International Journal of Science and Research (IJSR)
ISSN: 2319-7064
SJIF (2022): 7.942

Effectiveness of Structured Physiotherapy Intervention in Managing Shin Splints among Marathon Runners

Khilti Furia[1], Dr. Arnaz Doctor[2], Dr. Ali Irani[3]

[1]NMIMS Sunandan Divatia School of Science, V. L. Mehta Road, Vile- Parle (West), Mumbai– 400056
Email: *Khilti7f[at]gmail.com*

[2]NMIMS Sunandan Divatia School of Science, V. L. Mehta Road, Vile- Parle (West), Mumbai– 400056
Email: *physiosangeeta[at]gmail.com*

Abstract: ***Background**: The popularity of running as a physical activity has surged in recent decades, attracting individuals seeking improved fitness and weight management. Among the growing number of recreational runners, a significant concern is the prevalence of running-related injuries, particularly in the lower leg region. Medial tibial stress syndrome (MTSS), commonly known as shin splints, emerges as a primary affliction affecting a notable percentage of runners, ranging between 13.2% and 17.3%. For marathon enthusiasts, shin splints pose a considerable threat, capable of impeding performance and derailing training regimens. Recognizing the necessity for effective intervention, structured physiotherapy approaches have gained prominence, offering tailored exercises, biomechanical assessments, and patient education to address underlying causes and mitigate symptoms. However, understanding the true efficacy of such interventions is paramount, not only for injury prevention but also for sustaining athletes' competitive aspirations and promoting safe marathon practices. This study seeks to delve into the impact of structured physiotherapy on shin splints among marathon runners, aiming to elucidate its role in injury prevention, performance enhancement, and the pursuit of peak athletic potential. **Aim & Objectives**: To analyse the effects of structured physiotherapy intervention on pain, dorsiflexion range of motion & lower extremity performance and function in shin splints. **Method**: 56 participants were selected based on the inclusion and exclusion criteria. At the beginning of the study marathon runners was assessed using outcome measures which included VAS pain scale, Knee to wall test and Single leg side hop test. Participants underwent a structured exercise program designed to improve pain, dorsiflexion range of motion and lower extremity performance. Outcome measures were re-assessed post 6 days of intervention. Statistical analysis was performed to compare pre and post intervention outcomes. **Result**: This study demonstrated notable improvements in two key areas: pain reduction and increased ankle dorsiflexion range of motion. However, while lower extremity performance showed improvement from a clinical perspective, it did not reach statistical significance. **Conclusion**: The findings of this study indicate substantial improvement in pain management and increased ankle dorsiflexion range of motion following a structured physiotherapy intervention. However, there was no significant improvement observed in runners' lower extremity performance and function. Overall, these results highlight the beneficial impact of physiotherapy in reducing pain and improving ankle flexibility.*

Keywords: Marathon running, range of motion, rehabilitation, shin splints, VAS pain scale

1. Introduction

Running is one of the most popular physical activities enjoyed by people around the world and the number of runners has grown substantially over the past decades. People seeking a healthier lifestyle through weight control and improved exercise capacity frequently choose running, as this has been considered to be of low cost and can be easily implemented. (1, 2) The prevalence of running as a sport and also recreationally as a form of fitness is becoming increasingly popular. (3) Along with that there is also an increase in the number of competitions and marathons. Running is reasonably affordable, quick, and simple to access. Because of tremendous popularity and accessibility of running they are viewed as major factors in encouraging and enhancing a physically active lifestyle in individuals. (4) A recreational runner is an individual who has been running 1 to 3 times weekly for at least 6 months. A marathon runner is an athlete who participates in and specializes in running long-distance races with a distance of 10km or 21km or 42km and beyond. (5) Running is an efficient way to strengthen the cardiovascular system. It uses aerobic pathway that utilises both fatty acids and carbohydrates for metabolism. Thus, it is being increasingly taken up to reduce and maintain weight. It also reduces the resting heart rate and increases the maximum oxygen consumption. (6) Despite of the health benefits, novice, recreational, marathon runners are often affected by running-related overuse injuries which are associated in many cases with training errors characteristic of this population. Overuse injuries result in repetitive microtrauma, which leads to damage in cellular and intracellular degeneration. This is most likely to occur due to change in mode, intensity, or duration of the timing. (7) Studies have reported incidence rates of lower-extremity injuries for runners ranging from 19% to 75%. (8-11) Common overuse injuries of the lower leg include tendinopathy, stress fracture, chronic exertional compartment syndrome, and shin splint. The incorrect method of training or lack of proper training is the leading cause of this injury. An adequate light upon the correct regime can prevent this injury. In this regard, the lower leg has been proven to be one of the most frequently damaged areas, and shin splints is the main injury occurring in runners at a rate ranging between 13.2% and 17.3%. (12)

According to the American Medical Association's Nomenclature of Athletic Injuries, shin splints are pain and discomfort in the leg caused by recurrent physical activity on hard surfaces or violent, extensive use of the foot flexors. (13)

Shin splint is most often used to describe as exertional leg pain. There are mainly two types of shin splint that occur which are a) Anterior shin splint refers to as dysfunction of the anterior leg compartment or surrounding structures b) Medial tibial stress syndrome refers (MTSS) to as exercise due to pain associated to distal two-third of the leg. [14] In most of the studies, marathon runners have MTSS, mostly or second most frequently diagnosed injury. Shin splints, periostitis and tibial stress fracture is a frequent injury of the lower extremity and one of the most common causes of exertional leg pain in athletes along the medial and distal two-thirds of the tibia [15]. Shin splints account for about 10-15% of all running injuries (Gudas, 1980; James et al, 1978) and up to 60% of all lesions causing pain in athletes' legs (Orava and Puranen, 1979). [16,17] The predominant symptom is pain felt on or around the tibia. It is felt on exertion, initially towards the end of a run; but if more severe, can occur earlier and earlier during exercise. Most of the patients have tenderness at the site of pain. Slight oedema is sometimes noted (Devas, 1958) [18] as is thickening of the subcutaneous border of the tibia. Highly developed musculature may be seen (Mavor, 1956) [13] and the muscle compartments may feel tense. The pathophysiology of shin, splints is more easily understood after examining the relevant cross-sectional anatomy. There are 4 muscle compartments in the leg:

