

A Review of the Physiological Effects of Foam Rolling on Skeletal Muscle

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Abstract

As a commonly employed modality for self-myofascial release, foam rolling is widely used in sports rehabilitation and physical training. This article analyzes the physiological effects of foam rolling on skeletal muscle and explores its potential mechanisms. After retrieving PubMed, Cochrane, ScienceDirect, and Embase, and manually screening references, a total of 16 randomized controlled trials, 4 systematic reviews or mechanism reviews, 2 survey studies, and 3 other primary studies were finally included. Available evidence suggests that acute foam rolling is generally associated with improved joint range of motion, whereas muscle strength and explosive performance generally show acute inhibitory trends, consistent with a transient neurophysiological response. Foam rolling appears to have limited direct effects on muscle activation, although it may support recovery-related neuromuscular function in specific settings. It may also alleviate delayed-onset muscle soreness and improve pain-related or hemodynamic responses, but these effects appear to be context-dependent. Its mechanisms involve multifactorial interactions, including myofascial release, mechanoreceptor activation, and hemodynamic regulation. Limitations of existing studies include small sample sizes, heterogeneous intervention protocols, and short follow-up periods. Future research should adopt large-sample, long-term designs to determine optimal intervention parameters and confirm efficacy in clinical populations.

Keywords: foam rolling, self-myofascial release, muscle performance

1. Introduction

Foam rolling is a common tool for self-myofascial release, which is frequently used in sports rehabilitation and training. Its main function is to relieve muscle pain caused by exercise, improve joint mobility, and help exercise recovery to a certain extent (Bartsch K et al., 2025; Ikutomo H et al., 2025; Niazi S et al., 2025). However, the specific mechanism of foam rolling is still unclear. Previous studies and mechanistic reviews suggest that foam rolling may influence soft tissue mechanics, pain perception, and hemodynamic responses, possibly through interactions involving fascial loading, mechanoreceptor stimulation, and neural modulation. (Gao Y & Gao D., 2026; Dębski P et al., 2025; Clijisen R et al., 2025)

In recent years, clinical and sports scientific research has paid more attention to the application effect of foam rolling, but there are obvious differences in experimental design, intervention intensity, action site, measurement indicators, etc. (Amiri B & Zemková E., 2025; Aragão-Santos JC et al., 2025; Bartik P & Pacholek M., 2025; Bartsch K et al., 2025; Sezik AÇ et al., 2024; Gao Y & Gao D., 2026; Heinke L et al., 2025; Hosseini SM et al., 2026; Ikutomo H et al., 2025; Monteiro ER et al., 2025; Niazi S et al., 2025; Ormeno L & Driller M., 2025; Park S & Kim B., 2025; Patti A et al., 2025; Posch D et al., 2026; Rodoplu C et al., 2025; Siegel SD et al., 2026; Szajkowski S et al., 2025; Yeşilyaprak SS & Özden F., 2025; Wu CW et al., 2026; Wilke J et al., 2020). In addition, relevant studies focus on the acute improvement effect of foam rolling on joint mobility (Bartik P & Pacholek M., 2025; Hosseini SM et al., 2026; Patti A et al., 2025; Wilke J et al., 2020); relevant studies focus on

the impact of foam rolling on the recovery effect, specifically focusing on delayed muscle soreness or fatigue after exercise (Park S & Kim B., 2025; Szajkowski S et al., 2025; Wu CW et al., 2026). Recent studies have demonstrated potential benefits of the foam roller in specific clinical populations (e.g., knee osteoarthritis (Ikutomo H et al., 2025), Parkinson’s disease (Kaşlı K et al., 2025), and upper cross syndrome (Kalantariyan M et al., 2026)), although its efficacy exhibits situational dependence. This heterogeneity between studies makes it difficult to integrate the physiological effects of foam rolling systematically. To address this heterogeneity, this review proposes an “initial state dependence” framework as an organizing perspective: the effects of foam rolling differ systematically depending on whether the muscle is in a normal resting state versus a state of fatigue or injury. This framework is developed and supported throughout the Discussion.

