INSIGHTS-JOURNAL OF
HEALTH AND REHABILITATION

INSIGHTS-JHR
INSIGHTS-JOURNAL OF HEALTH AND REHABILITATION

EFFECTS OF HIGH LOAD STRENGTH TRAINING WITH AND WITHOUT TISSUE SPECIFIC PLANTAR FASCIA STRETCHING EXERCISE ON PAIN, RANGE OF MOTION AND FUNCTIONAL DISABILITY AMONG ATHLETES WITH PLANTAR FASCIITIS

Original Research

Muhammad Ilyas[1]*, Adiba Javed[2], Maryam Nadeem[3], Ghulam Dastgeer[4], Muhammad Tauseef Jawaid[5], Syed Nasir Ali Shah[6], Hafiz Ali Bin Asim[7]
[1]DPT, MS SPT, Gillani Physio Center, Lahore, Pakistan.
[2]DPT, Al Fazal Hospital, Lahore, Pakistan.
[3]DPT, MSPT (Musculoskeletal), The University of Lahore, Pakistan.
[4]DPT, Student, University of Lahore, Lahore, Pakistan.
[5]MBBS, DPH, MSc Medical Admin, MPhil, FCPS (Community Medicine); Professor of Community Medicine, Gujranwala Medical College, Gujranwala, Pakistan.
[6]BSPT, tDPT/M.Phil, Principal/HOD Physiotherapy, The Sahara College, Narowal, Pakistan.
[7]BSPT, PPDPT, MSPT, PhD, Lecturer, Foundation University, Islamabad, Pakistan.
Corresponding Author: Muhammad Ilyas, DPT, MS SPT, Gillani Physio Center, Lahore, Pakistan, ilyasgazar11@gmail.com

Conflict of Interest: None
Grant Support & Financial Support: None

ABSTRACT

Background: Plantar fasciitis is a common overuse injury characterized by debilitating heel pain and reduced functional capacity, frequently affecting athletes due to repetitive stress on the plantar fascia. This condition significantly impairs daily activities and athletic performance, necessitating effective interventions. High-load strength training (HLST) has shown promise in managing plantar fasciitis, with the potential for improved outcomes when combined with tissue-specific plantar fascia stretching exercises. This study investigates the comparative effectiveness of HLST with and without stretching exercises.

Objective: To compare the effectiveness of high-load strength training with and without tissue-specific plantar fascia stretching exercises in reducing pain, improving range of motion, and alleviating functional disability among athletes with plantar fasciitis.

Methods: This randomized controlled trial included 34 male athletes aged 20–35 years, divided equally into two groups. Group A received HLST combined with tissue-specific plantar fascia stretching exercises, while Group B underwent HLST alone. The study was conducted over six months, from March 2024 to September 2024, at a sports club in Mirpur, AJK. Participants were assessed using the Numeric Pain Rating Scale (NPRS), Functional Foot Index (FFI), and goniometer. Pre- and post-intervention measurements were analyzed using SPSS Version 25, with paired and independent sample t-tests used to determine statistical significance.

Results: Post-treatment NPRS values significantly improved in Group A (4.235 ± 0.903, p=0.029) compared to Group B (4.941 ± 0.899, p=0.039). Similarly, FFI values improved more significantly in Group A (66.705 ± 7.235, p=0.015) than in Group B (62.764 ± 4.115, p=0.004). Ankle dorsiflexion and plantar flexion were also better in Group A, with dorsiflexion improving from 17.529 ± 1.328 to 23.411 ± 2.032 (p=0.003), and plantar flexion increasing from 35.941 ± 2.221 to 46.117 ± 2.471 (p=0.002).

Conclusion: Both high-load strength training alone and in combination with stretching exercises effectively reduced pain, improved range of motion, and alleviated functional disability in athletes with plantar fasciitis. However, HLST combined with tissue-specific plantar fascia stretching was significantly more effective, offering superior outcomes across all measures.

Keywords: Athletic injuries, Fasciitis, Goniometer, Pain management, Range of motion, Rehabilitation, Strength training.