a) Anterior: this compartment contains the tibialis anterior muscle, the extensor hallucis longus, the extensor digitorum longus and the peroneus tertius. The tibialis anterior dorsiflexes the ankle and inverts the foot. The extensor hallucis longus extends the great toe, the extensor digitorum longus extends the other toes and assists in eversion as does the peroneus tertius.
b) Deep posterior: this contains the flexor digitorum longus, the tibialis posterior and the flexor hallucis longus. The tibialis posterior plantar flexes and inverts the foot. The others are predominantly toe flexors.
c) Superficial posterior: this is the gastrocnemius and soleus group; predominantly plantar flexors of the ankle.
d) Lateral: this compartment contains the peroneus brevis and longus, mainly foot evertors. [13]

There are a variety of etiological factors in the development of shin splints, including training on hard surfaces or uneven ground, inappropriate training techniques, rapidly increasing training intensity, changes in footwear, muscle imbalances or inflexibility, and biomechanical abnormalities like, lower standing foot angle, varus rearfoot and forefoot, maximum pronation and increased navicular drop.[19, 20] Pain may originate from a tibial stress fracture, chronic periosteal avulsion, microtears in muscle tissues, increased lower leg compartmental pressure or interosseous membrane irritation. Shin splints is associated with an imbalance of medial foot pressure and inward rolling of feet i.e., excessive pronation due to sudden increment in intensity or duration of training on hard surfaces or hill running. [19] Subsequent loading on the foot places additional strain on the muscles controlling pronation of foot (tibialis anterior, tibialis posterior and the medial half of the soleus) precipitating to shin splint syndrome. Shin splints in marathon runners often arise from a combination of biomechanical influences that stem from the demands of long-distance running. Biomechanics, encompassing the body's movement and function during physical activity, plays a pivotal role in understanding this condition. Gait analysis unveils irregularities like overpronation or supination, impacting muscle and tendon stress along the shinbone, a significant contributor to shin splint development. Muscle imbalances within the triceps surae complex, with the soleus positioned deeper and the two heads of gastrocnemius sitting more superficially, contributes to the strength, stability, and flexibility of the lower leg while aiding in propulsion and shock absorption during locomotion and muscles around the shin (tibialis anterior and posterior), influenced by running mechanics, can lead to unequal force distribution, intensifying pressure on the tibia. Inadequate footwear lacking proper support, cushioning, or stability can exacerbate biomechanical issues. [21-23] High-impact forces generated during running are not adequately absorbed, leading to increased stress on the lower leg structures. Training errors, such as abrupt mileage or intensity escalation without proper conditioning, also contributes significantly. [24] These factors cumulatively cause microtears in the shin's muscles, tendons, and bone tissue, inciting an inflammatory response, manifesting as pain, swelling, and tenderness. [24,25] Without addressing these biomechanical factors, microtears may progress to more severe damage, potentially leading to stress fractures or chronic shin pain. Management involves multifaceted strategies: correcting gait abnormalities, balancing and stretching muscles, selecting suitable footwear, and gradually advancing training to mitigate overuse injuries and ensure optimal performance while reducing the risk of lower limb complications. [26] Physiotherapy plays a crucial role in the comprehensive management of shin splints, providing a targeted and holistic approach to address the underlying causes and promote effective healing. Physiotherapists employ a variety of techniques, including tailored stretching and strengthening exercises, to address muscle imbalances, enhance flexibility, and improve biomechanics. By implementing targeted rehabilitation programs, physiotherapy helps reduce the strain on the muscles and tendons along the inner aspect of the shinbone, contributing to the resolution of pain and inflammation. Moreover, physiotherapists guide patients in proper conditioning, gradually reintroducing activities to prevent recurrence and fostering long-term musculoskeletal health. Education on proper footwear, biomechanics, and injury prevention strategies is also integral to physiotherapy interventions for shin splints. The personalized and evidence-based nature of physiotherapy ensures a comprehensive and patient-centered approach, making it a pivotal component in the successful management of shin splints, facilitating a faster return to pain-free physical activity.

Aim

To study the effectiveness of structured physiotherapy intervention in managing shin splints among marathon runners

Objectives

1) To analyse the effects of structured physiotherapy intervention on pain in shin splints
2) To analyse the effects of structured physiotherapy intervention on dorsiflexion range of motion in shin splints.
3) To analyse the effects of structured physiotherapy intervention on lower extremity performance and function in shin splints

2. Methodology

- ***Study design:*** Interventional study
- ***Study type:*** Single arm intervention study
- ***Study population:*** Marathon runners with shin pain
- ***Sampling method:*** Convenience Sampling
- ***Sample size:*** 56 (Calculated using G-power)
- ***Study duration:*** 1 year
- ***Duration of data collection:*** 6 months

Inclusion criteria
- Minimum of 6 months of experience as a marathon runner
- Runners with shin pain
- Age group 21 years & above (male & female)

Exclusion criteria
- Any lower limb musculoskeletal injury in the past 6 months
- History of trauma within past 12 weeks
- Any existing cardiovascular & neurological condition
- Circulatory disorders in lower extremities like varicose veins

3. Procedure

This was an Interventional study conducted on marathon runners. An ethical approval was obtained from the institutional ethical committee. Marathon running groups were approached and selected based on the inclusion and exclusion criteria. 56 runners participated in this study and were selected using convenience sampling method. A proper explanation about the assessment and the intervention was explained to all the runners. A signed informed consent was taken from the runners. All the participants were asked to mention their demographic data, duration of training experience and were assessed as per the outcome measures:
- Visual Analog Scale (VAS)
- Knee to wall test (KTWT)
- Single leg side hop test (SLSHT)

Structured physiotherapy intervention was given for 6 days and re-assessment was done post 6 days using the same outcome measures.

