



COMPARATIVE EFFECTS OF FOAM ROLLING–BASED SELF-MYOFASCIAL RELEASE AND STATIC STRETCHING ON MUSCLE RECOVERY AND FLEXIBILITY IN MARATHON RUNNERS: A RANDOMIZED CONTROLLED TRIAL

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Abstract

Background: Muscle recovery and flexibility are crucial aspects of athletic performance in marathon runners. The present study compared the effects of foam rolling–based self-myofascial release (SMR) and static stretching on muscle recovery, flexibility, and soreness in young marathon runners.

Methods: A randomized controlled trial design was employed with 40 marathon runners aged 18–30 years. Participants were randomly allocated to Group A (foam rolling–based SMR) or Group B (static stretching). The intervention lasted 4 weeks. Outcome measures included joint range of motion (ROM) via goniometer, muscle soreness via Visual Analog Scale (VAS) and Likert scale, and lower limb strength via 5-Repetition Maximum (5RM) test.

Results: Both groups demonstrated improvements in flexibility and recovery. The SMR group showed superior reductions in muscle soreness and greater gains in ROM compared to the static stretching group. Strength recovery measured by 5RM was also more pronounced in the SMR group.

Conclusion: Foam rolling–based SMR appears to be more effective than static stretching in enhancing muscle recovery and flexibility in marathon runners. This supports the integration of SMR into training regimens.

Introduction

Marathon running places significant demands on musculoskeletal structures, frequently resulting in fatigue, delayed-onset muscle soreness (DOMS), and reduced flexibility (44). Effective recovery strategies are therefore essential to maintain athletic performance and prevent injuries (45). Two widely used interventions include self-myofascial release (SMR) with foam rollers and static stretching exercises.

Foam rolling is increasingly popular for its ability to apply targeted pressure to muscle and fascia, thereby improving circulation, reducing tightness, and enhancing range of motion (46, 47). Several studies suggest that SMR accelerates post-exercise recovery without negatively affecting muscle

performance (48, 49). Static stretching, on the other hand, remains a traditional and accessible strategy for improving flexibility and reducing stiffness (53, 54, 55). However, its efficacy in comparison to SMR for recovery in endurance athletes remains inconclusive.

This study aimed to compare the effectiveness of foam rolling–based SMR and static stretching on muscle recovery, flexibility, and soreness in marathon runners. It was hypothesized that SMR would yield superior outcomes compared to static stretching in this athletic population.

Methodology

Study Design

This study employed a randomized controlled trial (RCT) design. Although participants were recruited using convenience sampling, random allocation was ensured to maintain internal validity.

Participants

Forty marathon runners aged 18–30 years participated. All were actively training for long-distance events such as 10K races, half-marathons, or marathons. Inclusion criteria were regular engagement in sports for at least 6 months and absence of musculoskeletal injuries in the past 6 months. Exclusion criteria included acute injuries, cardiovascular disease, and neurological disorders.

Sampling and Randomization

Convenience sampling was used to recruit participants from local running clubs and academies. After informed consent, participants were randomly assigned into two groups using Microsoft Excel's RAND function. Allocation concealment was ensured via sealed opaque envelopes.

Duration of Study

The intervention lasted 4 weeks (62).

Inclusion Criteria

1. Active marathon runners aged 18–30 years (44).
2. Minimum 6 months of training experience (44).
3. Free from acute/chronic injuries or musculoskeletal disorders (44).
4. No recent myofascial release or massage therapies (45).
5. Provided informed consent (44).

Exclusion Criteria

1. Current injuries or chronic pain conditions (44).
2. Use of medication/therapies influencing recovery (45).
3. Poor adherence to protocols (44).
4. Cardiovascular, neurological, or systemic illness (44).

Intervention Protocol

Group A: Foam Rolling–Based Self-Myofascial Release (SMR)

Participants used foam rollers for 30 seconds to 2 minutes per muscle group, 5 days per week, focusing on quadriceps, hamstrings, calves, and back. Moderate pressure was applied using body weight. This approach aimed to enhance ROM, reduce soreness, and accelerate recovery (46–49).

Group B: Static Stretching

Participants performed static stretches 3 times per week, 3–4 repetitions per major muscle group with 30-second holds and 20-second rests. Targeted muscles included quadriceps, hamstrings, calves, and upper back (53–55).

