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Case Report: Rehabilitation and Return to Running Program for Shin Splints Runners

Dipta Hiqmal Wirananta*, Farid Rahman

Department Physiotherapy of Muhammadiyah University of Surakarta, Indonesia

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Abstract

Shin splints, also known as medial tibial stress syndrome, is an overuse injury often caused by running. This injury occurs more often in women than men and is the third most common injury in runners. Research on rehabilitation and training plans to return to running after shin splint injuries, especially to return to exercise phase, has not been extensively researched. The aim of this article was to study the training to return to running and physiotherapy management in rehabilitation programs for amateur runners experiencing shin splints in the return to exercise phase. A male amateur runner who met the requirements, including had completed a long distance run (at least 21 km) and experienced shin splints in the return to exercise phase, was the subject of this case report study. The patient did not have any new complaints or specific complications, especially after starting an exercise program. On the contrary, the patient progress improved over time. Based on research findings, an amateur runner with complaints of shin splints in the superolateral third of the tibia, in the return to exercise phase, gained a benefit from the therapeutic intervention in the form of an exercise and rehabilitation program based on the FITT concept. The program includes a variety of training components, including strengthening, plyometrics, and running, and can also improve performance.

✉ Correspondence Address : Ahmad Yani Street, Kartasura, 57169, Jawa Tengah-Indonesia
E-mail : j120210188@student.ums.ac.id

INTRODUCTION

Around 621.16 million people are running worldwide. The running trend increased during the COVID-19 pandemic, with 28.76% of new runners discovering running for the first time during the pandemic and 72% of those runners motivated to stay healthy (Widia, 2024). Once considered an introverted activity for the few, running has become increasingly popular, becoming a symbol of fitness, self-improvement, and ubiquitous community (Scott, 2019). Running is frequently associated with overuse injuries of the lower extremities and lower back (Mendez-Rebolledo et al., 2021). Running-related injuries consist of complications involving the muscles, tendons, joints, or bones that occur during a training or competition (Mayooran et al., 2019). Medial tibial stress syndrome (MTSS), also known as "shin splints," is a prevalent group of injuries that occur specifically in the distal third or middle section of the posteromedial tibial border. It impacts the majority of runners, athletes, and military personnel (Deshmukh et al., 2022). Particularly due to overuse, running-related musculoskeletal injuries (RRMIs) are prevalent among runners (Kakouris et al., 2021).

The etiology of shin splints is complex, involving various intrinsic factors such as age, BMI, biomechanical factors (Q angle, limb length discrepancy, and foot arch), and previous injury history. Additionally, extrinsic factors like training duration, warm-up and cool-down routines, training intensity, training patterns, and changes, as well as the type and usage of running shoes, contribute to the development of shin splints (Mayooran et al., 2019). Pain in the medial aspect of the lower tibia may be attributed to periostitis. In contrast, pain in the lateral aspect of the upper tibia may be the result of higher pressure in the compartment (Bhusari and Deshmukh, 2023). Lower extremity stress injuries give rise to a multitude of functional compromises and also compromised mobility and joint, bone, reflex, and muscle functions in the lower limbs, with patients encountering difficulties in plantar ankle flexion (Mattock et al., 2021). Consequently, patients may encounter restrictions when it comes to their ability to take part in running.

Agustin (2022) conducted a study on 55 runners at Playon Jogja, which yielded findings on the prevalence of injuries among runners. Shin splints were observed in 50.9% of the participants, ranking third after ITBS (54.5%) in first place and calf injuries (52.7%) in second place. The prevalence of shin splints is greater among females than males (Patel and Patil, 2020; Wu et al., 2022). Because shin splints are so common, it is important to have the right plan, especially for rehab programs and running back training after an injury. According to Liem et al. (2013), there is little written about rehabilitation and functional development after lower limb stress fracture injury. This study is quite important in the rehabilitation scope, especially in phase IV, as it incorporates functional training treatments specifically for running sports, primarily focusing on plyometric exercises, so researchers are interested in conducting comprehensive research on rehabilitation programs and running back training for a male amateur runner with shin splints in the return-to-sport phase.

In accordance with the Medial Tibial Stress Syndrome Rehabilitation Guideline (2016) published by Sanford Orthopedics & Sports Medicine, patients are required to satisfy various criteria in order to progress to phase 3, which involves the return to running. These criteria include the ability to perform 15 painless jumps on the injured leg, the capability to walk for 30 minutes with minimal to no pain increase, the capability to perform 6 squats with 60% body weight for 6 seconds, and the capability to tiptoe more than 25 times. Assuming the patient meets these criteria. The physiotherapist can then design a rehabilitation exercise regimen and run back training course of action for the patient, with the ultimate goal of restoring normal strength and length of the lower limb kinetic chain muscles and enabling the patient to resume running and recreational/sports activities. The patient is focused on getting back to preparing for his performance in participating in future events.

During the rehabilitation phase, physiotherapists have the ability to design various exercise programs including weight training, muscle resistance training, plyometrics, core and pelvic girdle stability training, multicomponent neuromuscular training, flexibility training, gait retraining, proprioceptive and balance training, and cross-training exercises such as deep water running and antigravity treadmill workouts. The objective is to enhance the patient's muscular strength, particularly in the core and calf muscles, improve endurance, boost speed, enhance neuromuscular coordination and explosive power, train for controlled landing and hip

strategies, and minimize the impact on the lower extremities (Davies et al., 2015; Deshmukh et al., 2022; Doyle et al., 2022; Li et al., 2019; Liem et al., 2013; Mendez-Rebolledo et al., 2021).