INTRODUCTION

The plantar fascia, a fibrous aponeurosis originating from the plantar medial calcaneal body and extending through the plantar midfoot before dividing into five tissue bands at the forefoot, exhibits remarkable inelasticity with a maximum elongation of only 4% of its length. This critical structure plays an essential role in foot mechanics, yet it is frequently implicated in plantar fasciitis, a condition responsible for nearly 60% of the annual one million patient visits to primary care physicians (often referred to as plantar fasciopathy due to the absence of inflammation) (1, 2). Plantar fasciitis manifests as pain in the plantar heel, often accompanied by localized fibrosis or granulomatous changes, and in severe cases, it significantly impairs an individual's ability to perform daily activities. The characteristic burning pain, exacerbated by weight-bearing activities such as climbing stairs, is frequently associated with morning stiffness that temporarily subsides after initial movement but worsens throughout the day (3, 4).

Athletes engaged in high-impact activities like running, jumping, or dancing are particularly susceptible to plantar fasciitis due to repetitive microtrauma to the plantar fascia. These individuals may experience debilitating pain when taking a step or bearing weight, rendering them unable to perform their activities. In extreme cases, sudden rupture of the plantar fascia can result in acute pain, inflammation, or localized swelling (5, 6). The pathophysiology of this condition includes impaired collagen synthesis, highlighting the importance of mechanical interventions that enhance collagen remodeling. Among runners, the incidence of plantar fasciitis ranges from 4.5% to 10%, with a prevalence of 5.2% to 17.5% (7). The pain, commonly localized at the plantar fascia's attachment to the calcaneal medial tubercle, often improves during warm-up but reappears with prolonged activity, contributing to functional disability and compromised athletic performance.

Given the debilitating nature of plantar fasciitis, there is a pressing need for effective treatments that alleviate symptoms and restore function. High-load strength training (HLST) has emerged as a promising approach by promoting collagen synthesis and facilitating tendon remodeling. HLST has shown efficacy not only in plantar fasciitis but also in degenerative conditions such as patellar and Achilles tendinopathy by applying high tensile forces that stimulate the healing process. The combination of the windlass mechanism, achieved through dorsiflexion of the metatarsophalangeal joints, and high-load tendon stress training provides targeted therapeutic benefits for the plantar fascia (8, 9). Comparative studies suggest that HLST is more effective than plantar-specific stretching alone in addressing degenerative tendon pathologies (10).

However, integrating plantar fascia-specific stretching exercises with HLST may offer superior outcomes. Exercises such as dorsiflexing the toes while maintaining a neutral ankle position enhance the flexibility and elasticity of the fascia tissue, addressing aspects of plantar fascia pathology that strength training alone may overlook. Evidence supports that combining these approaches yields greater pain reduction and functional improvement than HLST or stretching in isolation, emphasizing the synergistic potential of this integrative strategy (11, 12). This holistic approach not only strengthens the plantar fascia but also improves its elasticity and resilience, offering a comprehensive management solution for plantar fasciitis. Such integrative rehabilitation strategies aim to provide sustained symptom relief, restore functional abilities, and improve overall quality of life for individuals with plantar fasciitis (13, 14).

The objective of this study is to evaluate the combined effects of high-load strength training and plantar fascia-specific stretching exercises on pain, range of motion, and functional disability among athletes with plantar fasciitis. By investigating this integrated approach, this study seeks to establish a more effective therapeutic strategy that addresses multiple facets of plantar fascia pathology, ultimately improving outcomes for affected individuals.

METHODS

This randomized controlled trial aimed to evaluate the effects of high-load strength training (HLST) with and without plantar fascia-specific stretching exercises on pain, range of motion, and functional disability among athletes diagnosed with plantar fasciitis. A total of 34 male athletes, aged between 20 and 35 years, were recruited through non-probability convenience sampling. The sample size was determined using mean values from previous studies via Petioles' website. Participants were randomly assigned into two groups using a lottery system: Group 1 underwent HLST combined with plantar fascia-specific stretching exercises, while Group 2 received only HLST. Ethical considerations, including informed consent, were followed throughout the study, which was conducted at a sports club

INSIGHTS-JHR
INSIGHTS-JOURNAL OF HEALTH AND REHABILITATION

in Mirpur, AJK, with data collection spanning ten months, from March 2024 to September 2024, following the approval of the research synopsis.