Based on this, this article systematically sorts out the existing literature, analyzes the impact of foam rolling on muscle performance, muscle activation, muscle pain and recovery after exercise, and vascular and hemodynamic function, and explores its potential mechanism to provide reference for clinical rehabilitation and exercise training.

2. Methods

In order to fully understand the physiological effect of foam rolling on muscles, this article first searches in four databases: PubMed, Cochrane, ScienceDirect and Embase. The keywords use “foam roller” and “muscle”. The title and abstract use the combination of Boolean logic “AND”. After deduplication and preliminary screening, 25 relevant articles were ultimately included.

Inclusion criteria: 1) randomized controlled trials; 2) systematic reviews; 3) narrative or mechanism-based reviews; 4) survey studies examining practitioner beliefs or usage patterns; 5) observational or correlational studies providing mechanistic context.

Exclusion criteria: 1) case reports or small sample cohorts; 2) research that focuses on technology development; 3) articles without accessible full text or non-English publications. Considering the rapid development of this field, priority was given to studies published within the past three years; however, one earlier high-quality systematic review was retained to support background synthesis.

Ultimately, 25 studies were included, comprising 16 randomized controlled trials (Amiri B & Zemková E., 2025; Aragão-Santos JC et al., 2025; Bartik P & Pacholek M., 2025; Heinke L et al., 2025; Hosseini SM et al., 2026; Ikutomo H et al., 2025; Niazi S et al., 2025; Ormeno L & Driller M., 2025; Patti A et al., 2025; Posch D et al., 2026; Rodoplu C et al., 2025; Szajkowski S et al., 2025; Yeşilyaprak SS & Özden F., 2025; Wu CW et al., 2026; Kaşlı K et al., 2025; Kalantariyan M et al., 2026), 4 systematic reviews or mechanism reviews (Gao Y & Gao D., 2026; Monteiro ER et al., 2025; Park S & Kim B., 2025; Wilke J et al., 2020), 2 survey studies (Bartsch K et al., 2025; Siegel SD et al., 2026), and 3 other primary studies (including correlation and observational studies (Sezik AÇ et al., 2024; Dębski P et al., 2025; Clijsen R et al., 2025)).