The return to running program involves a 6-week training regimen based on the FITT (frequency, intensity, time, type) principle. The goal is to ensure the runner can continue running and daily activities without pain or discomfort. A cooperative approach between the runner and physiotherapist is crucial for effectively managing shin splints, ensuring the runner can participate in running and daily activities without experiencing pain or discomfort.

METHODS

The case report study method with a standardized CARE checklist (Riley et al., 2017) entailed providing a comprehensive account of a patient's symptoms, signs, diagnosis, treatment, and subsequent monitoring. Case reports typically documented atypical or novel occurrences and, therefore, continued to be fundamental to advancements in medicine (García-Doval et al., 2018; Rison, 2013). The research was carried out at the Physiotherapy Clinic of Muhammadiyah University of Surakarta in October 2023.

Sampling Procedures

This study used purposive sampling, a deliberate method that deviates from random sampling (Campbell et al., 2020). The researcher chose a respondent for this study in the 'Akamsi Runners Solo' running community based on specific criteria that were pertinent to the issue being investigated. A male athlete who had completed a lengthy run of at least a half marathon (21 km) and had experienced shin splints throughout the period of returning to sports, which had lasted for more than 2 months but less than 6 months, was selected. The athlete committed to four sessions per week for a duration of six weeks. The objective of this research was to assess the efficacy of running training and physiotherapy interventions in the treatment of shin splints among amateur runners. Following an extensive interview procedure with several runners in the community, a runner who met the pre-established criteria was identified.

Participant

Mr. F, a 22-year-old male runner affiliated with the 'Akamsi Runners Solo' running community, received a medical diagnosis of shin splints after an extended period of rest from running. After completing his run, he suffered cramp-like pain in the upper outside part of his shin, which persisted for around three days and gradually improved. The patient had not previously sought medical attention from a doctor, physiotherapist, hospital, or any other healthcare institution and had not participated in any intervention program.

The patient had reported several grievances over the last year, including sensations of pulling or strain at the base of the rear calf and experiencing slight pain on the lateral side of the knee. The patient experienced reduced discomfort when maintaining a consistent and relaxed moderate exertion level. The patient engaged in regular running sessions four times weekly, maintaining an average pace of 5-7 km/h.

Before experiencing shin splints, the patient jogged short distances of 2-3 kilometers and then abruptly transitioned to running longer distances of 7-10 kilometers after a prolonged period of not exercising. During the previous week, the patient extended his distance to 25 kilometers, began interval training, and intensified his exercise. The patient tends to supinate in his foot landing pattern, resulting in complaints of discomfort on the superolateral aspect of his tibia, where most of the load is concentrated. There was no correlation between the patient's shin splints and any medical, familial, or psychosocial history.

Materials and Apparatus

In this study, researchers used various methods to measure pain, muscle strength, joint motion, and functional limitations in the patient. The Numerical Rating Scale (NRS) was used to assess pain levels (Lazaridou et al., 2018), while Manual Muscle Testing (MMT) was used to measure muscle strength in knee and ankle movements. The Range of Motion (ROM) was measured using a goniometer (Deshmukh et al., 2022), and the leg length was examined using a meterline (Gordon and Davis, 2019). The Foot & Ankle Disability Index (FADI) was utilized to assess functional limitations in daily activities and sports (Hale and Hertel, 2005). The

patient's running shoes, size 42 and classified as moderate daily trainer shoes (260 grams), were measured using a durometer to determine their midsole hardness. Finally, both the researchers and the patient used an online running tracker application on their smartphones to record the patient's running activity.

Procedure

The procedure began with a physical examination: NRS measurements for the degree of pain (resting, movement, tenderness), a goniometer for measuring ROM in limited regions (hip, knee, ankle), a meterline to compare the length of the right and left limbs (appearance length), and MMT to assess muscle strength in the knee and ankle regions. This was followed by a static inspection of the knee and foot alignment, and then a dynamic inspection during walking, knee bending, or squatting movements. In addition, leg muscle palpation was performed. The baseline data of these measurements are presented in Table 1.

minutes or more, and experiencing moderate pain during general activities and everyday tasks. The patient's sports score was 25 out of 32, equivalent to 78%. This indicated modest limitations in activities such as running, leaping, landing, rapid starting and stopping motions, completing activities with normal technique, and engaging in chosen sports. Diagnosing the patient's problem was straightforward.

The patient's running shoe midsole material had a durometer measurement of 35 on the shore hardness scale, specifically in the 35A group. This indicated a lower or softer hardness level, suitable for activities requiring significant shock absorption, such as long-distance walking or jogging, or for everyday comfort. Based on feedback from runners and the patient's experience, the shoes were suitable for various types of daily training, including easy runs, speed workouts, and long runs.

Patient Mr. F had not undergone X-rays, MRIs, or ultrasounds for his medical concerns. Consequently, the researcher performed specific examinations utilizing the Hop Test, Resisted Ankle Plantar Flexion, and Achilles Tendon Palpation on the right side. Furthermore, researchers performed a differential diagnosis to validate the diagnosis of shin splints and distinguish it from other conditions. Ober's Test and the Capillary Refill Test are presented in Table 2.

