



Massage Therapy Applied During Static Stretching as an Approach to Reducing Ankle Injury Pain

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Abstract

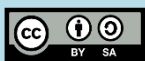
Ankle injuries are among the most common sports-related injuries and often result in pain and limitations in joint range of motion (ROM). This study aimed to introduce and describe massage therapy applied during static stretching as a novel approach for managing pain in post-acute ankle injuries. A descriptive, practice-based research design was employed and conducted in Bengkulu Province, Indonesia. The study involved 20 clients with ankle injuries who had passed the acute phase of injury. The intervention began with light massage to observe and identify the injured area, followed by static stretching combined with massage to release muscle stiffness and myofascial trigger points, and concluded with pain assessment and ROM evaluation. The results showed that the majority of participants experienced a reduction in pain and an improvement in ROM after a single treatment session. Specifically, 70% of participants improved from mild pain to no pain with maximal ROM, 20% improved from moderate pain to no pain with maximal ROM, and 10% of participants with severe pain showed partial improvement to mild pain with moderate ROM. These findings indicate that massage therapy applied during static stretching is effective in reducing pain and improving ROM in post-acute ankle injuries, particularly in cases with mild to moderate pain. This method is recommended for application only after the acute phase of injury has resolved and in the absence of active inflammation.

Keywords: *Ankle injury; Massage therapy; Muscle pain; Range of motion (ROM); Static stretching.*

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Introduction

Sports injuries frequently occur across all levels of physical activity, including educational, recreational, and competitive settings. The annual prevalence of injuries among adolescents ranges from 34% to 65%, with the highest incidence observed in contact sports such as soccer, basketball, and judo (Al-Qahtani et al., 2023; Milić et al., 2025; Prieto-González et al., 2021). These injuries often involve muscle tissue, resulting in pain, stiffness, restricted range of motion, and decreased physical function (Gavilanez et al., 2024; Schwiete et al., 2023). Appropriate post-injury management is therefore essential to accelerate recovery and prevent recurrent injuries, particularly in muscle-related injuries commonly experienced by athletes.

In the existing literature, the management of sports injuries is predominantly emphasized through medical approaches delivered by healthcare professionals, such as physicians and physiotherapists. Acute injuries, including muscle strains, ankle sprains, and contusions, are typically managed through clinical assessment, diagnostic imaging (X-ray, ultrasound, MRI), pharmacological treatment, physiotherapy, and surgical intervention when necessary (Chen et al., 2020; De Sire, 2022). Sports physicians and emergency medical teams play a central role in early management, stabilization, and decisions regarding referral or surgical intervention, particularly in severe or life-threatening injuries involving the head, spine, abdomen, or major fractures (Chen et al., 2020; Lenjani et al., 2021).

However, in clinical practice, post-injury medical management of muscle injuries does not always yield optimal outcomes, particularly in addressing residual muscle stiffness and persistent pain following the acute phase of injury. Evidence from previous studies indicates that muscle stiffness is closely associated with alterations in the mechanical properties of the muscle-tendon unit and pain-related factors, often necessitating

additional interventions beyond pharmacological treatment alone (Takeuchi et al., 2023; Warneke et al., 2024). This condition highlights the need for complementary approaches that can more effectively support the recovery process, particularly in facilitating muscle relaxation and the release of residual tension.

Massage therapy is widely recognized as a non-medical intervention in sports settings to facilitate the recovery of muscle injuries. From a physiological perspective, massage has been shown to enhance blood and lymphatic circulation, reduce edema and hematoma formation, decrease muscle tone and stiffness, and support collagen realignment and scar tissue remodeling, thereby improving tissue elasticity (Mylonas et al., 2021; Дживак et al., 2023).