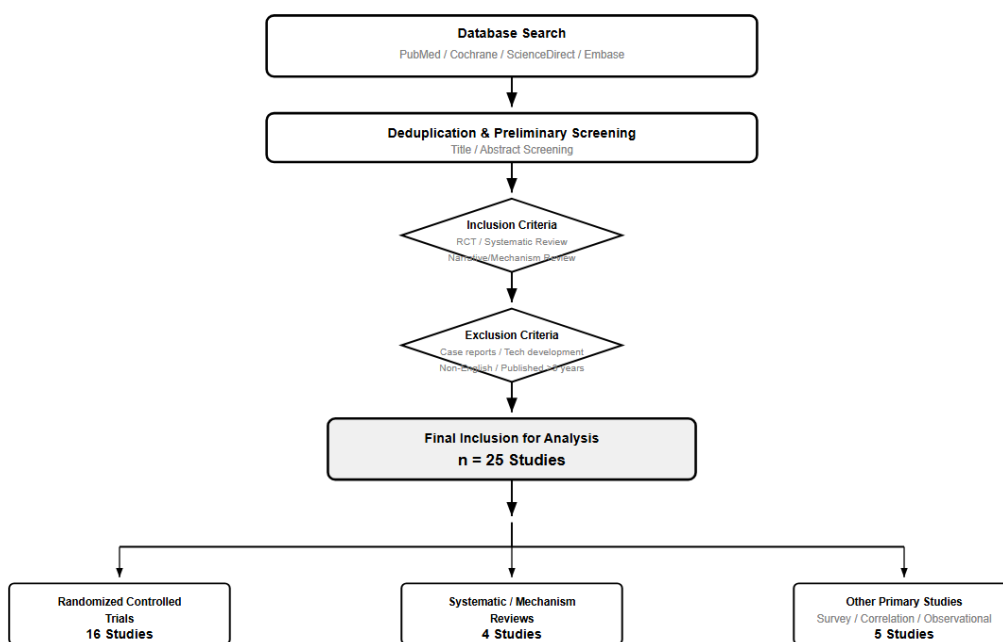


Figure 1. Literature search and screening algorithm

Quality evaluation uses the Cochrane bias risk assessment tool to evaluate the methodological quality of 16 randomized controlled trials. Evaluation points include random sequence generation, distribution hiding, subject and researcher blind method, outcome evaluation blind method, incomplete data, selective reports, and other biased sources. Most studies clearly describe random sequence generation. However, due to the operation limitations of foam rolling itself, it is difficult for the subjects and the researchers who carry out the intervention to be completely blind, which is a common limitation in methodology. Generally speaking, the quality included in the research is at a medium to high level, with the basis for systematic analysis.

3. Results

According to the research purpose, results and conclusions, the analysis of the 25 included studies shows that the physiological effects of foam rolling on skeletal muscle are mainly divided into four directions: Muscle Performance, Muscle Activation, Muscle Soreness and Recovery, and Vascular and Hemodynamic Function.

3.1 Muscle Performance

Acute foam rolling improves joint flexibility but may transiently reduce strength or explosive power (Amiri B & Zemková E., 2025; Aragão-Santos JC et al., 2025; Bartik P & Pacholek M., 2025; Hosseini SM et al., 2026; Patti A et al., 2025; Rodoplu C et al., 2025; Wilke J et al., 2020). Long-term effects on lower limb muscle groups and ROM appear positive, yet adaptive changes in metabolism or mechanical power are limited (Park S & Kim B., 2025; Posch D et al., 2026).

3.2 Muscle Activation

Direct evidence regarding the acute effects of foam rolling on muscle activation-related outcomes remains limited. Existing experimental evidence suggests no substantial immediate change in upper-extremity sensorimotor function following a single bout of foam rolling (Yeşilyaprak SS & Özden F., 2025), whereas findings from specific patient populations or multimodal corrective interventions should be interpreted cautiously (Niazi S et al., 2025; Kalantariyan M et al., 2026). Mechanistic reviews have proposed possible neurophysiological effects of myofascial release interventions, but these mechanisms remain to be confirmed by direct experimental studies (Gao Y & Gao D., 2026).

3.3 Muscle Soreness and Recovery

Foam rolling alleviates delayed-onset muscle soreness, increases pressure pain threshold, and aids flexibility recovery. Both vibration and non-vibration rolling improve post-exercise recovery compared with static stretching (Park S & Kim B., 2025; Rodoplu C et al., 2025; Szajkowski S et al., 2025; Wu CW et al., 2026).

3.4 Vascular and Hemodynamic Function

Evidence related to the vascular and hemodynamic effects of foam rolling remains limited. Existing reviews suggest that foam rolling may influence selected hemodynamic or autonomic responses (Monteiro ER et al., 2025). In clinical populations, foam rolling has also been associated with improvements in pain or functional outcomes in conditions such as hip osteoarthritis and Parkinson's disease, although these findings should not be interpreted as direct evidence of vascular effects (Ikutomo H et al., 2025;)²². Studies on soft tissue biomechanical responses (Dębski P et al., 2025) and adjacent percussive modalities (Clijssen R et al., 2025) may offer indirect mechanistic context, but they do not directly confirm foam rolling-specific vascular effects.

4. Discussion

This review systematically analyzes 25 studies and summarizes the physiological effects of foam rolling on skeletal muscle into four areas. Improved blood flow and autonomic regulation provide the physiological basis for muscle recovery and soreness relief, while muscle activation and coordination influence strength and performance. Enhanced flexibility improves fascial gliding and movement efficiency. These four dimensions interact to form a comprehensive mechanistic network, with effects that are condition-dependent, offering a theoretical foundation for training and rehabilitation.