Exercise Protocol
- Warm up was done by themselves prior to the session (1-2 km run)
- Exercises were given for 6 days – each session lasted for 45 mins
- Cool down

Table 1: Cool Down

Frequency	Stretches
2 set x 30 seconds hold – each side	• TA Stretch • Quadriceps Stretch • Hamstring • Adductors • Piriformis • Gluteal Stretch • Pigeon pose Self - MFR for Tibialis Anterior and Posterior with rubber ball (30 sec) Cryotherapy – 10 minutes (home program)

Table 2: Day 1- Day 3 Protocol

Day 1- Day 3	<u>Lower limb strengthening</u>: each exercise 10 reps x 1 set • Resisted Dorsiflexion • Resisted Plantarflexion • Inversion • Eversion • Clamshell in side lying • (with yellow loop band) • Toe curls with 10 second hold • Toe fanning • Great toe extension • Bridging with 10 second hold • Heel raises – with rubber ball (Tibialis Posterior) • Heel walking • Toe walking • Squat side walk <u>Core Exercise:</u> each exercise 2 sets x 30 second hold • Plank holds • Table top position with core engaged <u>Balance Exercise</u> • Single leg RDL (10 reps x 1 set) • Single leg balance eye close (15 seconds hold)

Table 3: Day 4 – Day 6 Protocol

Day 4- Day 6	<u>Lower limb strengthening</u>: each exercise 12 reps x 1 set • Splitted Dorsiflexion • Splitted Plantarflexion • Banded standing inversion • Clamshell in side lying • (with yellow loop band) • Toe curls with 10 second hold • Toe fanning • Great toe extension • Heel walking • Toe walking • Squat side walk • Single bridging • Seated heel raises • Flexor Hallucis strengthening with ball • Plantar fascia release with ball <u>Core Exercise:</u> each exercise 2 sets x 30 second hold • Plank holds • Table top position with core engaged • Naukasana (boat pose) <u>Balance Exercise</u> • Single leg RDL (12 reps x 1 set) • Single leg balance eye close (30 seconds hold) • Running Drill 10 reps x 1 set

4. Results

All the results were recorded and analyzed by using Statistical Package of Social Science (SPSS) software version 29.

The result was concluded to be statistically significant with $p<0.05$.

The intragroup data was analyzed by using the paired t test.

5. Discussion

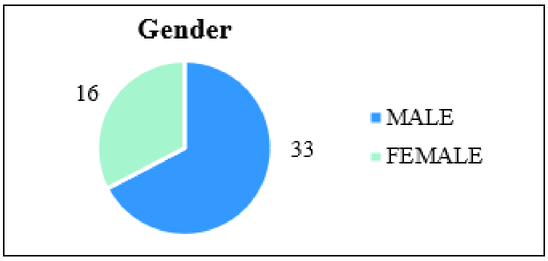
This study aimed to assess the effects of a structured physiotherapy intervention on pain levels, range of motion, and lower extremity performance in marathon runners experiencing shin splints.

Demographic Data

As shown in table 4 and graph 1, a total of 49 marathon runners were assessed, out of which 33 were males and 16 were females. The mean age of female participants was 38.50 ± 8.47 years and male participants was 41.97 ± 10.52 years.

Table 4: Demographic Data

	Female	Male	Total
No. of Participants	16	33	49
Age (Mean± SD)	38.50±8.47	41.97±10.52	40.84±9.94



Graph 1: Gender Distribution

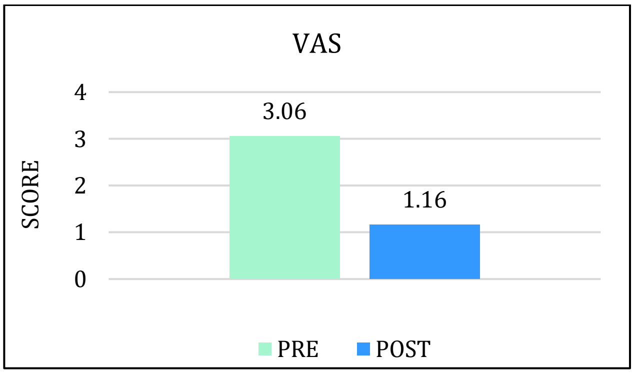
Pain

This study used Visual Analog Scale as a measure of pain for. A statistical and clinical significance was found between pre and post-test with $p<0.05$ which means that there is a reduction in pain levels post intervention as shown in graph 2 and table 5.

The development of medial tibial stress syndrome (MTSS) is intricately linked to the accumulation of unrepaired microdamage within the cortical bone of the distal tibia. Current understanding posits two prevailing theories regarding the underlying pathophysiology. Firstly, it is suggested that pain arises due to inflammation of the periosteum, triggered by excessive traction exerted on the tibialis posterior or soleus muscles. Alternatively, the condition may stem from bony overload injury, leading to microdamage and subsequent targeted remodeling. [38]

Table 5: Pre and Post Visual Analog Scale

	Pre	Post	P value
Visual Analog Scale (VAS)	3.06 ± 1.18	1.16 ± 0.898	< .001



Graph 2: Pre and Post Visual Analog Scale

A single bout of fatiguing exercise amidst chronic pain conditions can exacerbate pain through heightened phosphorylation of NMDA receptors in the RVM, indicative of amplified central facilitation. Conversely, regular exercise fosters pain relief by diminishing NMDA receptor phosphorylation, suggesting a reduction in central facilitation. Furthermore, consistent physical activity decreases serotonin transporter expression, elevates serotonin levels, and boosts opioids in central inhibitory pathways like the PAG and RVM, implying that exercise taps into endogenous inhibitory systems to alleviate pain. This delicate balance between inhibition and excitation within the central nervous system dictates whether exercise promotes analgesia or pain. Although animal studies have elucidated these mechanisms, inconsistencies persist in exercise protocols, including intensity, duration, and frequency, hindering interpretation. Understanding the nuances of different exercise forms and their effects on pain modulation, particularly in individuals with acute or chronic pain, is crucial for translating findings from animal models to human subjects. Studies in animal models of pain have shown that regular exercise, whether initiated prior to or after the onset of pain, suppresses hyperalgesia and pain behaviors, suggesting its potential as a preventive and therapeutic measure. Moreover, both forced and voluntary exercise have demonstrated analgesic effects, with the magnitude of pain relief correlating with the amount rather than the intensity of exercise. However, the optimal duration of exercise to achieve these pain-relieving effects remains variable across studies, ranging from one day to eight weeks. Thus, further investigation into the impact of exercise on central pain modification in chronic pain sufferers, such as those with cervicobrachial pain, is warranted. [39,40]