Conversely, biomechanical reviews have emphasized that stretching is commonly employed to improve flexibility, reduce tissue stiffness, and restore the functional capacity of the musculoskeletal unit, including joints, ligaments, tendons, and muscles, particularly in the prevention and management of joint injuries and contractures (Zvetkova et al., 2023). Despite these well-documented benefits, most intervention strategies reported in the literature continue to treat stretching and massage as separate modalities. Limited attention has been given to the deliberate integration of both techniques into a single, structured method for managing muscle injuries.

Based on practical field experience, the authors observed that the management of muscle injuries does not necessarily need to rely solely on medical interventions. A gap exists between medical approaches, which tend to emphasize clinical assessment and treatment, and the practical needs encountered in the field, particularly in addressing residual muscle stiffness and post-injury pain. Furthermore, physiotherapy is widely recognized as the first-line modality for many sports-related injuries and serves as the primary approach for rehabilitation



and return-to-performance (Agostini et al., 2025; Zhang, 2023). In contrast, the role of massage practitioners is often perceived as limited. Nevertheless, massage practitioners possess specific skills in soft tissue manipulation that can facilitate muscle release and alleviate stiffness following injury.

Through hands-on practice, the author identified a muscle injury management method that combines stretching in specific positions with massage applied to the muscles being stretched. This approach aims to maximize muscle relaxation, facilitate muscle release, and more effectively reduce post-injury pain. The simultaneous combination of targeted stretching and massage represents a novel method distinct from conventional approaches, which typically apply these techniques separately. Based on this background, the present study aims to introduce and describe position-based stretching accompanied by massage as a new approach for managing sports-related injury pain.

Method

This study employed a descriptive qualitative research design with a field-practice approach. This design was chosen because the research aimed to provide an in-depth description of a novel sports injury pain management method, position-based stretching combined with massage based on the author's long-term practical experience, rather than to experimentally test the method's effectiveness. The participants were clients treated by the author during massage practice from January 2023 to September 2025, totaling 720 individuals, including athletes and the general population aged 5–65 years in Bengkulu Province. Among these clients, 243 had ankle injuries. From this subgroup, 20 clients were selected as research subjects using purposive sampling, with a focus on ankle injuries. Subject selection was based on clear injury characteristics, observable treatment

responses, and willingness to participate in the entire study process. Treatments were conducted on injuries that had passed the acute phase, with no swelling or signs of inflammation.

The primary instrument in this study was the author. Data were collected through semi-structured interviews conducted before and after injury management. The interviews primarily focused on two aspects: the pain level experienced by the subjects and changes in the joint range of motion (ROM) in the injured area. In addition to interviews, the author conducted direct observations of the subjects' muscle responses and movement capabilities before and after treatment. Data on pain levels and changes in joint range of motion (ROM) were categorized in Table 1.

Table 1. Assessed Aspects and Categories of Pain Level and Range of Motion (ROM)

No	Assessed Aspect	Category
1	Pain Level	No Pain
		Mild Pain
		Moderate Pain
		Severe Pain
2	Range of Motion (ROM)	Minimal Range
		Moderate Range
		Maximal Range

The research procedure began with the identification of the type and location of muscle injuries in the subjects. An initial interview was then conducted to assess the subjects' pain levels and movement capabilities prior to treatment. Next, the subjects were positioned in specific stretches tailored to the muscle groups affected by the injury. While the muscles were held in a safe and controlled stretched position, manual massage was applied to areas exhibiting



stiffness and pain. After the intervention, follow-up interviews were conducted to evaluate changes in perceived pain and joint range of motion experienced by the subjects.

Data were analyzed using a descriptive qualitative approach, referring to the data analysis model by (Miles et al., 2014). The analysis steps included: (1) data reduction, which involved selecting and simplifying interview data in accordance with the research focus; (2) data display, which involved organizing the data into predetermined categories; and (3) drawing conclusions and verification, which involved interpreting changes in pain levels and joint range of motion following the application of the method.

