian and Polish cohorts due to differences in age and data collection periods, and because the study was not powered to test country-level effects. To address the primary aim of comparing intervention-related changes between groups, pre-post outcomes were summarized as individual absolute change scores (Mpost-Mpre). Between-group comparisons were conducted using independent-samples *t* tests when assumptions were met, or Mann-Whitney *U* tests when assumptions of normality were violated. Statistical significance was set at $p<0.05$.

Results

Descriptive statistics and absolute change scores (AC; post-pre) for DOMS and TAIKT are presented in Table 2. In the Latvian cohort, DOMS increased in the CG (AC=1.80±0.44) and decreased in the FR group (AC=-1.00±0.70), while TAIKT showed a small improvement in controls (AC=0.23±0.30) and a larger increase following FR (AC=1.26±0.19). In the Polish cohort, DOMS increased in the CG (AC=0.50±1.29) and decreased in the FR group (AC=-1.75±0.95), and TAIKT improved more following FR (AC=2.08±0.28) than in controls (AC=0.34±0.27).

Table 2. Descriptive statistics and absolute change for DOMS and TAIKT (n=18)

Cohort	Outcomes	Group	Pre M±SD	Post M±SD	Absolute change (Post-Pre)
LAT	DOMS	CG	3.00±0.70	4.80±0.44	1.80±0.44
		FR	2.40±0.54	1.40±0.54	-1.00±0.70
	TAIKT	CG	5.68±0.18	5.86±0.14	0.23±0.30
		FR	5.99±0.47	7.26±0.51	1.26±0.19
POL	DOMS	CG	4.25±0.95	4.75±1.89	0.50±1.29
		FR	4.00±0.81	2.25±1.25	-1.75±0.95
	TAIKT	CG	4.28±0.62	4.62±0.49	0.34±0.27
		FR	5.16±0.70	7.24±0.56	2.08±0.28

Notes: M – mean, SD – standard deviation, LAT – Latvia, POL – Poland, CG – control group, FR – foam rolling group.

Table 3 presents the between-group comparisons of absolute change scores for DOMS and TAIKT in the Latvian cohort. FR resulted in a significantly greater reduction in DOMS compared with the CG (U=25, $p=0.009$), with a Hodges-Lehmann estimate (95% CI [2.00, 4.00]), indicating a markedly larger decrease in perceived muscle soreness following the intervention.

Similarly, TAIKT improved significantly more in the FR group than in the CG, $t(8)=-6.39$, $p<0.001$, with a 95% confidence interval of [-1.40, -0.65] and a very large effect size (Cohen's $d=-4.04$), demonstrating a substantial improvement in TAIKT associated with post-exercise FR.

Table 3. Between-group comparison of DOMS and TAIKT for the Latvian athletes (n=10)

Cohort	Outcomes	Group	M±SD difference	u	t	*p*	d	95% CI
LAT	DOMS	CG	1.80±0.44	25.00 #	-	0.009*	-	HL 2.00, 4.00
		FR	-1.00±0.70					
	TAIKT	CG	0.23±0.30	-	-6.39	0.001*	-4.04	-1.40, -0.65
		FR	1.26±0.19					

Notes: # – nonparametric test, HL – Hodges-Lehmann, u – Mann-Whitney test, d – Cohen's *d*, CI – confidence interval, * – significant *p*-value ($p<0.05$), CG – control group, FR – foam rolling group.

Table 4 presents the between-group comparisons of absolute change scores for DOMS and TAIKT in the Polish cohort. FR resulted in a significantly greater reduction in DOMS compared with the CG, $t(6)=2.80$, $p=0.03$, with a large effect size (Cohen's $d=1.98$) and a 95% confidence interval of [0.28, 4.21]. Similarly, TAIKT improved significantly more in the FR group than in the CG, $t(6)=-8.76$, $p<0.001$, with a very large effect size (Cohen's $d=-6.19$) and a 95% confidence interval of [-2.23, -1.25].

Table 4. Between-group comparison of DOMS and TAIKT for the Polish athletes (n=8)

Cohort	Outcomes	Group	M±SD difference	t	*p*	d	95% CI
POL	DOMS	CG	0.50±1.29	2.80	0.03*	1.98	0.28, 4.21
		FR	-1.75±0.95				
	TAIKT	CG	0.33±0.27	-8.76	0.001*	-6.19	-2.23, -1.25
		FR	2.08±0.29				

Notes: # – Nonparametric test, HL – Hodges-Lehmann, u – Mann-Whitney test, d – Cohen's *d*, CI – confidence interval, * – significant *p*-value ($p<0.05$).