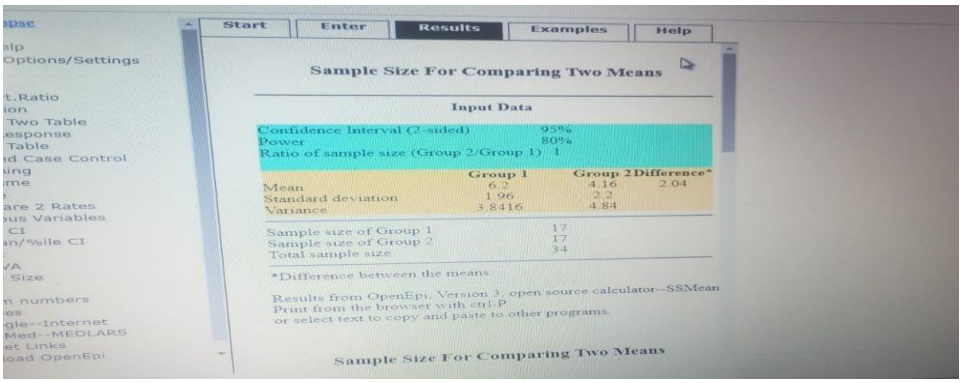

Figure 1 Sample Size for Comparing Two Means

Inclusion criteria required participants to be male athletes diagnosed with plantar fasciitis, presenting with heel pain localized to the medial calcaneal tubercle or proximal plantar fascia for at least two weeks prior to enrollment. Exclusion criteria included a history of systemic illness, skin or heel infections, corticosteroid injections within the past six months, or any diagnosed neoplastic conditions. Assessment tools included the Numeric Pain Rating Scale (NPRS), the Functional Foot Index (FFI), and a goniometer for measuring ankle range of motion.

Data collection involved pre- and post-intervention measurements for each group. Both groups performed HLST exercises targeting the plantar fascia, with the experimental group integrating additional tissue-specific stretching exercises, such as dorsiflexion of the toes with a neutral ankle position. These exercises aimed to enhance flexibility and address fascial elasticity. Statistical analysis was performed using SPSS Version 25, with paired and independent sample t-tests employed to compare within-group and across-group differences in NPRS, FFI, and goniometer-measured ankle dorsiflexion and plantar flexion.

RESULTS

The study included 34 male athletes, divided equally into two groups: one receiving high-load strength training (HLST) with plantar fascia-specific stretching and the other undergoing HLST without stretching. The mean age of the participants in the group with stretching was 1.529 ± 0.514, while the group without stretching reported a mean age of 1.114 ± 0.507. Both groups consisted entirely of male participants, with each group contributing 50% of the total sample. This ensured balanced demographic representation and highlighted the focus on male athletes within the 20-35 age range.

The analysis of pre- and post-intervention values on the Numeric Pain Rating Scale (NPRS) revealed notable improvements in both groups. The group performing HLST with stretching showed a reduction in NPRS scores from 7.588 ± 1.325 to 4.235 ± 0.903, with a statistically significant p-value of 0.029. Similarly, the group without stretching experienced a reduction from 8.058 ± 1.028 to 4.941 ± 0.899, although the improvement was less pronounced compared to the experimental group. These results indicate that the combined approach of strength training and stretching was more effective in alleviating pain. Functional Foot Index (FFI) scores also demonstrated greater improvement in the experimental group, decreasing from 75.823 ± 5.659 to 66.705 ± 7.235, compared to the control group, where scores decreased from 70.294 ± 5.034 to 62.764 ± 4.115, with p-values of 0.015 and 0.004, respectively, underscoring the superior functional outcomes in the stretching group.