Result and Discussion

Result

Based on field implementation results, the author developed and applied a muscle injury management method that combines static stretching in specific positions with simultaneous massage techniques. This method was designed as a practical and applicable approach for managing post-acute muscle injuries, particularly ankle injuries, with the primary goals of reducing muscle pain and improving joint range of motion (ROM). The development of this method is based on the understanding that ankle injuries not only involve joint structures but also affect surrounding soft tissues, particularly muscles, tendons, and fascia, which often exhibit increased tone, stiffness, and the formation of myofascial trigger points.

Physiologically, post-acute muscle injuries are generally characterized by reduced tissue elasticity, persistent localized contraction, and decreased microcirculation in the injured area. These conditions contribute to pain, limited mobility, and impaired joint function. Therefore, approaches that focus solely on light massage or stretching are often suboptimal in addressing the

underlying sources of pain arising from myofascial trigger points embedded within the tissue. The position-based stretching combined with massage method developed in this study was designed to address this need by integrating two primary interventions: passive muscle elongation and direct soft tissue manipulation.

The stages of this method (see Figure 1) begin with the application of light massage using the effleurage technique. Effleurage was chosen as the initial technique due to its physiological effects, including increased blood and lymph circulation, reduced sympathetic nervous system activity, and general relaxation of muscle tissue. At this stage, the massage is performed slowly and rhythmically following the direction of muscle fibers and venous flow, with light to moderate pressure. In addition to aiming to soften the tissue, this stage also serves as a manual assessment process, allowing the therapist to identify areas of muscle tension, differences in tissue texture, and regions sensitive to pressure. This initial identification provides the basis for determining the most appropriate stretching positions for the affected muscle groups.

Once the muscle tissue exhibited an initial relaxation response, the intervention proceeded with static stretching in positions tailored to the anatomy and function of the injured muscles. The static stretch was maintained for a controlled duration and intensity to avoid excessive pain. Biomechanically, static stretching helps increase muscle fiber length, reduce tissue viscosity, and decrease passive muscle resistance to movement. Maintaining the muscle in a stretched position is crucial, as it facilitates the detection of previously hidden myofascial trigger points through palpation. In addition, the stretched position enhances the effectiveness of subsequent massage by promoting the release of tissue adhesions and reducing muscle spasms.

While the muscle was maintained in a stretched condition, a subsequent massage was applied using a combination of effleurage and friction



techniques. Effleurage was used to sustain blood flow and tissue relaxation, whereas friction was applied in a more focused and deep manner to areas identified as stiff. Friction was delivered with pressure adjusted to the client's tolerance and directed at points with tissue consistency firmer than that of normal muscle, characteristic of myofascial trigger points. The application of pressure to these areas aimed to interrupt the pain-spasm-ischemia cycle, enhance tissue perfusion, and reduce local nociceptor sensitivity. The massage continued until the therapist perceived a change in tissue consistency toward a softer state, indicating the occurrence of muscle release.

This method is explicitly applied only to clients who have passed the acute phase of injury. During the acute phase, tissues remain in a state of active inflammation, making interventions such as massage and stretching potentially harmful and likely to exacerbate the injury. Therefore, the primary criteria for applying this method include the absence of swelling, redness, or severe tenderness. In certain cases, particularly when the muscle tissue still exhibits high stiffness despite initial massage, infrared radiation modalities are employed. The application of infrared aims to locally increase tissue temperature, enhance blood flow, and reduce tissue viscosity, thereby optimizing the response to massage and stretching.

Once the therapist assessed that sufficient muscle tension release had been achieved, a final evaluation was conducted, including joint range of motion (ROM) testing and pain assessment. ROM served as the primary functional indicator to evaluate the extent of joint function recovery following the intervention. An increase in ROM reflects reduced mechanical restrictions due to muscle stiffness and improved flexibility of the surrounding soft tissues. Pain assessment, on the other hand, was used to evaluate the client's subjective response to the intervention. When pain was significantly reduced and ROM

increased to near or optimal levels, the intervention was considered complete.