4.1 Effects of Foam Rolling on Flexibility and Its Underlying Mechanisms

In the included studies, foam rolling was generally associated with short-term improvements in joint mobility. Regardless of the intervention site (thoraco-lumbar fascia (Amiri B & Zemková E., 2025), hip joint (Ikutomo H et al., 2025), knee joint (Rodoplu C et al., 2025), or ankle joint (Patti A et al., 2025)) and measurement methods (sitting forward flexion, passive joint mobility, etc.), the vast majority of studies found significant results. Wilke et al. (2020) conducted a systematic review with multilevel meta-analysis and confirmed the acute effects of foam rolling on range of motion in healthy adults. Long-term intervention research focuses on lower limb muscle groups and joint flexibility (Park S & Kim B., 2025; Posch D et al., 2026). However, Posch et al. (2026) suggested that long-term adaptive effects may be limited, and there may be a discrepancy between objective measurements and subjective feelings. The only study that showed no significant effect (Bartik P & Pacholek

M., 2025) had a short intervention duration and involved young male athletes. This suggests that intervention dose and subject characteristics are critical. If the single session is too short or tissue characteristics differ, the effects may also differ.

Currently, there are three main explanations for the mechanism of flexibility improvement. The first is the myofascial mechanical response hypothesis. The pressure and friction of foam rolling can influence the fascial matrix, allowing smoother fascial gliding and more efficient force transmission (Gao Y & Gao D., 2026; Wilke J et al., 2020). Gao and Gao (2026) comprehensively reviewed the mechanisms of myofascial release, noting that direct histological evidence for structural changes following a single intervention remains insufficient. The second is the activation of mechanoreceptors. Foam rolling compresses Ruffini corpuscles and Pacinian corpuscles in the muscles and fascia. These signals are transmitted to the spinal cord and higher nerve centers, reducing muscle spindle sensitivity, soothing muscle tension, and expanding joint range of motion (Gao Y & Gao D., 2026; Dębski P et al., 2025). The third is altered perception and pain modulation. Dębski et al. (2025) found a relationship between attitude toward pain and the effects of foam rolling on soft tissue biomechanical parameters. Clijsen et al. (2025) observed physiological effects following local percussion massage, suggesting that foam rolling may activate descending inhibitory pathways, making individuals more tolerant of stretch and pain. These three mechanisms may work together rather than exclude each other.

4.2 Acute Inhibitory Effects of Foam Rolling on Strength and Power

The study of acute force or explosive force generally showed an inhibitory trend after foam rolling intervention, although the magnitude and consistency of this effect varied across studies. (Aragão-Santos JC et al., 2025; Heinke L et al., 2025; Ormeno L & Driller M., 2025). This pattern has been reported in several acute studies and may reflect a short-term neurophysiological response, although findings remain context-dependent. Aragão-Santos et al. (2025) found that foam rolling and massage ball with or without vibration affected the squat load-velocity profile, with some conditions showing decreased performance. Heinke et al. (2025) observed that jump height decreased following foam rolling, and this effect was correlated with pain intensity. Ormeno and Driller (2025) reported that foam roller use during a warm-up had limited effects on performance in trained athletes. Nerve inhibition means that the central nervous system actively downregulates the excitability of α -motor neurons, reducing muscle output. From the perspective of adaptation and protection, this may be beneficial: deep pressure is interpreted by the central system as a signal of tissue pressure or possible damage, which automatically triggers protective mechanisms and limits force output to avoid injury.

Gao and Gao (2026) discussed that this effect is based on neural circuits. It is worth noting that the decline in strength is not a decline in the intrinsic capacity of the muscle itself (e.g., cross-bridge ability or energy metabolism). It is more likely a temporary adjustment of neural drive strategy. This is consistent with the pain gate control theory and the neurophysiological model of manual treatment (Gao Y & Gao D., 2026; Dębski P et al., 2025). These results show that foam rolling has no significant positive impact on strength and power in the short term, and sometimes even has a short-term inhibitory effect. From a practical point of view, foam rolling needs to be used carefully before training dominated by strength or explosive power, such as weightlifting, sprinting, or jumping.

In addition, in terms of strength and power recovery, most studies have found that the use of foam rolling after exercise can promote subjective recovery (Rodoplu C et al., 2025; Szajkowski S et al., 2025; Wu CW et al., 2026), but Rodoplu et al. (2025) did not observe significant changes in functional muscle parameters. These results show that foam rolling can be used as an auxiliary tool in recovery training, which is especially suitable for relieving pain and restoring flexibility. However, if the goal is high-intensity strength training or the pursuit of extreme performance, it is better to cooperate with other training methods.