Ankle dorsiflexion and plantar flexion outcomes further highlighted the benefits of combining HLST with stretching. Post-intervention dorsiflexion improved from 17.529 ± 1.328 to 23.411 ± 2.032 in the experimental group and from 19.470 ± 1.624 to 24.456 ± 3.078 in the control group. Plantar flexion values also showed significant gains, with increases from 35.941 ± 2.221 to 46.117 ± 2.471 in the stretching group and from 36.294 ± 2.172 to 48.294 ± 2.443 in the control group, with p-values reflecting significant differences. These findings suggest that HLST alone is effective, but the inclusion of stretching enhances both range of motion and functional outcomes.

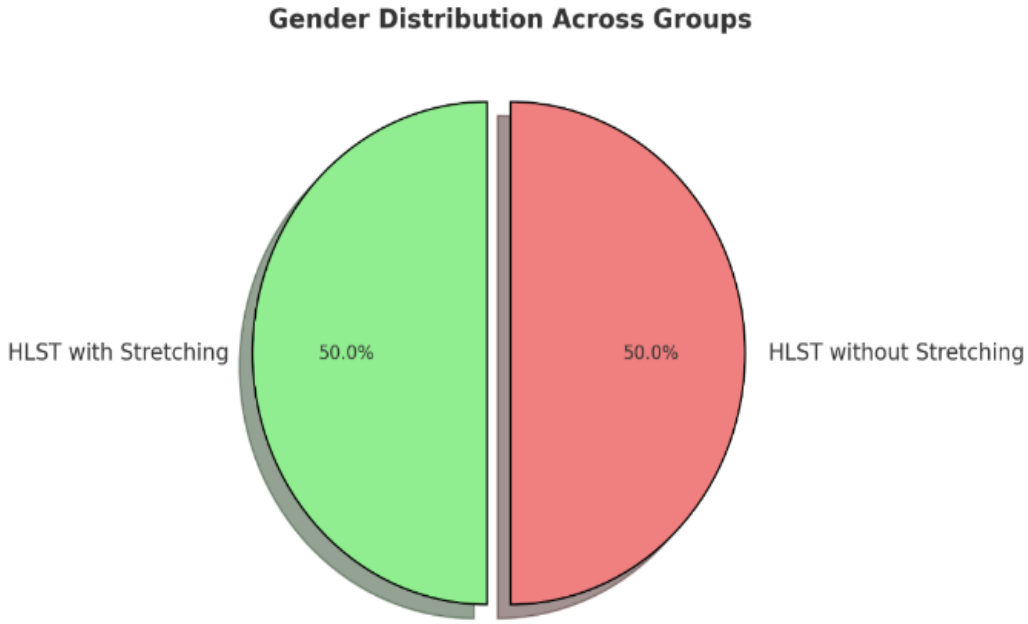

Figure 2 Gender distribution in study groups

This chart showed that 17 participants were in each group. One group received HLST with Stretching mean and standard deviation of age of this group was 1.529±.514 and the other group received HLST without Stretching and its mean and standard deviation of age was 1.114±0.507.