Table 1. Pain, ROM, Leg Length, and Muscle Strength Measurements

Measurements		Baseline data
NRS (pain) (Lazaridou et al., 2018)	Rest	3/10
	Movement	5/10
	Tenderness	6/10
Goniometer (ROM) (Deshmukh et al., 2022)	Hip	S: 20° - 0° - 120°
	Knee	S: 0° - 0° - 110° (dextra & sinistra)
	Ankle	S: 20° - 0° - 35° (dextra & sinistra) R: 45° - 0° - 50° (dextra & sinistra)
Meterline (leg length) (Gordon and Davis, 2019)	Appearance length	100cm (dextra & sinistra)
MMT (muscle strength) (Deshmukh et al., 2022)	Knee flexion (M. Quadriceps)	5 (maximum resistance)
	Knee extension (M. Hamstring)	5 (maximum resistance)
	Ankle dorsi flexion (M. extensor ankle)	Dextra: 4 (minimum resistance) Sinistra: 5 (maximum resistance)
	Ankle plantar flexion (M. flexor ankle)	Dextra: 4 (minimum resistance) Sinistra: 5 (maximum resistance)
Static Inspection	Knee joint	5cm (genu varum)
	Base of the back calf	Pain-like pulling
	Foot allignmet	Neutral
Dynamic Inspection	Squatting	Patellar Crepitation
Palpation	Leg muscles	Normal, no muscles imbalance

The FADI index was used to measure the functional limitations experienced by the patient in daily activities and sports (Hale and Hertel, 2005). The overall score obtained was 90 out of 104, which corresponded to 87%. This indicated that the patient had mild limitations or difficulties in performing certain functional activities such as walking on uphill or downhill surfaces, going up and down stairs, reaching the tip of the foot (limited ankle dorsiflexion), walking for 10-15

Table 2. Physical Examinations

No.	Physical Examinations	Results	Descriptions
		Specific Examinations	
1	Hop Test	Positive (+)	The patient had cramp-like pain in the superolateral region of the right leg's tibia.
2	Achilles Tendon Palpation	Positive (+)	Palpation of the right foot revealed tightness in the achilles tendon.
3	Ankle Plantar Flexion Resisted	Positive (+)	The patient experienced discomfort during resisted plantar flexion motions in the right foot.
		Differential Diagnosis	
4	Ober's Test	Negative (-)	It aims to determine the possibility of ITBS injury, also caused by overuse, and the expected results; the patient only feels mild pain and tends to be faint on the lateral side of the knee
5	Capillary Refill Test	Negative (-)	The examination of blood flow to the leg tissue showed normal results, with no evidence of vascularization or blood flow abnormalities in the patient's leg.

Table 3. ICF Browser diagnosis

		Impairment	
	Code	**ICF**	**Description**
Body function	b28015	Pain in lower limb	Cramp-like pain at the superolateral tibia and base of the back calf
	b7100	Mobility of a single joint	Limited ROM in the patient's right ankle region, especially during ankle dorsi flexion.
	b7300	Power of isolated muscles and muscle groups	Decreased muscle strength, especially in the right calf region, so that it is unable to support the body when standing perfectly
	b770	Gait pattern functions	Improper walking pattern due to overuse of the right calf region, so that it tends to rest on the healthy side (left) only
Body structure	s75011	Knee joint	Genu varum was found in the patient's knee of 5cm, and frequent crepitation during knee flexion or squatting.
	s75012	Muscles of lower leg	Tightness of the Achilles tendon and cramping at the base of the back calf
		Activities and participation	
	d4500	Walking short distance	The patient has difficulty walking short distances.
	d9108	Community life, other specified	The patient has difficulty participating in routine activities of his/her running community.
	d9201	Sports	The patient has difficulty exercising, especially in lower extremity exercises such as running and strengthening.
	d9301	Spirituality	The patient complains of difficulty when worshiping (prayer movements).
		Environmental factors	
Facilitators	e1401	Assistive products and technology for culture, recreation and sport	The shoes used by the patient are very suitable for supporting his running activities.
	e320	Friends	Friends in his running community are very supportive, so the patient can run again together.
	e310	Immediate family	The family is very supportive of the patient's recovery.
Inhibitor/ Barrier	e2100	Landforms	The surface used by the patient when running is asphalt, sometimes a road with a slope/uphill.