The application of this method demonstrated that the majority of clients with mild to moderate pain experienced significant improvement after a single session, as indicated by a reduction in pain to no pain and an increase in ROM to its maximum. These findings suggest that the combination of static stretching and position-specific massage provides a more optimal therapeutic effect compared to the application of each method separately. For clients with severe pain, although optimal results were not immediately achieved, improvements in ROM and reductions in pain were still observed, indicating a positive response to the method. This suggests that in cases of severe pain, repeated and gradual interventions are required to achieve maximal outcomes.

Overall, the position-based stretching combined with massage method in this study emphasizes the importance of an integrative approach in managing post-acute ankle injuries. The synergy between static stretching and soft tissue manipulation allows the therapist to more effectively identify sources of pain, maximize the release of myofascial trigger points, and improve joint function. Considering its practical applicability and the outcomes achieved, this method has the potential to serve as a valuable alternative or adjunct in sports injury management in the field. To clarify the systematic and practical stages of the method, the workflow for managing muscle injuries using the combination of position-based stretching and massage is presented schematically in Figure 1.

Figure 1. Steps in Muscle Injury Management Using Position-Based Stretching and Massage





After the intervention stages were applied according to the workflow in Figure 1, an evaluation was conducted to assess changes in muscle pain and joint range of motion (ROM) before and after the intervention. A quantitative summary of these evaluation results is presented in Table 2.

Table 2. Changes in Muscle Pain and Range of Motion (ROM) Before and After Intervention

No	Before		After		n	%
	Pain	ROM	Pain	ROM		
1	Mild	Moderate Range	No Pain	Maximal Range	14	70%
2	Moderate	Minimal Range	No Pain	Maximal Range	4	20%
3	Severe	Minimal Range	Mild Pain	Moderate Range	2	10%
Total					20	100%

The results of the study indicate that the application of massage during static stretching has a significant impact on reducing muscle pain and improving joint range of motion (ROM) in clients with ankle injuries. Based on the results presented in Table 2, the majority of subjects showed improvements in both pain condition and ROM after a single intervention session.

A total of 14 subjects (70%) who initially presented with mild pain and moderate ROM showed improvement to no pain with maximal ROM following the intervention. These findings indicate that the applied method is effective in reducing residual muscle tension and enhancing joint flexibility in mild ankle injuries. The combination of static stretching with massage facilitates more optimal muscle relaxation and aids in the release of stiff muscle tissue.

In the group with moderate pain and minimal ROM prior to intervention, 4 subjects (20%) also achieved optimal outcomes, reaching no pain and maximal ROM after treatment. These results

indicate that massage applied during stretching is not only effective for mild injuries but can also provide meaningful improvements in cases of moderate pain. Static stretching helps maintain muscle elongation, while simultaneous massage facilitates the identification of affected muscle areas, allowing for more targeted pain release.

Meanwhile, among subjects with severe pain and minimal ROM before the intervention, 2 subjects (10%) showed partial improvement, achieving mild pain and moderate ROM after treatment. Although optimal conditions were not reached, these results still demonstrate a positive response to the applied method. This suggests that for injuries with severe pain, a single session is insufficient to achieve maximal recovery, and additional interventions are required after the post-massage recovery period.

Overall, the findings of this study reinforce that massage applied during static stretching can significantly reduce muscle pain and improve ROM, particularly in ankle injuries with mild to moderate pain. This method offers advantages over conventional massage by facilitating the identification of pain sources and maximizing muscle relaxation. However, the application of this method must consider the condition of the injury and should only be performed on clients who have passed the acute phase and do not exhibit active inflammation or swelling.

Discussion

The massage method applied during static stretching was administered to clients in Bengkulu Province with the aim of reducing pain and improving joint range of motion (ROM) in ankle injuries. The application of this method focused on facilitating muscle release in muscles exhibiting stiffness due to the formation of myofascial trigger points. This process was carried out through a combination of static stretching positions and the application of massage pressure using various techniques,



allowing for more effective and targeted muscle tension release.