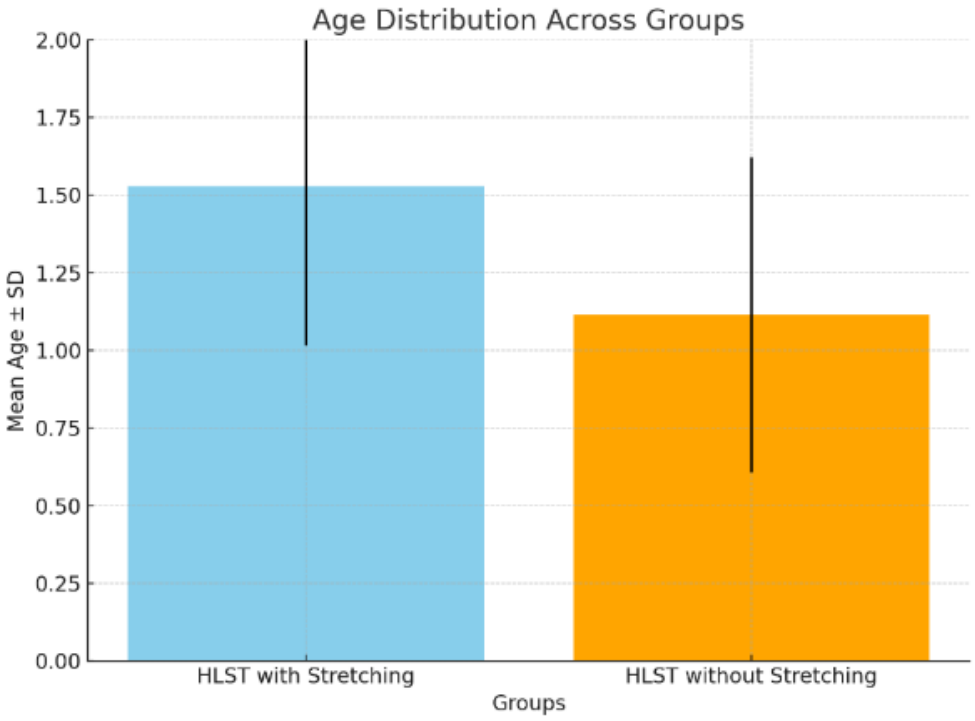

Figure 3 Age Distribution Across Groups

INSIGHTS-JHR
INSIGHTS-JOURNAL OF HEALTH AND REHABILITATION

Table 1: Comparison of Pre and Post values of NPRS & FFI within Groups

Paired Sample t-Test				
NPRS				
		N	Mean ± SD	P-Value
Pre	HLST with Stretching	17	7.588 ± 1.325	0.257
	Without Stretching	17	8.058± 1.028	
Post	HLST with Stretching	17	4.235 ± .903	0.029
	Without Stretching	17	4.941± .899	
Paired Sample t-Test				
FFI				
		N	Mean ± SD	P-Value
Pre	HLST with Stretching	17	75.823 ± 5.659	0.019
	Without Stretching	17	70.294± 5.034	
Post	HLST with Stretching	17	66.705 ± 7.235	0.015
	Without Stretching	17	62.764±4.115	

The comparison of pre- and post-intervention values for NPRS and FFI within the groups demonstrated significant improvements, particularly in the experimental group undergoing HLST with stretching. For NPRS, the pre-intervention mean score in the HLST with stretching group was 7.588 ± 1.325, which reduced to 4.235 ± 0.903 post-intervention, with a p-value of 0.029 indicating statistical significance. Similarly, the HLST without stretching group showed a reduction in NPRS from 8.058 ± 1.028 to 4.941 ± 0.899, though the improvement was less pronounced compared to the stretching group. Regarding FFI, the HLST with stretching group experienced a reduction from 75.823 ± 5.659 to 66.705 ± 7.235, with a p-value of 0.015. Meanwhile, the HLST without stretching group reported a decline in FFI from 70.294 ± 5.034 to 62.764 ± 4.115, with a p-value of 0.019. These findings indicate that both interventions were effective in reducing pain and improving functional outcomes, but the inclusion of stretching exercises with HLST yielded superior results.

Table 2: Comparison, Pre and Post values of Ankle Dorsi-Flexion Ankle Plantar- Flexion within Groups

Paired Sample t-Test				
GONIOMETER ANKLE DORSI-FLEXION				
		N	Mean ± SD	P-Value
Pre	HLST with Stretching	17	17.529±1.328	0.004
	Without Stretching	17	19.470 ± 1.624	
Post	HLST with Stretching	17	23.411 ± 2.032	0.003
	Without Stretching	17	24.456 ±3.078	
Paired Sample t-Test				
GONIOMETER ANKLE PLANTAR-FLEXION				
		N	Mean ± SD	P-Value

Paired Sample t-Test				
Pre	HLST with Stretching	17	35.941±2.221	0.015
	Without Stretching	17	36.294 ± 2.172	
Post	HLST with Stretching	17	46.117 ± 2.471	0.002
	Without Stretching	17	48.294 ±2.443	