Table 4. Functional Exercise Program Based on FITT Concepts

Functional Exercise Program	Dosage (FITT)	Objectives
Easy Run (pace 7): • 5 km (1st week) • 6 km (2nd week) • 7 km (3rd week) • 8 km (4th week) • 9 km (5th week) • 10 km (6th week)	F: twice per week I: low, 55 – 65% HR max (zone 1), talk test T: 30 – 60 minute T: cardio workout	To train cardiorespiratory fitness and adaptation at a moderate intensity, and at the usual average pace.
Speed Session (8 km): - Tempo Run (pace 6 – 4/km): • 7 km (40:15 – 42:00) • 8 km (46:00 – 48:00)	F: 1 x 2 weeks I: high, 85 – 88% HR max (zone 3) T: 40, 60 minute per session T: cardio workout	To maximize and train the patient's performance in achieving VO2 max and maximum ability threshold, patients were encouraged to choose only 1 type of exercise per week due to the high intensity. The chosen exercise could be replaced with another form among the 3 types of exercise the following week. Speed session training was given only once every two weeks, but the week following the speed session, it could be replaced with a long run.
Long Run (pace 7 – 6/km): • 15 km (3rd weeks) • 21 km (5th weeks)	F: 1 x 2 weeks I: moderate, 65% – 75% HR Max (zone 2) T: 1,5 – 2,5 hours T: cardio workout	A form of progression from the training program was applied during the week to train cardiorespiratory endurance. Training was given once every two weeks as an interlude after the speed session training in the previous week.
Recovery Run (pace 8 – 7/km): • 7 km	F: once per week I: low, 55% – 65% HR max (zone 1) T: 54 – 56 minute T: cardio workout	Workouts were structured at a lighter intensity than the usual running pace to maintain fitness or restore cardiorespiratory condition after several days of moderate-to-high intensity training.
Strength Training (postural, abdominal & core muscles): • Push up • Back up • Hip strengthening (clamshell with band, single leg glute bridge, quadruped with hip and knee extension, donkey kicks, side step with band) • Leg raises/bicycle crunch • Plank	F: twice per week I: 12 – 20 repetition T: 3 sets T: strength training	Optimized postural, abdominal, and core muscles affecting the patient's running form. Exercises can be combined with more than 1 exercise or used in a warm-up session before starting to run.
Strength Training (lower extremity): • Calf Raises • Single Leg Bridge • Single Leg Deadlift • Bulgarian Split Squat	F: twice per week I: 15 – 20 repetition T: 3 sets T: strength training	To optimize the muscles of the lower extremities, especially for endurance during long runs, and minimize injuries. Exercises could be combined with more than 1 form of exercise and can be used in a warm-up session before starting to run.
Plyometrics Training: • A, B, C drills • Pogo Hops • Hip Twister Hops (forwards/ backwards, sideways) • Single Leg Twister (forwards/ backwards, sideways) • Straight Leg Jumps • Single Leg Hops (2 forwards, 1 backwards) • Knee Tucks	F: twice per week I: 15 – 25 repetition T: 3 sets T: cardio workout	To enhance running efficiency by developing speed, explosiveness, and strength in the muscles of the lower extremities.

The patient's problems were easily diagnosed without any complications. The prognosis determined during the patient's evaluation was Quo ad Vitam (life): Sanam, the damage did not affect the patient's survival. Quo ad Functionam (function): Sanam, the patient's injury was affecting their ability to perform everyday activities. The physiotherapist's role was to restore the patient's limited movement and function by implementing treatments that sought to optimize mobility and function in order to enable them to resume running. Quo ad Sanationam (heal): Sanam, the patient's injury was a repetitive strain injury that did not result in permanent damage. Quo ad Cosmeticam (beauty): Sanam, the patient did not have any abnormalities in appearance as a result of the injury, and the wounded region maintained its usual form despite the postural situation. Researchers utilized the ICF browser as a point of reference for identifying individuals with shin splints, as indicated in Table 3.

Protocol Design

Patient Mr. F was categorized into the return-to-sport phase, provided that he passed several criteria mentioned in the MTSS Rehabilitation Guideline by Sanford Orthopedics & Sports Medicine, which was used as reference material for determining the dose of intervention in this study. This included being able to complete the interval running program without pain. Then, to return to the running stage after injury, it was started when the patient could walk for 30 consecutive minutes without pain or reinjury. If pain returned during running, it could be continued as long as the pain was not sharp, and the pain decreased or remained unchanged as the running session continued.

The researchers designed a 6-week exercise program based on the standards used by Besselink & Clark (2018) and Liem et al. (2013) for patients by combining different types of exercises in a table format. The exercises were arranged in a way that prevented overuse by alternating between exercise and rest days. The program included one week of high-intensity training (speed sessions) followed by one week of endurance exercises (long run). The program started with light exercises to assess the patient's functional adaptation, gradually increased exercise doses, and focused on progressivity. The dosage of exercises was gradually increased, as shown in Table 5.

Table 5. Six-week training program

Weeks	Days	Exercise Program
1	1st	Strength Training: Postural, abdominal, and core muscles (12 reps, 3 set) Lower extremity (15 reps, 3 set) Cardio Workout: Plyometrics training (15 reps, 3 set)
	2nd	Rest
	3rd	Cardio Workout: Easy run (5 km)
	4th	Rest
	5th	Strength Training: Postural, abdominal, and core muscles (12 reps, 3 set) Lower extremity (15 reps, 3 set) Cardio Workout: Plyometrics training (15 reps, 3 set)
	6th	Rest
	7th	Cardio Workout: Easy run (5 km)
2	1st	Cardio Workout: Plyometrics training (15 reps, 3 set) Easy run (6 km)
	2nd	Rest
	3rd	Strength Training: Postural, abdominal, and core muscles (14 reps, 3 set) Lower extremity (15 reps, 3 set) Cardio Workout: Speed session (pace 4 – 3, total: 8 km)
	4th	Rest
	5th	Cardio Workout: Plyometrics training (15 reps, 3 set) Recovery run (7 km)
	6th	Rest
	7th	Strength Training: Postural, abdominal, and core muscles (14 reps, 3 set) Lower extremity (15 reps, 3 set) Cardio Workout: Easy run (6 km)
3	1st	Strength Training: Postural, abdominal, and core muscles (16 reps, 3 set) Lower extremity (17 reps, 3 set) Cardio workout: Easy run (7 km)
	2nd	Rest
	3rd	Cardio Workout: Plyometrics training (20 reps, 3 set) Long run (15 km)
	4th	Rest
	5th	Strength Training: Postural, abdominal, and core muscles (16 reps, 3 set) Lower extremity (17 reps, 3 set) Cardio workout: Easy run (7 km)
	6th	Rest
	7th	Cardio Workout: Plyometrics training (20 reps, 3 set) Recovery run (7 km)