In line with this approach, previous studies have shown that the combination of massage and stretching, as well as other manual techniques, can significantly reduce pain and improve ROM. In extremity joint and muscle injuries, the application of massage combined with stretching or techniques such as manurak, effleurage, and friction has been shown to reduce pain by approximately 35–44% and increase ROM by 10–20% or more, particularly in wrist and knee injuries (Hasan et al., 2025; et al., 2025). Furthermore, various systematic reviews and randomized controlled trials on lower back, neck, knee, hip pain, and temporomandibular disorders (TMD) have also reported that manual therapy or massage provides pain reduction and functional improvement with low to moderate effectiveness and a favorable safety profile (Draper-Rodi et al., 2024; Mak et al., 2024).

In the context of evaluating treatment outcomes, range of motion (ROM) is an important functional indicator for assessing the severity of muscle injuries as well as the recovery of joint function. Reviews on ROM emphasize that joint ROM is a key indicator of physical function and musculoskeletal health, both for reducing the risk of injury and maximizing performance; in rehabilitation, ROM recovery is a primary requirement for restoring optimal function (Aleksic, 2023). Findings from Bengkulu Province indicate that the application of massage during static stretching can significantly improve ankle ROM. This increase in ROM is directly associated with reductions in muscle pain and stiffness following the release of myofascial trigger points, resulting in more optimal joint function. Therefore, ROM can be used as a relevant and practical indicator for evaluating the success of post-acute ankle injury management.

Based on these findings, it can be concluded that massage applied during static stretching is effective in reducing pain and improving ROM in

ankle injuries. The increase in ROM reflects the improvement in joint function resulting from reduced muscle stiffness and the release of myofascial trigger points. However, in cases of severe pain, ROM improvement is not yet fully optimal, indicating that this method requires additional follow-up interventions and can only be applied once the client has passed the acute phase of injury.

The implications of this study suggest that massage applied during static stretching has practical potential for managing post-acute ankle injuries, particularly in non-medical and field-based settings. This method can serve as an alternative or adjunct to conventional interventions for pain reduction and ROM improvement. The consistent increase in ROM observed indicates that the method is effective in facilitating joint function recovery through the release of muscle stiffness and myofascial trigger points, making it potentially applicable for massage practitioners with competencies in sports injury management.

In addition to its practical implications, this study also provides a scientific contribution by introducing a method for managing ankle injuries that combines static stretching and massage simultaneously, whereas these techniques are typically applied separately. The primary contribution of this research lies in its practice-based evidence approach, where the method was developed from hands-on clinical experience and supported by empirical findings in the field. This study also underscores the importance of ROM as a functional indicator for assessing injury severity and the effectiveness of ankle injury management.

Nevertheless, this study has several limitations. The method was applied only to clients who had passed the acute phase of injury, so its effectiveness during the acute phase could not be evaluated. In addition, for cases with severe pain, the improvements in ROM were not yet optimal. Pain and ROM assessments were also primarily



functional and observational, without the use of more standardized objective measurement tools.

Based on these limitations, future studies are recommended to include subjects with a wider range of injury conditions, considering both pain severity (mild, moderate, and severe) and injury phase (subacute to chronic). Furthermore, the use of more objective instruments for measuring pain and ROM, as well as research designs with larger sample sizes, is expected to provide a more comprehensive understanding of the effectiveness of massage applied during static stretching.

Conclusion

This study concludes that massage applied during static stretching is effective in reducing pain and improving joint range of motion (ROM) in post-acute ankle injuries. The combination of static stretching and massage pressure allows for more targeted release of myofascial trigger points, thereby accelerating muscle relaxation and restoring joint function. The results indicate that clients with mild to moderate pain achieved pain relief to no pain and optimal ROM improvement after a single session, whereas those with severe pain experienced partial improvement, requiring further intervention. Thus, this method can be introduced as a novel approach for managing sports-related pain, particularly in ankle injuries, with the stipulation that it is applied only after the acute phase and in the absence of active inflammation or swelling.