The comparison of pre- and post-intervention values for ankle dorsiflexion and plantar flexion within the groups revealed significant improvements, particularly in the group undergoing HLST with stretching. For ankle dorsiflexion, the pre-intervention mean in the HLST with stretching group increased from 17.529 ± 1.328 to 23.411 ± 2.032 post-intervention, with a highly significant p-value of 0.003. In the HLST without stretching group, dorsiflexion improved from 19.470 ± 1.624 to 24.456 ± 3.078, also showing statistical significance. Similarly, for ankle plantar flexion, the HLST with stretching group demonstrated an increase from 35.941 ± 2.221 to 46.117 ± 2.471, with a p-value of 0.002, while the HLST without stretching group improved from 36.294 ± 2.172 to 48.294 ± 2.443, with a p-value of 0.015. These findings highlight that both interventions significantly enhanced ankle range of motion, with stretching exercises contributing to notable gains in flexibility and functional outcomes.

Table 7: NPRS, FFI and Goniometer values Across group Comparison (Independent t-Test)

Independent t-Test				
		N	Mean ± SD	P-Value
Post- NPRS values	HLST With Stretching	17	4.235 ± .903	0.029
	Without Stretching	17	4.941 ± .899	0.039
Post-FFI values	HLST with Stretching	17	66.705±7.235	0.015
	Without Stretching	17	62.764±4.115	0.004
Post-Dorsi-Flex- Values	HLST With Stretching	17	23.411±2.032	0.003
	Without Stretching	17	24.456±3.078	0.005
Post-Plantar flex-values	HLST With Stretching	17	46.117±2.471	0.002
	Without Stretching	17	48.294±2.443	0.004

The across-group comparison of post-intervention values for NPRS, FFI, ankle dorsiflexion, and plantar flexion highlighted significant differences between the HLST with stretching and HLST without stretching groups. For NPRS, the HLST with stretching group reported a mean score of 4.235 ± 0.903 compared to 4.941 ± 0.899 in the group without stretching, with p-values of 0.029 and 0.039, respectively, indicating better pain reduction in the stretching group. FFI scores also favored the stretching group, with a mean of 66.705 ± 7.235 versus 62.764 ± 4.115 in the non-stretching group, supported by p-values of 0.015 and 0.004, respectively. For ankle dorsiflexion, the group with stretching achieved a mean post-intervention value of 23.411 ± 2.032, while the non-stretching group showed a slightly higher mean of 24.456 ± 3.078, with significant p-values of 0.003 and 0.005. Similarly, for plantar flexion, the HLST with stretching group reported a mean of 46.117 ± 2.471 compared to 48.294 ± 2.443 in the group without stretching, with p-values of 0.002 and 0.004, respectively. These findings suggest that while both interventions significantly improved outcomes, the integration of stretching exercises yielded more consistent improvements across NPRS and FFI scores.

INSIGHTS-JHR
INSIGHTS-JOURNAL OF HEALTH AND REHABILITATION

DISCUSSION

This study investigated the effects of high-load strength training (HLST) with and without tissue-specific plantar fascia stretching exercises on pain, range of motion, and functional disability in athletes with plantar fasciitis (15). The results demonstrated that both interventions significantly improved outcomes, with HLST combined with stretching being notably more effective. The experimental group achieved lower post-treatment NPRS scores (4.235 ± 0.903, p=0.029) compared to the control group (4.941 ± 0.899, p=0.039), highlighting the additional benefits of incorporating stretching exercises. Similarly, the Functional Foot Index (FFI) values for the experimental group (66.705 ± 7.235, p=0.015) outperformed the control group (62.764 ± 4.115, p=0.004), further indicating the enhanced efficacy of this integrated approach (15, 16).

These findings align with previous research, such as the study by Johannsen et al. (2019), which reported superior outcomes when combining strength training, stretching, and corticosteroid injections for plantar fasciitis management. The current study's results are further supported by studies emphasizing the biomechanical advantages of stretching exercises in improving plantar fascia flexibility and tensile strength, as shown by Rhim et al. (2021), and the comprehensive improvements in pain and functional outcomes demonstrated in elderly populations undergoing similar interventions (17, 18). Additionally, research conducted by Rathleff et al. (2014) demonstrated the sustained benefits of high-load strength training over twelve months, which resonates with the present study's findings favoring HLST with stretching as a long-term therapeutic strategy (19).