MTSS, commonly known as shin splints, manifests as exercise-induced pain along the lower leg's distal posterior-medial aspect of the tibia. This condition arises from repetitive stress placed on the leg during activities such as running and jumping. Individuals experiencing MTSS typically describe a dull, aching pain localized to the distal two-thirds of the posteromedial tibial border, which may commence either at the conclusion of physical activity or during its course. When addressing the immediate care of athletic injuries, cryotherapy emerges as a cornerstone intervention. Employed as part of the RICE protocol (rest, ice, compression, elevation), cryotherapy is pivotal for its dual action in mitigating swelling and delivering analgesic relief. By applying cold therapy to the affected area, inflammation is curtailed, thereby reducing the risk of further tissue damage. Furthermore, the application of cryotherapy induces a numbing effect, alleviating discomfort and facilitating the initial stages of recovery. In summary, cryotherapy stands as a frontline strategy in the management of MTSS, serving to both prevent swelling and mitigate pain, thereby aiding athletes in their rehabilitation journey. [41]

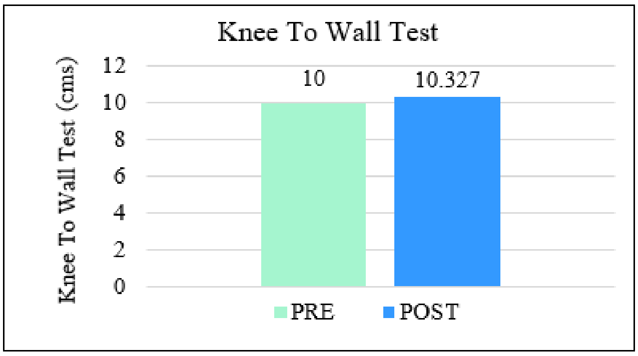
Cryotherapy is the superficial application of cold as a therapeutic agent. One of its most common uses is to alleviate chronic pain in specific areas through local application or more broadly through non-local application. Chronic inflammation can contribute to constant pain by chemical and mechanical stimulation of pain receptors and free nerve endings. Oedema and cytokines are key inflammatory markers used to assess the effects of treatments on inflammation. Oedema is a cardinal sign of inflammation, caused by vascular changes and increased permeability that allows fluid to enter the extravascular space. The increased pressure in this space often leads to mechanical stimulation and pain production. Cryotherapy is thought to decrease swelling by a combination of decreasing vascular permeability and reducing both arterial and soft tissue blood flow to the affected areas. Another mechanism suggested for the analgesic effects of cryotherapy is cold-induced vasoconstriction, which can reduce blood flow to the target tissue and reduce the release of inflammatory mediators, and also, it promotes the accumulation of local anaesthetic in the target tissue [(42)] A study by Nadler SF et al. who studied the physiological basis and clinical application of cryotherapy for pain practitioner found that cryotherapy reduces the conduction velocity of the nerve fibres due to the asynchronous transmission in pain fibres, the release of endorphins, and the inhibition of spinal neurons, and an increase in the refractory period, which leads to a gradual lessening in the transmission of impulses in the sensitive nerves. [(42)] Autogenic inhibition is seen with self-myofascial release. The pressure applied to the muscles during the rolling massage period stimulates the sensory receptors (i.e., Golgi's body) at the muscle junction and the muscle bonds. The variation in muscle tension is detected by Golgi's body, and the muscle spindle regulates the length of muscle fibres to relax the muscles. Myofascial release inhibits the H-reflex, which is an indirect measure of alpha motor-neuron excitability. This phenomenon is attributed to mechanoreceptor activation, which is thought to inhibit the central nervous system during myofascial release. [(43)] Thus, the combination of these effects must have resulted in an improvement in pain levels.

Range of motion

This study used Knee to Wall Test as a measure of DROM in ankle joint. A statistical and clinical significance was found between pre and post-test with p<0.05 which means that there is an improvement in the range of motion post intervention as shown in graph 3 and table 6.

Table 6: Pre and Post Knee to Wall Test

	Pre	Post	P value
Knee to Wall Test (KTWT)	10.00 ± 2.29	10.327 ± 2.14	< .001



Graph 3: Pre and Post Knee to Wall Test

Muscle stretching is frequently used in clinical practice for flexibility gain. This intervention is capable of causing morphologic changes in muscle fibers and connective tissue generated by plastic and elastic responses of these structures, thus influencing flexibility and generation of total muscle strength. [(44)] Ankle dorsiflexion motion is important in multi-directional running tasks to facilitate ground clearance and preparation for foot impact. Consequently, restricted performance in the ankle dorsiflexion test would suggest potential movement impairment, which could alter the mechanics of movement in multi-directional running tasks. Kurihara et al. [(45)] reported that maximum isometric toe flexor muscle strength was significantly correlated with the cross-sectional area of the plantar intrinsic and extrinsic muscles. [(46)] According to Gajdosik et al., [(47)] the reduced length and greater rigidity of a shortened muscle not only decrease joint ROM but also decrease the muscle's ability to store elastic energy to maximize contractions. Gajdosik et al. [(48)] found an increase in muscle length, less rigidity, greater absorbed elastic energy, and also a gain, although not significant, in muscle strength after stretching in older women. [(48)]

Muscle spindles, nestled within the muscle fibers, serve as vigilant monitors of alterations in muscle length, while Golgi Tendon Organs (GTOs), strategically positioned near musculotendinous junctions, exhibit sensitivity to escalating muscle tension. Upon stimulation, GTOs induce reflexive muscle relaxation. When a muscle undergoes stretching, concomitant elongation occurs in the muscle spindle, which meticulously records both the extent and velocity of this alteration. Subsequently, these sensory signals are swiftly conveyed to the spinal cord, initiating the stretch reflex, also known as the myotatic reflex. This reflex mechanism endeavors to counteract the change in muscle length by provoking contraction within the stretched muscle.

