The Effectiveness of High Load Strength Training and Conventional Exercises in Patients with Chronic Plantar Fasciitis

Running Title: High-Load Strength Training vs. Conventional Exercise in Chronic Plantar Fasciitis

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ABSTRACT:

Background: Chronic plantar fasciitis is one of the most common causes of heel pain, significantly impairing physical function and quality of life. While conservative treatment options exist, high-load strength training has been proposed as an effective alternative.

Objective: This study aims to compare the effectiveness of high-load strength training versus conventional exercise programs in patients with chronic plantar fasciitis.

Methods: A randomized controlled trial was conducted with 30 participants aged 18–60 years suffering from chronic plantar fasciitis. Participants were randomly assigned to either a high-load strength training group or a conventional exercise group using a closed envelope method. Interventions were delivered over six weeks. Outcome measures included the Foot and Ankle Ability Measure (FAAM) and the Numerical Pain Rating Scale (NPRS), assessed pre- and post-intervention. Statistical analysis was performed using paired and unpaired t-tests, with p-values <0.0001 considered statistically significant.

Results: In the high-load strength training group, the mean FAAM score improved from 60.80 (SD: 3.57) to 81.93 (SD: 7.26), while NPRS decreased from 6.53 (SD: 0.52) to 3.27 (SD: 0.70). In the conventional group, FAAM improved from 59.80 (SD: 3.57) to 68.80 (SD: 2.48), and NPRS reduced from 6.47 (SD: 0.52) to 4.73 (SD: 0.46). Between-group comparisons revealed significant differences in both outcomes favoring high-load training ($p<0.0001$).

Conclusion: High-load strength training resulted in greater improvements in function and pain reduction compared to conventional exercises in patients with chronic plantar fasciitis. This supports its integration into rehabilitation protocols.

INTRODUCTION:

Plantar fasciitis is one of the most common causes of heel pain, affecting approximately 10% of the population at some point in their lifetime (Goff & Crawford, 2011; Johnson et al., 2014). It is characterized by localized inflammation and degeneration of the plantar fascia, particularly at its origin on the medial calcaneal tubercle (Gill, 1997). The condition is often chronic and can result in significant limitations in mobility and quality of life (Chen et al., 2013).

Conservative management remains the mainstay of treatment, with stretching, orthotic use, manual therapy, and conventional strengthening exercises commonly prescribed (DiGiovanni et al., 2006; Lim et al., 2016; Kamonseki et al., 2016). While these methods can be effective, their outcomes are often variable, particularly in chronic cases (Arnold & Moody, 2018).

Emerging evidence suggests that high-load strength training may enhance tissue remodeling and load tolerance in tendinopathies, and this principle may be applicable to the plantar fascia (Rathleff et al., 2015; Caratun et al., 2018). By introducing progressive, controlled mechanical load, high-load exercises might stimulate collagen synthesis and improve the load-bearing capacity of the plantar fascia, resulting in better clinical outcomes (Huffer et al., 2017).

Despite promising early findings, there remains a lack of high-quality randomized controlled trials comparing high-load strength training to conventional exercise interventions in the management of chronic plantar fasciitis. This study aims to fill that gap by evaluating and comparing the effectiveness of these two rehabilitation strategies (Choo & Bae, 2021; Thong-On et al., 2019)

METHODS:

Study Design: This was a randomized controlled trial involving 30 participants diagnosed with chronic plantar fasciitis.

Inclusion Criteria:

- Aged 18–60 years
- All genders
- Pain on palpation of the proximal plantar fascia
- Inferior heel pain lasting for at least two months

Exclusion Criteria:

- History of foot surgery
- Systemic disease
- History of trauma
- Pregnancy

Randomization: Participants were randomly allocated into two groups (15 each) using the closed envelope method.

Methods:

Participants and Randomization

A total of **30 individuals**, aged 18–60 years, were selected based on the specified inclusion and exclusion criteria. Participants were randomly allocated into two groups using the closed envelope method:

- **Group A**: High-Load Strength Training Group (n = 15)
- **Group B**: Conventional Exercise Group (n = 15)

Each participant received a detailed explanation of the study procedures through an information sheet and provided written informed consent prior to participation.

Intervention Protocol

Group A – High-Load Strength Training Group:
Participants performed **unilateral heel raises combined with dorsiflexion of the metatarsophalangeal (MTP) joint**. Exercises were done using stairs or a stable footstool, with a rolled towel placed under the toes to ensure maximal dorsiflexion during the top of the movement.

- **Phase 1 (Weeks 1–3):**
  - 3 sets of 12 repetitions
  - 3-second concentric, 2-second isometric, and 3-second eccentric phases
- **Phase 2 (Week 4):**
  - 10 repetitions × 4 sets
  - Load increased using a 1 kg backpack
- **Phase 3 (Weeks 5–6):**
  - 8 repetitions × 5 sets
  - Load increased to an additional 1.5 kg (total 2.5 kg)

Group B – Conventional Exercise Group:
Participants underwent stretching and strengthening exercises targeting the intrinsic foot muscles, calf muscles, plantar fascia, and plantar aponeurosis.