4.3 The Role of Foam Rolling in Post-Exercise Recovery

Contrary to the force inhibition effect observed during acute use, foam rolling shows a positive and extensive recovery effect in the state of fatigue or injury induced by exercise. Most studies have found that foam rolling can significantly relieve delayed-onset muscle soreness (Park S & Kim B., 2025; Rodoplu C et al., 2025; Szajkowski S et al., 2025; Wu CW et al., 2026), and also shows advantages in subjective recovery. Park and Kim (2025) confirmed the positive effects of vibration foam rolling on pain and fatigue in individuals with muscle fatigue. This seemingly contradictory two-way effect (inhibiting strength in normal muscles while promoting recovery in fatigued muscles) can be explained by “initial state dependence.”

In the exercise-induced fatigue state, metabolic waste accumulates inside the muscles, stimulating acid-sensitive channels and nociceptors, resulting in fatigue and pain. There is also slight damage and inflammation of muscle fibers. Against this background, foam rolling plays a recovery role through several pathways.

The first is improvement of hemodynamics and autonomic responses. Monteiro et al. (2025) conducted a scoping review suggesting that foam rolling may influence heart rate and blood pressure regulation. The second

is promotion of lymphatic return and reduction of edema. Foam rolling applies pressure, encouraging tissue fluid flow toward lymphatics, relieving local swelling and pressure. The third is pain modulation at the neurological level. By activating descending inhibitory pathways in the spinal cord and releasing endogenous opioids and serotonin, pain is reduced (Gao Y & Gao D., 2026; Dębski P et al., 2025; Clijsen R et al., 2025). Dębski et al. (2025) highlighted the role of pain attitude in modulating foam rolling effects. Pain relief makes exercise more comfortable and allows for a faster return to normal movement patterns, reducing secondary injuries caused by compensation.

In normal muscles, the pathological state that needs “repair” does not exist, and foam rolling mainly manifests as neural inhibition. This also explains why the same tool has completely different effects in different scenarios. However, Amiri and Zemková (2025) found that trunk stability and breathing exercises were superior to foam rolling for restoring postural stability after core muscle fatigue, suggesting that foam rolling may not be the optimal choice in certain recovery contexts.

4.4 Muscle Activation and Agonist-Antagonist Balance

This review finds that the acute effect of foam rolling on muscle activation is limited. Yeşilyaprak and Özden (2025) found that a single foam rolling intervention had no significant effect on muscle activation and was not sufficient to change central nervous system regulation.

What is worth paying attention to is the agonist-antagonist balance. Gao and Gao (2026) discussed that when foam rolling targets the quadriceps, the activation of the antagonist hamstring muscles may decrease through reciprocal inhibition, potentially affecting overall exercise performance. From a neurophysiological perspective, this effect comes from the principle of reciprocal inhibition: agonist muscle Ia fibers are stimulated by pressure, and the excitatory signal downregulates the output of antagonist muscle α -motor neurons through inhibitory interneurons in the spinal cord. Foam rolling may trigger this mechanism.

This discovery has significant clinical and training implications. Kalantariyan et al. (2026) demonstrated the importance of agonist-antagonist balance in the rehabilitation of upper crossed syndrome. In practice, when relieving tension or soreness in a muscle group, it should be considered to also roll the antagonist muscle to maintain agonist-antagonist balance. For example, after rolling the quadriceps, the hamstrings should also be rolled; after rolling the biceps, the triceps should also be rolled. This “agonist-antagonist balance” principle can be used as a guideline for foam rolling, especially for knee and shoulder joint stability training and rehabilitation.

4.5 The Knowledge-Practice Gap

A notable finding of this review is the persistent gap between practitioner beliefs and the available scientific evidence. Two international survey studies included in this review (Bartsch K et al., 2025; Siegel SD et al., 2026) collectively reveal that sports and rehabilitation professionals commonly hold beliefs about foam rolling—such as its ability to directly increase muscle flexibility or improve performance—that are not fully supported by current evidence. Bartsch et al. (2025) found that many practitioners were unaware of documented contraindications and adverse events, while Siegel et al. (2026) confirmed that practitioner beliefs often exceed what the evidence supports. This gap may lead to suboptimal application—for instance, using foam rolling immediately before strength-dominant activities despite evidence of acute inhibitory effects, or over-attributing recovery benefits to foam rolling alone. Bridging this gap requires better dissemination of evidence-based guidelines, particularly regarding optimal application parameters and context-dependent indications.