The stretching of a muscle fiber begins with the sarcomere, the basic unit of contraction in the muscle fiber. As the sarcomere contracts, the area of overlap between the thick and thin myofilaments increases. As it stretches, this area of overlap decreases, allowing the muscle fiber to elongate. Once the muscle fiber is at its maximum resting length (all the sarcomeres are fully stretched), additional stretching places force on the surrounding connective tissue. As the tension increases, the collagen fiber in the connective tissue aligns themselves along the same line of force as the tension. Hence when you stretch, the muscle fiber is pulled out to its full-length sarcomere by sarcomere, and then the connective tissue takes up the remaining slack. When this occurs, it helps to realign any disorganized fiber in the direction of the tension.

Muscle lengthening: Stretching exercises directly target muscles, tendons, and connective tissues, encouraging them to elongate and increase their length. Regular stretching over time leads to a gradual increase in muscle length, thereby improving flexibility. Long-term stretching of human skeletal muscles increases joint range of motion through altered stretch perception and decreased resistance to stretch. There is also some evidence that stretching induces changes in muscle morphology. Static stretching training increases fascicle length at rest and during stretching in healthy participants. [(49)] Stretching exercises can influence the nervous system's control over muscle length and tension. By stimulating sensory receptors within muscles and tendons, stretching signals the nervous system to relax the muscles, allowing for greater flexibility. Stretching has been shown to induce neuromuscular adaptations. The morphology of the neuromuscular junction can adapt to changes in muscle use and exercise patterns. [(50)] Neural responses to repeated muscle stretching can lead to implicit learning and adaptation, resulting in changes in muscle resistance to perturbations. Stretching is commonly practiced to prevent muscle injuries, although its effectiveness is still unclear. [51] These studies provide insights into the various neuromuscular adaptations that can occur as a result of stretching.

Stretching exercises are designed to target specific joints and muscle groups, facilitating an increased range of motion (ROM) over time. This gradual improvement in joint flexibility enables individuals to execute movements more effortlessly and effectively. Several mechanisms contribute to the enhancement of joint ROM through stretching. Firstly, there's a reduction in tissue viscoelasticity as tissue temperatures rise, rendering them more pliable. Secondly, the activation of inhibitory reflexes or the disfacilitation of spindle reflexes, achieved through techniques like static stretching or proprioceptive neuromuscular facilitation (PNF) stretching, further aids in ROM expansion. Moreover, stretching fosters an increase in stretch tolerance, empowering individuals to surpass their previous limits of ROM. In essence, stretching induces a combination of physiological and neurological adaptations that collectively enhance joint ROM. [52-54]

The foot plays significant role in four primary anatomy trains. Anatomy Trains are direct fascial connections between muscular structures within the fascial net. The foot and shin are a component of 4 main Anatomy Trains (Superficial Back & front line, Lateral line and Spiral line) The Superficial Front line: it joins the entire anterior surface of the body, from the dorsal part of the feet to lateral parts of the skull. It also consists of two parts: one ranging from toes to the pelvis and the other from the pelvis to the head - the components of this belt are as follows: dorsal surface of phalanges of toes – short and long extensors of toes, musculus tibialis anterior (anterior compartment of the lower leg) – tuberosity of tibial bone sub patellar tendon – patella – quadriceps muscle of thigh – anterior superior iliac spine – pubic tubercle – musculus rectus abdominis – the fifth rib – sternalis and sternochondral fascia – manubrium of sternum – sternocleidomastoid muscle – mastoid process – fascia of the skull. [55] When the fascia covering the affected periosteal shin area tightens in response to a protective mechanism, it not only limits joint mobility but also increases tension within the tibial bone, leading to pain due to friction. To alleviate these constraints, myofascial release (MFR) techniques are employed to target the deeper layers of the fascia. Through altering the viscosity of the fascia's ground substance and extending the muscle's elastic component and crosslink of the fascia, MFR aims to release restrictions and barriers within the fascial network. By restoring the proper biomechanical alignment of the skeleton, elastin enables tissues to regain their original form and pliability, thereby gradually expanding their range of motion. Consequently, as pain diminishes, there is a reduction in guarding and involuntary muscle contraction, resulting in increased range of motion. MFR, as a manual release method, involves stretching the fascia and releasing adhesions between it and adjacent structures such as muscles, tendons, and bones, further promoting improved joint mobility and function.

Performance & function

This study used Single leg side Hop Test as a measure of functional performance for lower extremity. There was no statistically significant difference between pre and post intervention for lower extremity performance, since $p > 0.05$ as shown in table 7.

Table 8: Pre and Post Single Leg Side Hop Test

	Pre	Post	P value
Single Leg Side Hop Test (SLSHT)	8.94 ± 2.40	9.14 ± 2.27	0.115

Skeletal muscle tissue is sensitive to the acute and chronic stresses associated with resistance training. These responses are influenced by the structure of resistance activity (i.e. frequency, load and recovery) as well as the training history of the individuals involved. [56] It is hypothesized that 3 primary factors are responsible for initiating the hypertrophic response to resistance exercise: mechanical tension, muscle damage, and metabolic stress. [57-60] Mechanically induced tension produced both by force generation and stretch is considered essential to muscle growth, and the combination of these stimuli appears to have a pronounced additive effect. [60] More specifically, mechanical overload increases muscle mass while unloading results in atrophy.