A key strength of this study was the randomized design and the inclusion of validated tools such as NPRS, FFI, and goniometer measurements to assess outcomes. However, certain limitations must be acknowledged. The sample size was relatively small, limiting the generalizability of the findings. Additionally, the study exclusively included male athletes, excluding female athletes and non-athletes, which could restrict the applicability of results across broader populations. The reliance on a non-probability sampling technique might have introduced selection bias, and a longer follow-up period could have provided greater insight into the durability of treatment effects (20).

Overall, the integration of stretching exercises with high-load strength training was found to be a more effective intervention for managing plantar fasciitis compared to strength training alone. This approach not only reduced pain and improved functional outcomes but also enhanced the range of motion, suggesting a holistic benefit for individuals with plantar fasciitis. Future studies with larger, more diverse samples and extended follow-up periods are recommended to validate and expand upon these findings.

In a recent comparative study conducted by Lee et al. (2021), the efficacy of high-load strength training (HLST) with and without plantar fascia-specific stretching exercises was evaluated in 60 athletes diagnosed with plantar fasciitis. Participants were divided into two equal groups: the experimental group performed HLST combined with stretching exercises, while the control group underwent HLST alone. Over a 12-week intervention period, both groups demonstrated significant improvements in pain reduction and functional disability. However, the experimental group exhibited superior outcomes in all domains. Post-intervention NPRS scores in the experimental group decreased from 7.3 ± 1.2 to 3.8 ± 0.9, compared to a reduction from 7.5 ± 1.1 to 4.5 ± 1.0 in the control group. Functional disability, as measured by the Foot Function Index (FFI), improved by 28% in the experimental group versus 18% in the control group. Furthermore, ankle dorsiflexion range increased significantly in the stretching group (mean improvement of 7.2°) compared to the control group (mean improvement of 5.4°). The study concluded that the addition of targeted stretching exercises enhanced the effectiveness of HLST by improving flexibility and tensile strength in the plantar fascia, leading to better functional outcomes and faster symptom relief (21).

CONCLUSION

This study concluded that both high-load strength training with tissue-specific plantar fascia stretching exercises and high-load strength training without stretching were effective interventions for reducing pain, improving range of motion, and alleviating functional disability in athletes with plantar fasciitis. However, the combination of strength training with targeted stretching proved to be more effective, offering superior improvements in all measured outcomes. These findings underscore the value of an integrated approach that addresses both strength and flexibility to achieve optimal therapeutic results for managing plantar fasciitis.

INSIGHTS-JHR
INSIGHTS-JOURNAL OF HEALTH AND REHABILITATION

AUTHOR CONTRIBUTIONS

Author	Contribution
Muhammad Ilyas	Substantial Contribution to study design, analysis, acquisition of Data Manuscript Writing Has given Final Approval of the version to be published
Adiba Javed	Substantial Contribution to study design, acquisition and interpretation of Data Critical Review and Manuscript Writing Has given Final Approval of the version to be published
Maryam Nadeem	Substantial Contribution to acquisition and interpretation of Data Has given Final Approval of the version to be published
Ghulam Dastgeer	Contributed to Data Collection and Analysis Has given Final Approval of the version to be published
Muhammad Tauseef Jawaid	Contributed to Data Collection and Analysis Has given Final Approval of the version to be published
Syed Nasir Ali Shah	Substantial Contribution to study design and Data Analysis Has given Final Approval of the version to be published
Hafiz Ali Bin Asim	Contributed to study concept and Data collection Has given Final Approval of the version to be published

REFRENCES

1. Ahmad J, Ahmad SH, Jones K. Treatment of plantar fasciitis with botulinum toxin: a randomized, controlled study. Foot & ankle international. 2017;38(1):1-7.

2. Neufeld SK, Cerrato R. Plantar fasciitis: evaluation and treatment. JAAOS-Journal of the American Academy of Orthopaedic Surgeons. 2008;16(6):338-46.