4.6 Limitations of the Study

There are some limitations in this review. First, the sample sizes of the included studies are generally small (Sezik AÇ et al., 2024; Posch D et al., 2026; Wilke J et al., 2020), limiting statistical power and generalizability. Second, the foam rolling intervention parameters vary significantly: rolling speed differs; pressure magnitude varies; single session duration ranges from 30 seconds to several minutes; frequency is not uniform; intervention cycles are inconsistent (acute vs. several weeks), making it difficult to conduct dose-effect analyses (Bartsch K et al., 2025; Siegel SD et al., 2026). Third, most studies only observe acute effects and lack long-term follow-up data (Amiri B & Zemková E., 2025; Bartik P & Pacholek M., 2025; Heinke L et al., 2025; Ormeno L & Driller M., 2025). Fourth, the nature of the intervention makes it difficult to achieve blinding, and there may be implementation bias. Fifth, Bartsch et al. (2025) and Siegel et al. (2026) highlighted a significant gap between practitioner beliefs and scientific evidence, which may affect the translation of research findings into clinical practice. Sixth, most study subjects are healthy young individuals, and caution should be exercised when generalizing results to clinical populations (such as those with chronic pain or post-operative recovery), although preliminary evidence exists for osteoarthritis (Ikutomo H et al., 2025) and Parkinson’s disease (Kaşlı K et al., 2025). In general, these limitations remind us to be cautious when interpreting the results and suggest that future research can be further improved in terms of sample size, intervention standardization, long-term follow-up, and application to different populations.

5. Conclusion

Based on the existing literature, the physiological effects of foam rolling on skeletal muscle can be summarized as follows:

First, under normal muscle state, foam rolling intervention can significantly improve joint flexibility, which is relatively stable in acute use and limited long-term intervention. However, strength and explosive power tend to decrease slightly in the short term, which may be due to neural inhibition. Therefore, before strength- or power-based training, the timing of foam rolling needs to be carefully arranged.

Second, during muscle fatigue or mild injury after exercise, foam rolling plays a positive role. Most studies show that it can relieve delayed-onset muscle soreness, raise the pressure pain threshold, and promote subjective recovery. This mainly depends on several pathways: improving hemodynamic responses, promoting lymphatic return, and activating descending pain suppression pathways.

Third, the acute effect of foam rolling on muscle activation is limited, but it may improve neuromuscular function during the recovery period in specific contexts. It is worth noting that when rolling on the agonist muscle group, the activation level of the antagonist muscle may be reduced through reciprocal inhibition, affecting joint stability. Therefore, in training and rehabilitation, it is necessary to arrange the order of agonist-antagonist muscle groups and adopt the “agonist-antagonist balance” principle.

Fourth, foam rolling may accelerate muscle recovery and improve training adaptability by improving blood flow and possible neural regulation. Preliminary evidence also supports the application of foam rolling in specific clinical populations, including hip osteoarthritis and Parkinson’s disease.

Fifth, a significant gap exists between practitioners’ beliefs and current scientific evidence regarding foam rolling applications. Survey studies indicate that many professionals hold views about foam rolling’s benefits that exceed what the evidence supports, underscoring the need for improved knowledge translation and clearer evidence-based practice guidelines.

Future research can further clarify the optimal parameters of foam rolling intervention, such as intervention site, rolling speed, pressure, single session duration, frequency, and total cycle (dose-effect relationship), while exploring synergistic application protocols for agonist-antagonist muscles. In addition, large-sample, multi-center, and long-term follow-up studies should be conducted, including clinical populations such as those with chronic pain or post-operative recovery, combining objective physiological indicators and subjective feelings to comprehensively evaluate the effects of foam rolling in different movement states and rehabilitation scenarios.

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