A study conducted by Stephen C Glass et.al compared the effects of imposed versus self-selected strength training over two weeks. Both groups showed significant improvements in selecting loads exceeding 60% of their one repetition maximum (1RM). However, only the imposed group lifted to fatigue and adjusted loads accordingly. Both groups also increased repetitions and perceived exertion over the training period. Interestingly, only the pec fly lift exceeded 60% 1RM among novel exercises. These findings suggest that at least two weeks of supervised resistance training is necessary to observe changes in muscle size and mass. [61] Some other studies have observed increase in muscle strength and cross-sectional area (CSA) after only 2 to 4 weeks. This early increase in strength is likely caused by neuromuscular and connective tissue adaptations, whereas the early increases in muscle CSA size may be the result of edema. [62-66] Given the absence of statistical significance in lower limb performance observed with SLSHT as a result of the factors mentioned above, it is important to note that there are still significant clinical implications evident in its effects.

6. Conclusion

The study's reliability is reinforced by employing rigorous statistical methods, such as paired t-tests, to analyze pre- and post-intervention data. These robust statistical findings provide strong evidence supporting the effectiveness of the structured intervention in achieving its intended outcomes, thus enhancing confidence in the study's validity.

To conclude, the findings of the study highlight significant improvements in pain management and range of motion among marathon runners through a structured intervention. These outcomes emphasize the necessity of proactive strategies to enhance musculoskeletal health and prevent running-related injuries in this demographic. This study adds valuable insights to the existing literature, supporting the integration of such interventions for the treatment of shin pain in future approaches.

7. Limitations

A potential area for enhancement in this study lies in the intervention duration, as extending it could potentially yield more pronounced results and greater improvements in functional performance among runners. By prolonging the intervention period, researchers could better assess the long-term efficacy and sustainability of the interventions employed, providing deeper insights into their impact on runners' overall performance and musculoskeletal health.

8. Future Scope of the Study

- Conducting gait analysis and examining running biomechanics to tailor individualized protocols, thereby enhancing precision in intervention strategies.
- Recommending footwear modifications and subsequently analysing their effects through experimentation with various types of footwear, elucidating their correlation with running biomechanics.
- Broadening the research scope to include more aspects of runners' fitness, which will deepen understanding of the complex relationships among individual fitness factors, ergonomic elements, and the likelihood of musculoskeletal injuries in clinical environments.

References

[1] Debi, Živčić, Tomić., Martina, Tomić., Filip, Vuletić., Goran, Vrgoč. Running addiction.. Journal of Sports Medicine and Physical Fitness, (2022). doi: 10.23736/S0022-4707.22.14285-4
[2] E., De, Clercq., Senne, Bonnaerens., Pieter, Fiers., Edward, C., Frederick., Yasunori, Kaneko., Veerle, Segers. Low running offers a way to make distance running a viable physical activity option for more people. Footwear Science, (2023). doi: 10.1080/19424280.2023.2201260
[3] Cantwell JD. Cardiovascular aspects of running. Clinics in Sports Medicine. 1985 Oct 1;4(4):627-40.
[4] Hespanhol Junior LC, Pillay JD, van Mechelen W, Verhagen E. Meta-analyses of the effects of habitual running on indices of health in physically inactive adults. Sports medicine. 2015 Oct;45:1455-68.
[5] Mulvad B, Nielsen RO, Lind M, Ramskov D. Diagnoses and time to recovery among injured recreational runners in the RUN CLEVER trial. PloS one. 2018 Oct 12;13(10):e0204742.
[6] Buist I, Bredeweg SW, Bessem B, Van Mechelen W, Lemmink KA, Diercks RL. Incidence and risk factors of running-related injuries during preparation for a 4-mile recreational running event. British journal of sports medicine. 2010 Jun 1;44(8):598-604.
[7] Simona, Steina., Sandra, Rozenstoka. P-79 Overuse sports injuries in children. British Journal of Sports Medicine, (2016). doi: 10.1136/BJSPORTS-2016-097120.132
[8] Jakobsen BW, Krøner K, Schmidt SA, Jensen J. Running injuries sustained in a marathon race. Registration of the occurrence and types of injuries in the 1986 Arhus Marathon. Ugeskrift for laeger. 1989 Aug 1;151(35):2189-92.
[9] Lun V, Meeuwisse WH, Stergiou P, Stefanyshyn D. Relation between running injury and static lower limb alignment in recreational runners. British journal of sports medicine. 2004 Oct 1;38(5):576-80.
[10] Taunton JE, Ryan MB, Clement DB, McKenzie DC, Lloyd-Smith DR, Zumbo BD. A prospective study of running injuries: the Vancouver Sun Run "In Training" clinics. British journal of sports medicine. 2003 Jun 1;37(3):239-44.
[11] Walter SD, Hart LE, McIntosh JM, Sutton JR. The Ontario cohort study of running-related injuries. Archives of internal medicine. 1989 Nov 1;149(11):2561-4.
[12] Menéndez C, Batalla L, Prieto A, Rodríguez MÁ, Crespo I, Olmedillas H. Medial tibial stress syndrome in novice and recreational runners: A systematic review. International Journal of Environmental Research and Public Health. 2020 Oct;17(20):7457.
[13] Bates P. Shin splints--a literature review. British Journal of Sports Medicine. 1985 Sep 1;19(3):132-7.
[14] Patel PY, Patil N. Prevalence of shin splint in recreational marathon runner. International Journal of Physiotherapy. 2020 Feb 9:37-41.
[15] Priyanka KR, Ranganathan A, Wadhwa M. Effect of Arch Support on Shin Splints In Recreational Runners: Cross Sectional Study.
[16] Gudas CJ. Patterns of lower-extremity injury in 224 runners. Comprehensive Therapy. 1980 Sep 1;6(9):50-9.
[17] James SL, Bates BT, Osternig LR. Injuries to runners. The American journal of sports medicine. 1978 Mar;6(2):40-50.
[18] Gamelas J, Amaral LB, Forriol F. Lower Limb Periostitis. Injuries and Health Problems in Football: What Everyone Should Know. 2017:481-90.
[19] Nikita, Bhusari., Mitushi, Kishor, Deshmukh. Shin Splint: A Review. Cureus, (2023). doi: 10.7759/cureus.33905
[20] Nikita, S., Deshmukh., Pratik, Phansopkar., Mayur, Wanjari. A Novel Physical Therapy Approach in Pain Management and Enhancement of Performance in Shin Splints Athletes: A Case Report. Cureus, (2022). doi: 10.7759/cureus.26676
[21] Nicolas, Flores., S.P., García., Cédric, Morio. Relationships between pronation-related kinematics and musculoskeletal loadings during running: implications for footwear. Footwear Science, (2023). doi: 10.1080/19424280.2023.2199260
[22] Alexandra, F., DeJong, Lempke., William, P., Meehan., Kristin, E., Whitney. Running gait adaptations among adolescent runners with soft tissue impairments following lateral ankle sprains.. Pm&r, (2023). doi: 10.1002/pmrj.13000
[23] Jiri, Skypala., Joseph, Hamill., Steriani, Elavsky., Andrea, Monte., Daniel, Jandacka. Running-Related Achilles Tendon Injury: A Prospective Biomechanical Study in Recreational Runners. Journal of Applied Biomechanics, (2023). doi: 10.1123/jab.2022-0221
[24] Young-Seong, Lee., Ho, Jong, Gil., Jiseon, Ryu., Sukhoon, Yoon., Sang-Kyoon, Park. Different heel strike patterns change the impact of the whole body