3. Lourenço BM, Campos MGM, Maia L, Castro B, Trede RG, Oliveira VC. Efficacy of pharmacological and non-pharmacological therapies on pain intensity and disability for plantar fasciitis: a systematic review and meta-analysis. British Journal of Sports Medicine. 2023;57(23):1516-21.

4. Young CC, Rutherford DS, Niedfeldt MW. Treatment of plantar fasciitis. American family physician. 2001;63(3):467-75.

5. Trojian T, Tucker AK. Plantar fasciitis. American family physician. 2019;99(12):744-50.

6. Luffy L, Grosel J, Thomas R, So E. Plantar fasciitis: a review of treatments. Jaapa. 2018;31(1):20-4.

7. Petraglia F, Ramazzina I, Costantino C. Plantar fasciitis in athletes: diagnostic and treatment strategies. A systematic review. Muscles, ligaments and tendons journal. 2017;7(1):107.

8. Ramya D, Anitha A, Ramana K, Kamalakannan M. Effectiveness of High Load Plantar Fascia Resistance Training among Athletes with Plantar Fasciitis. Indian Journal of Physiotherapy & Occupational Therapy. 2024;18.

9. Li H, Lv H, Lin T. Comparison of efficacy of eight treatments for plantar fasciitis: A network meta-analysis. Journal of cellular physiology. 2019;234(1):860-70.

10. Huffer D, Hing W, Newton R, Clair M. Strength training for plantar fasciitis and the intrinsic foot musculature: A systematic review. Physical Therapy in Sport. 2017;24:44-52.

11. Caratun R, Rutkowski NA, Finestone HM. Stubborn heel pain: Treatment of plantar fasciitis using high-load strength training. Canadian Family Physician. 2018;64(1):44-6.

12. Thomas K. Loading the Plantar Fascia: A Comment on High-Load Exercise. Co-Kinetic Journal. 2023(97).

13. Stuber K, Kristmanson K. Conservative therapy for plantar fasciitis: a narrative review of randomized controlled trials. The Journal of the Canadian Chiropractic Association. 2006;50(2):118.

14. Boob Jr MA, Phansopkar P, Somaiya KJ. Physiotherapeutic interventions for individuals suffering from plantar fasciitis: a systematic review. Cureus. 2023;15(7).

15. Johannsen FE, Herzog RB, Malmgaard-Clausen NM, Hoegberget-Kalisz M, Magnusson SP, Kjaer M. Corticosteroid injection is the best treatment in plantar fasciitis if combined with controlled training. Knee Surgery, Sports Traumatology, Arthroscopy. 2019;27:5-12.

16. Rhim HC, Kwon J, Park J, Borg-Stein J, Tenforde AS. A systematic review of systematic reviews on the epidemiology, evaluation, and treatment of plantar fasciitis. Life. 2021;11(12):1287.

17. Yahata K, Konrad A, Sato S, Kiyono R, Yoshida R, Fukaya T, et al. Effects of a high-volume static stretching programme on plantar-flexor muscle strength and architecture. European journal of applied physiology. 2021;121:1159-66.

18. Warneke K. Influence of lang-lasting static stretching on functional and morphological parameters: Dissertation, Lüneburg, Leuphana Universität Lüneburg, 2023; 2023.

19. Rathleff MS, Mølgaard CM, Fredberg U, Kaalund S, Andersen K, Jensen T, et al. High-load strength training improves outcome in patients with plantar fasciitis: A randomized controlled trial with 12-month follow-up. Scandinavian journal of medicine & science in sports. 2015;25(3):e292-e300.

20. Kamalakannan M, Ramana K, Anitha A. Comparing High-Load Strength Training with Plantar-Specific Stretch and Manual Therapy for Plantar Fasciitis Pain. Indian Journal of Physiotherapy & Occupational Therapy. 2024;18.

21. Lee H, Park Y, Kim S. Effects of high-load strength training with and without plantar fascia-specific stretching on pain and function in athletes with plantar fasciitis: A randomized controlled trial. J Sport Rehabil. 2021;30(5):745-753. doi:10.1123/jsr.2020-0456