Weeks	Days	Exercise Program
4	1st	Strength Training: Postural, abdominal, and core muscles (18 reps, 3 set) Lower extremity (17 reps, 3 set) Cardio workout:
	2nd	Rest
	3rd	Cardio Workout: Plyometrics training (20 reps, 3 set) Recovery run (7 km)
	4th	Rest
	5th	Cardio workout: Plyometrics training (20 reps, 3 set) Easy run (8 km)
	6th	Rest
	7th	Strength Training: Postural, abdominal, and core muscles (18 reps, 3 set) Lower extremity (17 reps, 3 set) Cardio workout:
5	1st	Strength Training: Postural, abdominal, and core muscles (20 reps, 3 set) Lower extremity (20 reps, 3 set) Cardio Workout:
	2nd	Rest
	3rd	Cardio Training: Plyometrics training (25 reps, 3 set) Easy run (9 km)
	4th	Rest
	5th	Strength Training: Postural, abdominal, and core muscles (20 reps, 3 set) Lower extremity (20 reps, 3 set) Cardio Workout:
	6th	Rest
	7th	Cardio Workout: Plyometrics training (25 reps, 3 set) Recovery run (7 km)
6	1st	Strength Training: Postural, abdominal, and core muscles (20 reps, 3 set) Lower extremity (20 reps, 3 set) Cardio Workout:
	2nd	Rest
	3rd	Cardio Workout: Plyometrics training (25 reps, 3 set) Recovery run (7 km)
	4th	Rest
	5th	Strength Training: Postural, abdominal, and core muscles (20 reps, 3 set) Lower extremity (20 reps, 3 set) Cardio Workout:
	6th	Rest
	7th	Cardio Workout: Plyometrics training (25 reps, 3 set) Easy run (10 km)

Prognosis

While providing the exercise program, the patient has shown good compliance and progress, with improvements noted and no new complaints or complications observed, especially during the implementation of the exercise program. The patient has also experienced positive effects from the progressive nature of the exercises since the second week of physiotherapy sessions, following the routine physiotherapy program consistently at a frequency of 4 times per week for 6 weeks.

After measuring Mr. F's pain levels using the NRS, the results indicated a decrease in pain levels that tended to improve in the superolateral third of the patient's tibia during the program, including resting pain, pain on movement, and tenderness. These findings are presented in detail in Figure 1.

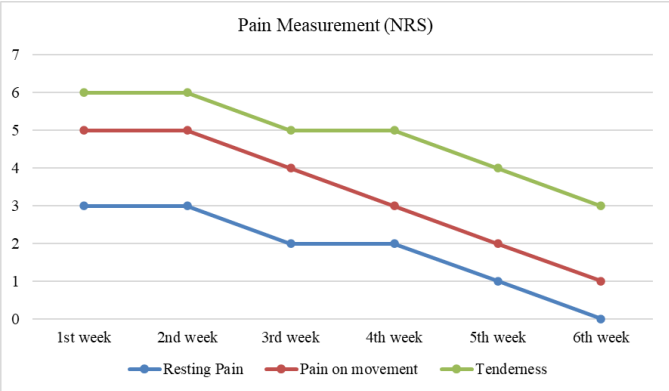

Figure 1. Follow-up Pain Measurement with NRS

Mr. F measured joint motion using goniometer every two weeks, revealing an increase in the hip, knee, and ankle joints range of motion, as detailed in Table 6.

Mr. F's dextra ankle showed increased muscle strength, particularly in the extensor and flexor muscle groups, as measured by MMT before and after the program, as shown in Table 7.

Mr. F also underwent a physical examination at the end of the program, which included a Hop Test, Ankle Plantar Flexion Resisted, and Palpation of the Achilles Tendon on the right side, to ensure there were no indications of reinjury caused by overuse after completing the program. The results were negative (-), as shown in Table 8.

Table 6. Follow-up Range of Motion Measurement with Goniometer

ROM Measurement (Goniometer)				
Weeks	Hip	Knee (dextra & sinistra)	Ankle (dextra & sinistra)	
2nd	S: 20° - 0° - 120°	S: 0° - 0° - 110°	S: 20° - 0° - 35°	R: 45° - 0° - 50°
4th	S: 20° - 0° - 125°	S: 0° - 0° - 115°	S: 20° - 0° - 40°	R: 45° - 0° - 55°
6th	S: 20° - 0° - 130°	S: 0° - 0° - 120°	S: 20° - 0° - 40°	R: 45° - 0° - 60°

Table 7. Follow-up Muscle Strength with MMT

Muscle Strength Measurement of Ankle Dextra (MMT)			
Regio		**Before Program**	**After Program**
Knee	Knee Flexion (M. Hamstrings)	Score 5 (maximum resistance)	Score 5 (maximum resistance)
	Knee Extension (M. Quadriceps)	Score 5 (maximum resistance)	Score 5 (maximum resistance)
Ankle	Ankle Plantar Flexion (M. FlexorAnkle)	Dextra: Score 4 (minimum resistance) Sinistra: Score 5 (maximum resistance)	Dextra: Score 5 (maximum resistance) Sinistra: Score 5 (maximum resistance)
	Ankle Dorsi Flexion (M. Extensor Ankle)	Dextra: Score 4 (minimum resistance) Sinistra: Score 5 (maximum resistance)	Dextra: Score 5 (maximum resistance) Sinistra: Score 5 (maximum resistance)