during running. Footwear Science, (2023). doi: 10.1080/19424280.2023.2199395
[25] Joshua, Mattock., Julie, R., Steele., Karen, J, Mickle. Lower leg muscle structure and function are altered in long-distance runners with medial tibial stress syndrome: a case control study.. Journal of Foot and Ankle Research, (2021). doi: 10.1186/S13047-021-00485-5
[26] Anne, Kuwabara., Paige, Dyrek., Emily, Miller, Olson., Emily, Kraus. Evidence-Based Management of Medial Tibial Stress Syndrome in Runners. Current Physical Medicine and Rehabilitation Reports, (2021). doi: 10.1007/S40141-021-00326-3
[27] O'Connor PJ. Pain During a Marathon Run: Prevalence and Correlates in a Cross-Sectional Study of 1,251 Recreational Runners in 251 Marathons. Frontiers in Sports and Active Living. 2021 Feb 10;3:630584.
[28] Deshmukh Jr NS, Phansopkar P, Wanjari MB, Wanjari M. A Novel Physical Therapy Approach in Pain Management and Enhancement of Performance in Shin Splints Athletes: A Case Report. Cureus. 2022 Jul 9;14(7).
[29] Shafshak TS, Elnemr R. The visual analogue scale versus numerical rating scale in measuring pain severity and predicting disability in low back pain. JCR: Journal of Clinical Rheumatology. 2021 Oct 1;27(7):282-5.
[30] Merritt NC, Powden CJ. Assessing lower extremity injury risk in a Mid-Atlantic drum corps using the weight bearing lunge test. Clinical Practice in Athletic Training. 2018 Oct 31;1(2):37-41.
[31] Šuc A, Šarko P, Pleša J, Kozinc Ž. Resistance exercise for improving running economy and running biomechanics and decreasing running-related injury risk: A narrative review. Sports. 2022 Jun 24;10(7):98.
[32] Manasi, Bhutani., Tanvi, Patole. To study the immediate effects of dynamic stretching v/s dynamic stretching and kinesio taping in marathon runners with shin splints: a comparative study. International journal of scientific research, (2021). doi: 10.36106/IJSR/6327188
[33] Boonstra AM, Preuper HR, Reneman MF, Posthumus JB, Stewart RE. Reliability and validity of the visual analogue scale for disability in patients with chronic musculoskeletal pain. International journal of rehabilitation research. 2008 Jun 1;31(2):165-9.
[34] Boonstra AM, Preuper HR, Reneman MF, Posthumus JB, Stewart RE. Reliability and validity of the visual analogue scale for disability in patients with chronic musculoskeletal pain. International journal of rehabilitation research. 2008 Jun 1;31(2):165-9.
[35] Powden CJ, Hoch JM, Hoch MC. Reliability and minimal detectable change of the weight-bearing lunge test: a systematic review. Manual therapy. 2015 Aug 1;20(4):524-32.
[36] Bennell K, Talbot R, Wajswelner H, Techovanich W, Kelly D, Hall AJ. Intra-rater and inter-rater reliability of a weight-bearing lunge measure of ankle dorsiflexion. Australian Journal of physiotherapy. 1998 Jan 1;44(3):175-80.
[37] Fältström A, Hägglund M, Hedevik H, Lindblom H, Kvist J. The side hop test: Validity, reliability, and quality aspects in relation to sex, age and anterior cruciate ligament reconstruction, in soccer players. Physical Therapy in Sport. 2023 Jun 3.
[38] Milgrom C, Zloczower E, Fleischmann C, Spitzer E, Landau R, Bader T, Finestone AS. Medial tibial stress fracture diagnosis and treatment guidelines. Journal of science and medicine in sport. 2021 Jun 1;24(6):526-30.
[39] Lima LV, Abner TS, Sluka KA. Does exercise increase or decrease pain? Central mechanisms underlying these two phenomena. The Journal of physiology. 2017 Jul 1;595(13):4141-50.
[40] Yukiko, Shiro., Takako, Matsubara. Influence of exercise on the pain modulation system. Pain Research, (2017). doi: 10.11154/PAIN.32.246
[41] Prachi, J, Zope., Namrata, A., Kadam. Efficacy of Cryo-compression on Shin Splints in Female Amateur Marathon Runners. International journal of physiotherapy and research, (2022). doi: 10.16965/ijpr.2022.155
[42] Nadler SF, Weingand K, Kruse RJ. The physiologic basis and clinical applications of cryotherapy and thermotherapy for the pain practitioner. Pain physician. 2004;7(3):395.
[43] Beardsley C, Škarabot J. Effects of self-myofascial release: a systematic review. Journal of bodywork and movement therapies. 2015 Oct 1;19(4):747-58.
[44] Batista LH, Vilar AC, de Almeida Ferreira JJ, Rebelatto JR, Salvini TF. Active stretching improves flexibility, joint torque, and functional mobility in older women. American Journal of Physical Medicine & Rehabilitation. 2009 Oct 1;88(10):815-22.
[45] Kurihara T, Yamauchi J, Otsuka M, Tottori N, Hashimoto T, Isaka T. Maximum toe flexor muscle strength and quantitative analysis of human plantar intrinsic and extrinsic muscles by a magnetic resonance imaging technique. Journal of foot and ankle research. 2014 Dec;7(1):1-6.
[46] Guillén-Rogel P, San Emeterio C, Marín PJ. Associations between ankle dorsiflexion range of motion and foot and ankle strength in young adults. Journal of Physical Therapy Science. 2017;29(8):1363-7.
[47] Gajdosik RL, Vander Linden DW, McNair PJ, Riggin TJ, Albertson JS, Mattick DJ, Wegley JC. Viscoelastic properties of short calf muscle-tendon units of older women: effects of slow and fast passive dorsiflexion stretches in vivo. European journal of applied physiology. 2005 Oct;95:131-9.
[48] Gajdosik RL, Vander Linden DW, McNair PJ, Williams AK, Riggin TJ. Effects of an eight-week stretching program on the passive-elastic properties and function of the calf muscles of older women. Clinical biomechanics. 2005 Nov 1;20(9):973-83.
[49] Ioli, Panidi., Olyvia, Donti., Andreas, Konrad., Petros, C., Dinas., Gerasimos, Terzis., Vasiliki, Gaspari., Anastasia, Donti., Gregory, C., Bogdanis. Muscle Architecture Adaptations to Static Stretching Training: A Systematic Review with Meta-Analysis. Sports Medicine - Open, (2023). Doi: 10.1186/s40798-023-00591-7.
[50] Carolin, Jacob., Gabriela, Klein, Barbosa., Mariana, P., Rodrigues., Jurandyr, Pimentel, Neto., Lara, Caetano, Rocha., Adriano, Polican, Ciena. Stretching prior to resistance training promotes adaptations on the postsynaptic region in different myofiber types.