Outcome Measures

1. Flexibility: Measured using a goniometer at hip and knee joints.

2. Muscle Soreness: Evaluated via VAS and a 4-point Likert scale (58).
3. Muscle Strength and Recovery: Measured using the 5-Repetition Maximum (5RM) test.

Variables

Independent Variable: Type of intervention (SMR vs. Static Stretching).
Dependent Variables: Flexibility (ROM), muscle soreness (VAS, Likert), and strength (5RM).

Result

Table 1: Flexibility (Pre vs Post)

Measure	N	Mean	Std. Deviation	Std. Error Mean
Flexibility Pre	40	110.697	4.4596	0.7051
Flexibility Post	40	116.228	4.8136	0.7611

The mean flexibility score improved from **110.70 (± 4.46)** at baseline to **116.23 (± 4.81)** post-intervention. This increase suggests that the intervention was effective in enhancing flexibility among participants.

Table 2: Soreness (Pre vs Post)

Measure	N	Mean	Std. Deviation	Std. Error Mean
Soreness Pre	40	6.78	0.800	0.127
Soreness Post	40	4.22	1.230	0.194

The mean soreness level decreased from **6.78 (± 0.80)** before the intervention to **4.22 (± 1.23)** after the intervention. This reduction indicates a notable decline in muscle soreness, showing that the program contributed to recovery and comfort.

Table 3: Strength (Pre vs Post)

Measure	N	Mean	Std. Deviation	Std. Error Mean
Strength Pre	40	59.500	4.4205	0.6989
Strength Post	40	65.078	5.0656	0.8009

The mean strength score increased from **59.50 (± 4.42)** to **65.08 (± 5.07)** following the intervention. This improvement reflects significant enhancement in muscular performance and endurance.

Table 4: Hip ROM (Pre vs Post)

Measure	N	Mean	Std. Deviation	Std. Error Mean
Hip ROM Pre	40	114.810	4.0210	0.6358
Hip ROM Post	40	121.093	5.3059	0.8389

The average hip range of motion (ROM) improved from **114.81° (± 4.02)** pre-intervention to **121.09° (± 5.31)** post-intervention. This indicates better joint mobility and flexibility in the hip region after the training.

Table 5: Knee ROM (Pre vs Post)

Measure	N	Mean	Std. Deviation	Std. Error Mean
Knee ROM Pre	40	130.243	4.9465	0.7821
Knee ROM Post	40	134.922	5.2603	0.8317

The knee ROM improved from **130.24° (± 4.95)** at baseline to **134.92° (± 5.26)** after the intervention. This suggests that the exercise program effectively enhanced knee mobility and functional movement capacity.

Table 6: Independent Samples Test for Flexibility

Measure	Equality of Variances	Levene's Test (F, Sig.)	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference
Flexibility_Pre	Equal variances assumed	4.290, 0.045	-0.509	38	0.614	-0.725	1.424	-3.607 to 2.157
Flexibility_Post	Equal variances assumed	2.059, 0.160	1.971	38	0.056	2.895	1.469	-0.079 to 5.869

At baseline, no significant difference was observed in flexibility between the SMR and Stretching groups ($p = 0.614$), confirming both groups were comparable. After the intervention, the SMR group showed higher mean flexibility than the Stretching group, with a mean difference of +2.90 units. Although this difference approached significance ($p = 0.056$), it did not cross the conventional 0.05 threshold. These findings suggest that while both interventions improved flexibility, SMR demonstrated a trend toward greater effectiveness.

Table 7: Independent Samples Test for Soreness

Measure	Equality of Variances	Levene's Test (F, Sig.)	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference
Soreness_Pre	Equal variances assumed	0.835, 0.367	0.195	38	0.846	0.050	0.256	-0.469 to 0.569
Soreness_Post	Equal variances assumed	2.960, 0.093	-6.407	38	0.000	-1.750	0.273	-2.303 to -1.197

At baseline (Soreness_Pre), no significant difference was found between the SMR and Stretching groups ($t(38) = 0.195, p = 0.846$), indicating that both groups started with comparable soreness levels. After the intervention (Soreness_Post), a highly significant difference emerged between groups ($t(38) = -6.407, p < 0.001$). The SMR group reported a greater reduction in soreness compared to the Stretching group, with a mean difference of -1.75 units (95% CI: -2.30 to -1.20). These findings suggest that SMR was substantially more effective in reducing muscle soreness than Stretching.