Table 8. Follow-up Physical Examination

Physical Examination			
Specific Test	**Before Program**	**After Program**	**Descriptions**
Hop Test	Positive (+)	Negative (-)	Pain felt in the superolateral area of the patient's tibia has decreased/tends to disappear during the one-legged jump test.
Ankle Plantar Flexion Resisted	Positive (+)	Negative (-)	No pain on ankle plantar flexion against resistance.
Achilles Tendon Palpation	Positive (+)	Negative (-)	Normal Achilles tendon without tension when palpated

Mr. F assessed his functional abilities using the FADI Index, which measures activities and sports. The results indicated a gradual decrease in complaints regarding functional abilities in activities and sports. Compared to the previous condition, this improvement was observed, characterized by mild limitations, as shown in the data presented in Figures 2 and 3.

Furthermore, Mr. F's progressivity in the training program was assessed by measuring his performance in the long run sessions of 15 km during 3rd and 5th weeks. This was done using a running tracker application on his smartphone. The purpose was to determine if there was an improvement in his functional abilities, particularly endurance, and to ensure that he was prepared to resume his participation in running community activities and future competitions without the risk of reinjury or overuse during the long run. The findings indicated an increase in speed from the initial extended run in week 3, which was recorded at a pace of 6:53/km. Furthermore, during the subsequent long run in week 5, the respondent was able to maintain a faster pace of 5:59/km. Regarding the time aspect, there was a notable rise in week 5, with a nearly 14-minute faster than week 3. Additionally, there was an increase in the number of steps per minute in week 5, with a difference of 6 steps greater than week 3. These findings are presented in Table 9.

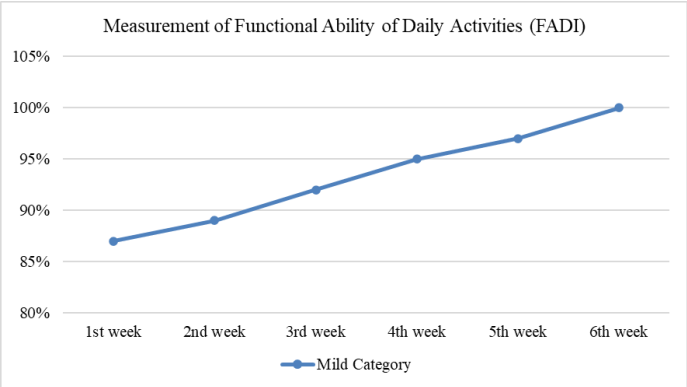

Figure 2. Follow-up Functional Ability of Daily Activities with FADI

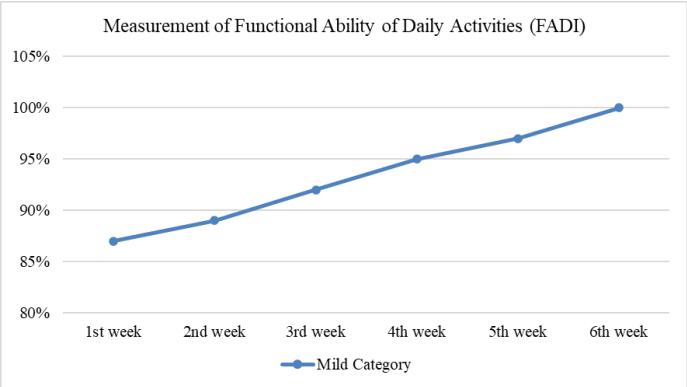

Figure 3. Follow-up Functional Ability of Sports with FADI

Table 9. Follow-up Measurement of Exercise Program Progressiveness

Measurement of Exercise Program Progressivity			
Long Run (15 km)	**Run Tracker App Results**		
	Pace (minute/km)	**Time**	**Step Per Minute (SPM)**
3rd weeks	6:53/km	1:43:21	164 SPM
5th weeks (pace increased)	5:59/km	1:29:45	170 SPM

DISCUSSION

Based on the data gathered from the research on a rehabilitation program and running back training for an amateur runner with shin splints, significant improvements have been observed in various aspects. These include a decrease in complaints and an increase in range of motion, muscle strength, and functional abilities. These improvements have positively impacted the runner's performance during long runs. According to research data from Ramskov et al. (2022), higher running speeds and excessive running volume significantly contribute to injury occurrence. To mitigate this risk, training errors in running should be addressed, and recreational runners are advised to adhere to evidence-based running programs (Ramskov et al., 2016). Therefore, the researcher developed a therapy intervention consisting of a gradually modified exercise program tailored to the specific stage of injury encountered by the patient. This intervention was informed by the MTSS Rehabilitation Guideline published by Sanford Orthopedics & Sports Medicine, as well as the FITT concept.