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Declarations

Author Contribution Statement

RW contributed to the conceptualization of the study, development of the massage–stretching method, data collection, analysis, interpretation of results, and manuscript preparation.

AI Disclosure Statement

The author used ChatGPT during the preparation of this work for language refinement and structuring of academic writing. After using this tool, the author thoroughly reviewed, revised, and edited the content and takes full responsibility for the accuracy and integrity of the publication.

Conflicts of Interest

The author declares that there are no financial, institutional, or personal conflicts of interest that could have influenced the conduct of this study, the analysis and interpretation of data, or the preparation and publication of this manuscript.

References

- Agostini, F., De Sire, A., Finamore, N., Savina, A., Sveva, V., Fisicaro, A., Fricano, A., Longo, U., Ammendolia, A., Bernetti, A., Mangone, M., & Paoloni, M. (2025). Rehabilitative Good Practices in the Treatment of Patients with Muscle Injuries. *Journal of Clinical Medicine*, 14. <https://doi.org/10.3390/jcm14155355>
- Al-Qahtani, M., Allajhar, M., Alzahrani, A., Asiri, M., Alsalem, A., Alshahrani, S., & Alqahtani, N. (2023). Sports-Related Injuries in Adolescent Athletes: A Systematic Review. *Cureus*, 15. <https://doi.org/10.7759/cureus.49392>



- Aleksic, J. (2023). Computer Vision Solutions for Range of Motion Assessment. Southeastern European Medical Journal. <https://doi.org/10.26332/seemedj.v7i1.276>
- Alfen, Z., Arovah, N. I., Graha, A. S., Kushartanti, B. W., & Zanada, J. F. (2025). Effectiveness of Manurak Therapy in Increasing Range of Motion and Reducing Pain in Wrist Injury Patients. International Journal of Multidisciplinary Research and Analysis, 08(04), 2129–2137. <https://doi.org/10.47191/ijmra/v8-i04-68>
- Chen, Y., Bunman, S., & Prakobsrikul, P. (2020). Management of Acute Sport Injuries. The Bangkok Medical Journal. <https://doi.org/10.31524/bkkmedj.2020.13.001>
- De Sire, A. (2022). Sports-related musculoskeletal injuries: From diagnostics to rehabilitation. Journal of Back and Musculoskeletal Rehabilitation, 35, 687–689. <https://doi.org/10.3233/bmr-225002>
- Draper-Rodi, J., Newell, D., Barbe, M., & Bialosky, J. (2024). Integrated manual therapies: IASP taskforce viewpoint. Pain Reports, 9. <https://doi.org/10.1097/pr9.0000000000001192>
- Gavilanez, A., Riofrío, J., Rumipamba, Y., Loaiza, F., Tipan, F., Váscenez, P., Proaño, E., Coral, C., & Villota, B. (2024). Clinical and etiological findings of musculotendinous injuries after physical exercise. International Journal of Research in Medical Sciences. <https://doi.org/10.18203/2320-6012.ijrms20244162>
- Hasan, C. R., Setiawan, A., & Akhiruyanto, A. (2025). The Impact of Effriction and Frirage Massage Techniques on Pain and Range of Motion Improvement in Knee Injuries. ACPES Journal of Physical Education, Sport, and Health (AJPESH), 5(1), 8–16. <https://doi.org/10.15294/ajpesh.v5i1.23467>
- Lenjani, B., Rashiti, P., Shabani, G., Demiri, A., Pelaj, B., Demi, A., Sylaj, R., Mulaj, E., & Lenjani, D. (2021). Emergency Medical Care and Management of Sports Injuries on the Football Court. Albanian Journal of Trauma and Emergency Surgery. <https://doi.org/10.32391/ajtes.v5i1.172>
- Mak, S., Allen, J., Begashaw, M., Miake-Lye, I., Beroes-Severin, J., De Vries, G., Lawson, E., & Shekelle, P. (2024). Use of Massage Therapy for Pain, 2018–2023. JAMA Network Open, 7. <https://doi.org/10.1001/jamanetworkopen.2024.22259>
- Miles, M. B., Huberman, A. M., & Saldana, J. (2014). Qualitative Data Analysis: A Methods Sourcebook.
- Milić, V., Radenković, O., Čaprić, I., Mekić, R., Trajković, N., Špirtović, O., Koničanin, A., Bratić, M., Mujanović, R., Preljević, A., Murić, B., & Kahrović, I. (2025). Sports Injuries in Basketball, Handball, and Volleyball Players: Systematic Review. Life, 15. <https://doi.org/10.3390/life15040529>
- Mylonas, K., Angelopoulos, P., Tsepis, E., Billis, E., & Fousekis, K. (2021). Soft-Tissue Techniques in Sports Injuries Prevention and Rehabilitation. Recent Advances in Sport Science. <https://doi.org/10.5772/intechopen.96480>
- Prieto-González, P., Martínez-Castillo, J., Fernández-Galván, L., Casado, A., Soporki, S., & Sánchez-Infante, J. (2021). Epidemiology of Sports-Related Injuries and Associated Risk Factors in Adolescent Athletes: An Injury Surveillance.