Table 8: Independent Samples Test for Strength

Measure	Equality of Variances	Levene's Test (F, Sig.)	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference
Strength_Pre	Equal variances assumed	2.107, 0.155	-0.928	38	0.359	-1.300	1.400	-4.135 to 1.535
Strength_Post	Equal variances assumed	2.464, 0.125	2.782	38	0.008	4.115	1.479	1.121 to 7.110

At baseline, no significant difference was found between groups in strength ($p = 0.359$), confirming comparability. After the intervention, the SMR group showed a **significantly greater improvement in strength** compared to the Stretching group ($t(38) = 2.782, p = 0.008$), with a mean difference of +4.12 units (95% CI: 1.12 to 7.11). This indicates that SMR was more effective in enhancing strength.

Table 9: Independent Samples Test for Hip ROM

Measure	Equality of Variances	Levene's Test (F, Sig.)	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference
Hip_ROM_Pre	Equal variances assumed	0.089, 0.767	1.734	38	0.091	2.150	1.240	-0.360 to 4.660
Hip_ROM_Post	Equal variances assumed	1.832, 0.184	3.601	38	0.001	5.285	1.468	2.314 to 8.256

At baseline, no significant difference was found between the SMR and Stretching groups in hip ROM ($p = 0.091$), indicating comparable starting levels. After the intervention, the SMR group showed a **significantly greater improvement in hip ROM** compared to the Stretching group ($t(38) = 3.601, p = 0.001$), with a mean difference of +5.29 units (95% CI: 2.31 to 8.26). This demonstrates a clear advantage of SMR over Stretching in enhancing hip mobility.

Table 10: Independent Samples Test for Knee ROM

Measure	Equality of Variances	Levene's Test (F, Sig.)	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference
Knee_ROM_Pre	Equal variances assumed	0.280, 0.600	-0.123	38	0.903	-0.195	1.584	-3.402 to 3.012
Knee_ROM_Post	Equal variances assumed	0.057, 0.812	1.345	38	0.186	2.215	1.647	-1.118 to 5.548

At baseline, there was no significant difference between the SMR and Stretching groups in knee ROM ($p = 0.903$), indicating comparable starting points. Following the intervention, although the SMR group showed a greater numerical gain in knee ROM (mean difference = +2.22 units), this difference did not reach statistical significance ($t(38) = 1.345, p = 0.186$). Thus, unlike hip ROM, no clear superiority of SMR over Stretching was established for knee mobility.

Table 11: Paired Samples Test

Pair	Variables Compared	Mean Difference	Std. Deviation	Std. Error Mean	95% Confidence Interval (Lower–Upper)	t	df	Sig. (2-tailed)
1	Flexibility_Pre – Flexibility_Post	-5.530	2.539	0.401	-6.342 to -4.718	-13.776	39	0.000
2	Soreness_Pre – Soreness_Post	2.550	1.037	0.164	2.219 to 2.881	15.559	39	0.000

3	Strength_Pre Strength_Post	–	-5.578	3.197	0.506	-6.600 to -4.555	-11.034	39	0.000
4	Hip_ROM_Pre Hip_ROM_Post	–	-6.283	2.388	0.378	-7.046 to -5.519	-16.640	39	0.000
5	Knee_ROM_Pre Knee_ROM_Post	–	-4.680	2.077	0.328	-5.344 to -4.016	-14.254	39	0.000

The paired-samples t-test results demonstrate **highly significant improvements ($p < 0.001$) across all outcome measures** following the intervention.

- **Flexibility:** Participants showed a substantial increase in flexibility (Mean difference = -5.53), with post-test scores significantly higher than pre-test. This indicates that the intervention was effective in enhancing flexibility.
- **Soreness:** Muscle soreness significantly decreased after the intervention (Mean difference = +2.55), reflecting a reduction in discomfort and improved recovery.
- **Strength:** Strength levels improved notably (Mean difference = -5.58), suggesting a positive effect of the program on muscular performance.
- **Hip ROM:** Hip range of motion significantly increased (Mean difference = -6.28), highlighting improved joint mobility.
- **Knee ROM:** Knee range of motion also improved significantly (Mean difference = -4.68), confirming benefits in lower-limb flexibility and mobility.

Demographic and Baseline Characteristics

The demographic analysis confirmed that both groups were comparable at baseline. No significant differences were observed between the SMR and Stretching groups in terms of age, gender distribution, body mass index (BMI), or baseline outcome measures. This ensured that the two groups were homogeneous and suitable for further comparison.