The researcher's exercise program design incorporates strengthening exercises targeting both the upper body (postural, abdominal, and core muscles) and the lower extremities. The aim is to enhance muscle strength, endurance, pain management, and neuromuscular function (Deshmukh et al., 2022; Eihara et al., 2022; Li et al., 2019; Šuc et al., 2022). Plyometric exercises are beneficial for increasing speed and explosive power (Davies et al., 2015; Denadai et al., 2017; Eihara et al., 2022; Li et al., 2019). Speed session training, categorized as High-Intensity Interval Training, is advantageous for enhancing cardiorespiratory fitness (Abarzúa V et al., 2019; Cao et al., 2019). An easy run program is implemented to sustain cardiorespiratory endurance, while a recovery run helps maintain cardiorespiratory fitness after a speed session. The long-run program is utilized to train endurance for running long distances and to assess the patient's functional ability to safely return to running within his community or participate in future running events without the risk of reinjury or overuse.

The patient demonstrated significant improvement in their outcomes after completing a 6-week exercise routine, noting a decrease in symptoms and enhancement in functional abilities. Prior to the program, the patient experienced shin splint injuries resulting from sporadic activities. The patient exhibited exemplary commitment by consistently completing the program on a weekly basis. The researcher facilitated conversations to ensure patient adherence and effective execution. However, exercises that could be performed independently at home were also permitted.

The researcher employed a recall method to moni-

tor the advancement of each exercise protocol, utilizing internet messaging programs and workout checklists as indirect means, requesting photo documentation evidence and exercise checklists for each implemented program on that day. The patient's exercise schedule was modified to include 8 km road tempo runs instead of interval/fartlek runs due to the absence of a flat track. In week 5, the patient's original 21 km long run was adjusted to 15 km, matching the distance from week 3. The target pace was initially set at 7-6 minutes per kilometer in week 3 and increased to 5-6 minutes per kilometer in week 5. These adjustments aimed to enhance efficiency and assess the patient's progress in improving functional ability by comparing their performance during long-distance running in the 3rd and 5th weeks. HIIT exercises are known to improve cardiorespiratory fitness, cardiovascular function, anthropometric variables, exercise capacity, muscle structure, and function (Martland et al., 2020). The researchers modified the original 21 km low-intensity running program for patients, shortening it to 15 km while increasing the intensity to a moderate to high level.

The patient occasionally attempted to adjust the exercise plan due to competing obligations, but the exercise components were consistently performed over the week without altering their substance, as required. This measure was implemented to mitigate any adverse effects on performance or the risk of overtraining, which could potentially result in reinjury. The researcher monitored the patient's condition by soliciting information about any complaints and evaluating their progress in performance to prevent overuse or overexertion. Additionally, researchers engaged in sessions with patients to oversee their physical health, water intake, and the running environment, ensuring the patients' well-being was optimal throughout the program and that the atmosphere was safe for their running sessions.

CONCLUSION

This research serves as the foundation for phase IV shin splint injury rehabilitation studies and clinical applications aimed at enhancing performance, particularly for the return to running. Based on the research findings, therapeutic interventions in the form of an exercise program incorporating various types of exercises, including strengthening (postural, abdominal, core muscles, and lower extremities), plyometric, and running (easy run, recovery run, speed session, and long run), can effectively reduce complaints (pain and functional limitations) and enhance performance (range of motion, muscle strength, endurance, functional ability for daily activities and sports). Mr. F, an amateur runner who experienced shin splints on the superolateral third of the tibia, benefited from such an exercise program. It is crucial that the exercise program is tailored to the specific phase of injury and progressively adjusted based on the FITT concept. Future research is anticipated to employ quasi- or true experiments with or without a randomized control trial design, focusing on functional outcomes. This will help to further understand the effects of such interventions in diverse populations and with larger sample sizes.

CONFLICT OF INTEREST

The authors declared no conflict of interest.

REFERENCES

Bahamondes, J., Olivera, Y., Poblete-Aro, C., Herrera-Valenzuela, T., Oliva, C., & García-Díaz, D. F. (2019). High intensity interval training in teenagers. Rev Med Chile, 147, 221-230.

Agustin, F. S., Nurwahida Puspitasari, S. S. T., Rizky Wulandari, S. S. T., & Fis, M. (2022). Hubungan jarak tempuh lari terhadap kejadian cedera pada runners (Doctoral dissertation, Universitas' Aisyiyah Yogyakarta).

Besselink, A., & Clark, B. (2018). Running injuries: etiology and recovery-based treatment. Clinical Orthopaedic Rehabilitation: A Team Approach, Fourth Edition, 577-587.e1.

Nikita, B., & Mitushi, D. (2023). Shin Splint: A Review. Cureus, 15(1).

Campbell, S., Greenwood, M., Prior, S., Shearer, T., Walkem, K., Young, S., ... & Walker, K. (2020). Purposive sampling: complex or simple? Research case examples. Journal of research in Nursing, 25(8), 652-661.

Cao, M., Quan, M., & Zhuang, J. (2019). Effect of high-intensity interval training versus moderate-intensity continuous training on cardiorespiratory fitness in children and adolescents: a meta-analysis. International journal of environmental research and public health, 16(9), 1533.

Davies, G., Riemann, B. L., & Manske, R. (2015). Current concepts of plyometric exercise. International journal of sports physical therapy, 10(6), 760.

Denadai, B. S., de Aguiar, R. A., de Lima, L. C. R., Greco, C. C., & Caputo, F. (2017). Explosive train-

ing and heavy weight training are effective for improving running economy in endurance athletes: a systematic review and meta-analysis. Sports medicine, 47, 545-554.