European Journal of Histochemistry, (2022). Doi: 10.4081/ejh.2022.3356.

[51] Alex, Emanuel, Semanderes. Effects of a Six Week Gastrocnemius PNF Stretching Intervention on Structural Properties of Muscle and Neural Adaptations of Muscle in Young Women. (2018).

[52] Andreas, Konrad., Masatoshi, Nakamura., Florian, Kurt, Paternoster., Markus, Tilp., David, G., Behm. A comparison of a single bout of stretching or foam rolling on range of motion in healthy adults. European Journal of Applied Physiology, (2022). Doi: 10.1007/s00421-022-04927-1.

[53] Vasiliki, Gaspari., Kostantina, Papia., Ioli, Panidi., Olyvia, Donti., Gregory, C., Bogdanis. Acute Effect of Intermittent and Continuous Static Stretching on Hip Joint Range of Motion in Trained and Untrained Subjects. (2019). Doi: 10.3390/PROCEEDINGS2019025016.

[54] David, G., Behm. Mechanisms underlying acute changes in range of motion. (2018). Doi: 10.4324/9781315110745-4.

[55] Ostiak W, Kaczmarek-Maciejewska M, Kasprzak P. Foot and shin in terms of Anatomy Trains. Journal of Orthopaedics Trauma Surgery and Related Research. 2011;5(25):38-46.

[56] Abernethy PJ, Jürimäe J, Logan PA, Taylor AW, Thayer RE. Acute and chronic response of skeletal muscle to resistance exercise. Sports Medicine. 1994 Jan;17:22-38.

[57] Evans WJ. Effects of exercise on senescent muscle. Clinical Orthopaedics and Related Research (1976-2007). 2002 Oct 1;403:S211-20.

[58] Jones DA, Rutherford OM. Human muscle strength training: the effects of three different regimens and the nature of the resultant changes. The Journal of physiology. 1987 Oct 1;391(1):1-1.

[59] Shinohara M, Kouzaki M, Yoshihisa T, Fukunaga T. Efficacy of tourniquet ischemia for strength training with low resistance. European journal of applied physiology and occupational physiology. 1997 Dec;77:189-91.

[60] Vandenburgh HH. Motion into mass: how does tension stimulate muscle growth? Medicine and science in sports and exercise. 1987 Oct 1;19(5 Suppl):S142-9.

[61] Ahmad S, Glass S, Gabler T. Effect of a 2-Week Strength Training Learning Intervention on Self-selected Weight Training Intensity. Official Journal of the American College of Sports Medicine Vol. 2019 Jun 1;49(5 Supplement):S35.

[62] Staron RS, Karapondo DL, Kraemer WJ, Fry AC, Gordon SE, Falkel JE, Hagerman FC, Hikida RS. Skeletal muscle adaptations during early phase of heavy-resistance training in men and women. Journal of applied physiology. 1994 Mar 1;76(3):1247-55.

[63] Seynnes OR, de Boer M, Narici MV. Early skeletal muscle hypertrophy and architectural changes in response to high-intensity resistance training. Journal of applied physiology. 2007 Jan;102(1):368-73.

[64] DeFreitas JM, Beck TW, Stock MS, Dillon MA, Kasishke PR. An examination of the time course of training-induced skeletal muscle hypertrophy. European journal of applied physiology. 2011 Nov;111:2785-90.

[65] Damas F, Phillips SM, Lixandrão ME, Vechin FC, Libardi CA, Roschel H, Tricoli V, Ugrinowitsch C. Early resistance training-induced increases in muscle cross-sectional area are concomitant with edema-induced muscle swelling. European journal of applied physiology. 2016 Jan;116:49-56.

[66] Sale DG. Neural adaptation to resistance training. Medicine and science in sports and exercise. 1988 Oct 1;20(5 Suppl):S135-45.