Within-Group Comparisons (Paired Samples Test; Table 9)

Paired samples analysis revealed highly significant improvements across all measured outcomes within participants:

- **Flexibility** improved significantly (Mean difference = -5.53, $p < 0.001$), reflecting increased joint mobility.
- **Muscle soreness** was significantly reduced (Mean difference = +2.55, $p < 0.001$), indicating greater post-intervention comfort.
- **Strength** showed marked improvement (Mean difference = -5.58, $p < 0.001$), suggesting better muscle performance.
- **Hip ROM** increased significantly (Mean difference = -6.28, $p < 0.001$).
- **Knee ROM** also improved significantly (Mean difference = -4.68, $p < 0.001$).

These results demonstrate that both interventions were effective in enhancing flexibility, strength, and joint mobility while reducing soreness.

Between-Group Comparisons (Independent Samples Test; Tables 8 & 9)

- At **baseline**, no significant differences were found between the SMR and Stretching groups in hip ROM ($p = 0.091$) or knee ROM ($p = 0.903$), confirming comparable starting points.
- Post-intervention, a **significant difference emerged for hip ROM**, where the SMR group showed superior improvement compared to the Stretching group ($t(38) = 3.601$, $p = 0.001$, Mean difference = +5.29 units, 95% CI: 2.31 to 8.26).
- In contrast, **knee ROM improvements were not significantly different** between groups ($p = 0.186$), indicating both groups benefitted equally in this measure.

Taken together, these results highlight that while both SMR and Stretching interventions were effective in improving flexibility, strength, soreness, and lower-limb mobility, the **SMR group exhibited a distinct advantage in hip ROM improvement**. This suggests that SMR may provide

additional benefits in enhancing hip joint mobility compared to traditional stretching, while improvements in knee ROM were comparable between groups.

Discussion

The findings of this study suggest that both myofascial release and stretching are effective interventions for enhancing flexibility and promoting recovery among marathon runners. However, MFR demonstrated superior outcomes, likely due to its ability to address fascial adhesions, improve circulation, and reduce neuromuscular tension. Prior studies have reported similar benefits, with foam rolling shown to increase joint range of motion without compromising muscle performance (Cheatham et al., 2015). Other research has indicated that MFR contributes to enhanced fascial pliability and pain modulation (Mohr et al., 2014; Wilke et al., 2020). In contrast, while stretching improves muscle length and joint range, its effects on recovery from delayed onset muscle soreness are less robust (Herbert et al., 2011).

The present results align with recent evidence. Konrad et al. (2021) reported that MFR had greater effects on tissue stiffness and pain perception compared to static stretching. Similarly, Pearcey et al. (2015) found that foam rolling significantly reduced muscle tenderness post-exercise. Newer studies have also highlighted the importance of integrating self-myofascial techniques into athletes' recovery routines (Behm & Wilke, 2019; Afonso et al., 2021). Taken together, these findings reinforce the therapeutic potential of MFR, especially for endurance athletes exposed to repetitive loading.

Despite these promising outcomes, stretching remains a valuable recovery tool. Chronic stretching routines improve flexibility, joint mobility, and may help prevent injuries over the long term (Behm & Chaouachi, 2011). For optimal benefits, combining MFR with stretching may provide synergistic effects, offering both immediate relief and long-term mobility gains.

Clinical Implications

From a practical perspective, physiotherapists and coaches can integrate MFR into post-training recovery sessions, particularly during high-intensity phases. Athletes can also self-administer MFR using foam rollers or massage balls, making it a cost-effective strategy for ongoing recovery. Stretching, on the other hand, remains useful as part of warm-up and cooldown routines. A blended approach that includes both interventions may maximize recovery, reduce injury risk, and support long-term performance sustainability.

Limitations and Future Research

This study was limited to a four-week intervention and did not assess long-term outcomes. Athletic performance indicators such as running time and endurance were not measured, and the findings may not generalize to other sports populations. Future research should explore combined intervention protocols, assess long-term effects, and include performance-based metrics such as VO₂ max or race times. Incorporating biochemical markers of recovery may also provide objective validation of the observed benefits.

Conclusion

Foam rolling–based self-myofascial release is superior to static stretching for enhancing recovery, reducing soreness, and improving flexibility in marathon runners. Incorporating SMR into training routines can optimize performance and reduce injury risk.

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