Competition performance of the Latvian athletes (the FR group)

Two days after completing the intervention, all the Latvian athletes in the FR group (n=5) participated in the 5th Latvian National Cup (November 2025) held in Riga, Latvia. Four athletes competed in the junior division (14-17 years), including two males (+75 kg) and two females (-52 kg and -62 kg), and one athlete competed in the senior division (+18 years; male, -70 kg). According to the Latvian Taekwon-Do Federation, the competition included more than 112 athletes across multiple categories; however, several weight divisions consisted of only two to four competitors. Matches were conducted in two-minute single-round bouts, and athletes were permitted to compete in higher weight categories when applicable. Competition draw sheets indicated that female athletes each competed against one opponent, while male athletes in the -70 kg and +75 kg categories competed against two opponents. Among the foam-rolling group, two male athletes (-70 kg and +75 kg) placed first in their respective categories, whereas the remaining three athletes did not advance beyond their initial matches. These competition outcomes are reported descriptively and were not subjected to statistical analysis.

Discussion

This pilot study examined the feasibility and preliminary effects of a two-week post-exercise FR intervention on DOMS and kicking performance in Latvian and Polish martial arts athletes. Across both cohorts, FR was associated with reduced DOMS and improvements in kicking performance compared with control conditions. However, these findings should be interpreted with caution due to the small sample sizes, short intervention duration, and the continuation of training throughout the study. Therefore, the observed effects likely reflect the combined influence of ongoing training and FR rather than the isolated effect of the intervention.

The results of the present study are consistent with previous research reporting beneficial effects of FR on delayed-onset muscle soreness and performance outcomes across various sports, including martial arts [2,4,18-20]. Previous studies have shown that FR can help limit post-exercise declines in muscle function, particularly after high-intensity exercise. Research involving martial arts, futsal, and professional football players has demonstrated that FR supports the maintenance of lower-limb explosive strength, reduces perceived fatigue, and preserves agility compared with passive recovery. Together, these findings suggest that FR may be an effective recovery strategy for maintaining muscle performance following strenuous physical activity [2,4,18-20].

In contrast to the present findings, some studies have reported little or no benefit of FR on post-exercise recovery. Previous research has shown that FR may not significantly improve muscle power, agility, or flexibility, nor substantially reduce delayed-onset muscle soreness following exercise [21,22]. These mixed findings may be explained by differences in study design and recovery conditions. Muscle recovery is a complex process influenced by factors such as the extent of muscle damage, inflammatory responses, and the accumulation of metabolic byproducts, which may contribute to variability in observed outcomes. Consistent with the present results, brief FR sessions lasting less than two minutes per muscle group are often associated with short-term improvements in physical performance [23]. Nevertheless, there is currently no agreement on the most effective duration of FR interventions [3]. The response to FR may also vary depending on individual characteristics, including training experience, age, gender, and competitive level [24]. In addition, muscle stiffness and flexibility appear to influence individuals' responses to FR. Although the majority of participants in this study were male, previous research indicates that female athletes typically demonstrate greater joint range of motion, which may enhance the effectiveness of FR in this population [25]. By comparison, some evidence indicates that male athletes may experience particular benefits from FR, especially in reducing muscle stiffness and alleviating exercise-related discomfort [20,26]. Recent studies have also examined FR alongside other recovery approaches, such as cryotherapy, and suggest that combining FR with additional recovery methods may enhance its overall effectiveness [21,27]. The impact of FR appears to be influenced by methodological aspects such as the type of exercise performed, the duration of the intervention, and the timing of outcome measurements. Several limitations should be acknowledged. Most notably, the small sample size and exploratory design of this pilot study limit the strength of the conclusions and the ability to detect broader group effects. Future research should involve larger, more diverse samples, including more athletes of both genders, to better clarify the effectiveness of FR interventions. Many recovery outcomes are based on self-reported soreness or fatigue, which can introduce individual-level bias and variability in the results. In addition, the short duration of most recovery studies limits understanding of the longer-term effects of these interventions, which may be important for evaluating their true impact on athletic recovery. Although competition outcomes were not analyzed statistically and cannot be attributed solely to the intervention, the participation of foam-rolling athletes in a national-level competition shortly after the intervention provides contextual insight into athlete readiness during a competitive period.

Future studies should incorporate objective physiological biomarkers of recovery, as well as psychological and emotional assessments [28-30]. In the present study, factors such as sleep quality, nutritional intake, and external stressors were not controlled and may have influenced subjective perceptions of recovery

Conclusions

This pilot study suggests that post-exercise FR may support recovery in martial arts athletes by reducing delayed-onset muscle soreness and enhancing kicking performance. However, these findings should be interpreted cautiously due to the small sample sizes, short intervention duration, and the continuation of training throughout the study. Therefore, the observed effects likely reflect the combined influence of training and FR rather than the isolated effect of the intervention. Future research using larger samples and controlled designs is required to confirm these preliminary findings.

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The study followed the Declaration of Helsinki and was approved by the Ethical Committee of the Latvian Academy of Sport Education (protocol no. 9/3, May 31, 2024) and the Józef Piłsudski University of Physical Education in Warsaw (no. SKE.0030.67.2025). Informed consent was obtained from all the individuals included in the study.

Artificial intelligence (AI) was not used in the creation of the manuscript.

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