International Journal of Environmental
Research and Public Health, 18.
<https://doi.org/10.3390/ijerph18094857>

Schwiete, C., Roth, C., Skutschik, C., Möck, S.,
Rettenmaier, L., Happ, K., Broich, H., &
Behringer, M. (2023). Effects of muscle
fatigue on exercise-induced hamstring
muscle damage: a three-armed randomized
controlled trial. *European Journal of Applied
Physiology*, 123, 2545–2561.
[https://doi.org/10.1007/s00421-023-05234-
z](https://doi.org/10.1007/s00421-023-05234-z)

Takeuchi, K., Nakamura, M., Fukaya, T., Konrad,
A., & Mizuno, T. (2023). Acute and Long-
Term Effects of Static Stretching on Muscle-
Tendon Unit Stiffness: A Systematic Review
and Meta-Analysis. *Journal of Sports
Science & Medicine*, 22, 465–475.
<https://doi.org/10.52082/jssm.2023.464>

Warneke, K., Plöschberger, G., Lohmann, L.,
Lichtenstein, E., Jochum, D., Siegel, S.,
Zech, A., & Behm, D. (2024). Foam rolling
and stretching do not provide superior
acute flexibility and stiffness improvements
compared to any other warm-up
intervention: A systematic review with
meta-analysis. *Journal of Sport and Health
Science*, 13, 509–520.
<https://doi.org/10.1016/j.jshs.2024.01.006>

Zhang, Y. (2023). Common sports injuries and
physical treatments. *Theoretical and
Natural Science*.
[https://doi.org/10.54254/2753-
8818/20/20230732](https://doi.org/10.54254/2753-8818/20/20230732)

Zvetkova, E., Koytchev, E., Ivanov, I., Ranchev, S.,
& Antonov, A. (2023). Biomechanical,
Healing and Therapeutic Effects of
Stretching: A Comprehensive Review.
Applied Sciences.
<https://doi.org/10.3390/app13158596>

Дживак, В., Горішній, І., Хлібовська, О.,
Воронцова, Т., Кучер, С., Руда, М., &
Рогальська, Я. (2023). Modern methods of
diagnosis and treatment of muscle injuries.
Перспективи Та Інновації Науки, 16(34),
714–733.
[https://doi.org/https://doi.org/10.52058/27
86-4952-2023](https://doi.org/https://doi.org/10.52058/2786-4952-2023)