Deshmukh Jr, N. S., Phansopkar, P., Wanjari, M. B., & Wanjari, M. (2022). A Novel Physical Therapy Approach in Pain Management and Enhancement of Performance in Shin Splints Athletes: A Case Report. Cureus, 14(7).

Eihara, Y., Takao, K., Sugiyama, T., Maeo, S., Terada, M., Kanehisa, H., & Isaka, T. (2022). Heavy resistance training versus plyometric training for improving running economy and running time trial performance: a systematic review and meta-analysis. Sports Medicine-Open, 8(1), 138.

García-Doval, I., Albrecht, J., Flohr, C., Batchelor, J., Ingram, J. R., & European Dermato-Epidemiology Network (EDEN). (2018). Optimizing case reports and case series: guidance on how to improve quality. British Journal of Dermatology, 178(6), 1257-1262.

Gordon, J. E., & Davis, L. E. (2019). Leg length discrepancy: the natural history (and what do we really know). Journal of Pediatric Orthopaedics, 39, S10-S13.

Hale, S. A., & Hertel, J. (2005). Reliability and sensitivity of the Foot and Ankle Disability Index in subjects with chronic ankle instability. Journal of athletic training, 40(1), 35.

Kakouris, N., Yener, N., & Fong, D. T. (2021). A systematic review of running-related musculoskeletal injuries in runners. Journal of sport and health science, 10(5), 513-522.

Lazaridou, A., Elbaridi, N., Edwards, R. R., & Berde, C. B. (2018). Pain assessment. In Essentials of pain medicine (pp. 39-46). Elsevier.

Li, F., Wang, R., Newton, R. U., Sutton, D., Shi, Y., & Ding, H. (2019). Effects of complex training versus heavy resistance training on neuromuscular adaptation, running economy and 5-km performance in well-trained distance runners. PeerJ, 7, e6787.

Liem, B. C., Truswell, H. J., & Harrast, M. A. (2013). Rehabilitation and return to running after lower limb stress fractures. Current sports medicine reports, 12 (3), 200-207.

Martland, R., Mondelli, V., Gaughran, F., & Stubbs, B. (2020). Can high-intensity interval training improve physical and mental health outcomes? A meta-review of 33 systematic reviews across the lifespan. Journal of sports sciences, 38(4), 430-469.

Mattock, J., Steele, J. R., & Mickle, K. J. (2021). 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, 14, 1-8.

Mayooran, S., Nanayakkara, S. D. I., Rajaratne, A. A. J., & HMSRB, K. (2019). Prevalence and associated factors of injuries related to running: A study among runners in Sri Lanka. American Journal of Sports Science and Medicine, 7(2), 28-33.

Medial Tibial Stress Syndrome Rehabilitation Guideline. (2016). (online) accsess at https://www.sanfordhealth.org/-/media/org/files/medical-professionals/resources-and-education/medial-tibial-stress-syndrome-guideline.pdf[2023]

Mendez-Rebolledo, G., Figueroa-Ureta, R., Moya-Mura, F., Guzmán-Muñoz, E., Ramirez-Campillo, R., & Lloyd, R. S. (2021). The protective effect of neuromuscular training on the medial tibial stress syndrome in youth female track-and-field athletes: A clinical trial and cohort study. Journal of sport rehabilitation, 30(7), 1019-1027.

Patel, P., & Patil, N. (2020). Prevalence of shin splint in recreational marathon runner.

Ramskov, D., Nielsen, R. O., Sørensen, H., Parner, E., Lind, M., & Rasmussen, S. (2016). The design of the run Clever randomized trial: running volume,− intensity and running-related injuries. BMC musculoskeletal disorders, 17, 1-11.

Ramskov, D., Rasmussen, S., Sørensen, H., Parner, E. T., Lind, M., & Nielsen, R. (2022). Interactions Between Running Volume and Running Pace and Injury Occurrence in Recreational Runners: A Secondary Analysis. Journal of Athletic Training, 57(6), 557-563.

Riley, D. S., Barber, M. S., Kienle, G. S., Aronson, J. K., von Schoen-Angerer, T., Tugwell, P., ... & Gagnier, J. J. (2017). CARE guidelines for case reports: explanation and elaboration document. Journal of clinical epidemiology, 89, 218-235.

Rison, R. A. (2013). A guide to writing case reports for the Journal of Medical Case Reports and BioMed Central Research Notes. Journal of Medical Case Reports, 7, 1-9.

Scott, B. (2019, October 19). The Running Revolution: How Running is Taking Over the World. (online) access at https://exepose.com/2023/10/19/the-running-revolution/[2023]

Šuc, A., Šarko, P., Pleša, J., & Kozinc, Ž. (2022). Resistance exercise for improving running economy and running biomechanics and decreasing running-related injury risk: A narrative review. Sports, 10(7), 98.

Widia, S. (2024, February 13). Tren Olahraga Lari Meningkat di Indonesia, Ada 160 Event di 2023. (online) dapat diunduuh pada https://youngster.id/news/tren-olahraga-lari-meningkat-di-indonesia-ada-160-event-di-2023/#google_vignette [diakses 2023]

Wu, A. C., Rauh, M. J., DeLuca, S., Lewis, M., Ackerman, K. E., Barrack, M. T., ... & Tenforde, A. S. (2023). Running-related injuries in middle school cross-country runners: Prevalence and characteristics of common injuries (Retraction of Vol 14, Pg 793, 2022).