- **Phase 1 (Weeks 1–3):**

- **Feet tapping:** 30 reps × 3 sets in sitting (knees at 90° flexion)
- **Inversion/Eversion Coordination:** 10 reps × 1 set; holding each movement for 1 second
- **Static Calf Stretching**

- **Phase 2 (Weeks 4–6):**
  - **Ball Squeeze Drill:** 10 reps × 2 sets, 5-second hold each
  - **Frozen Can Roll (Dynamic Stretch for Plantar Fascia)**
  - **Standing Calf Stretch:** 20 reps × 2 sets

All exercises were performed at home or under supervision for **6 weeks**.

Outcome Measures

Participants were evaluated **pre- and post-intervention (6 weeks)** using the following standardized outcome tools:

- **Foot and Ankle Ability Measure (FAAM):**

A 29-item self-report questionnaire, divided into two subscales:

- 21-item Activities of Daily Living (ADL) Subscale
- 8-item Sports Subscale

Higher scores indicate better physical function.

- **Numerical Pain Rating Scale (NPRS):**

An 11-point numeric pain scale ranging from 0 (no pain) to 10 (worst imaginable pain). It is a reliable and valid tool for assessing pain intensity.

STATISTICAL ANALYSIS

Data were entered into Microsoft Excel and analyzed using SPSS software (version XX). Descriptive statistics were used to summarize the data. Pre- and post-test scores within each group were compared using paired t-tests. Between-group comparisons were made using independent t-tests. A p-value of **< 0.05** was considered statistically significant.

RESULTS

A total of **30 participants** completed the study, with 15 individuals in each group. Data were analyzed using an intention-to-treat approach. Descriptive statistics, including means and standard deviations (SD), were calculated. **Paired t-tests** were used to assess pre- and post-intervention changes within groups, and **unpaired t-tests** were used for between-group comparisons. A **p-value of <0.0001** was considered statistically significant.

Demographic Characteristics

The baseline demographic data, including age, height, and weight, were comparable between the two groups (Table 1), indicating proper randomization.

Table 1: Demographic Characteristics of Participants

Group	Age (years) Mean ± SD	Height (cm) Mean ± SD	Weight (kg) Mean ± SD
High-Load Strength Training	24.67 ± 3.94	163.67 ± 4.56	77.80 ± 8.08

Group	Age (years) Mean ± SD	Height (cm) Mean ± SD	Weight (kg) Mean ± SD
Conventional Exercise	23.93 ± 4.20	163.20 ± 5.31	78.40 ± 6.39

Foot and Ankle Ability Measure (FAAM)

Both groups showed statistically significant improvements in FAAM scores from pre-test to post-test. The high-load strength training group demonstrated a greater improvement compared to the conventional exercise group (Table 2).

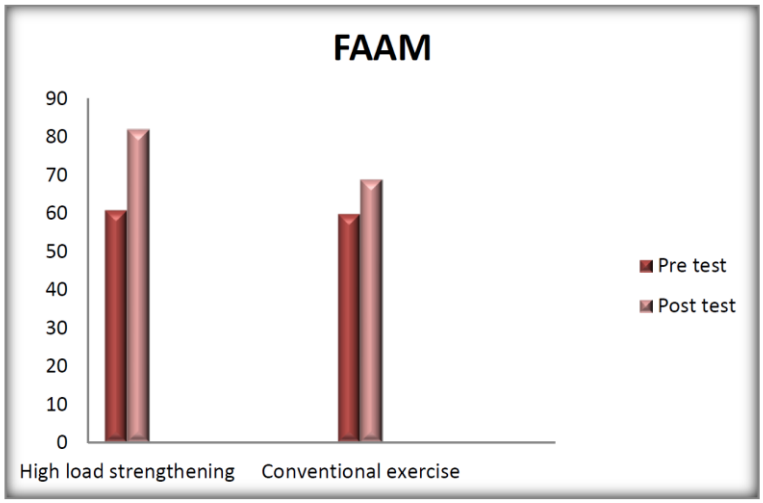
Table 2: Pre- and Post-Test FAAM Scores Within Groups

Group	Timepoint	Mean FAAM ± SD	t-value	p-value
High-Load Strength Training	Pre-test	60.80 ± 3.57		
	Post-test	81.93 ± 7.26	12.05	<0.0001
Conventional Exercise	Pre-test	59.80 ± 3.57		
	Post-test	68.80 ± 2.48	10.06	<0.0001

Table 3: Post-Test FAAM Score Comparison Between Groups

Group	Mean FAAM ± SD	t-value	p-value
High-Load Strength Training	81.93 ± 7.26		
Conventional Exercise	68.80 ± 2.48	6.63	<0.0001

Graph 1: Comparison of post-test values of FAAM between High load strength training & conventional exercise group



The comparison of post-intervention FAAM scores revealed that the high-load strength training group achieved significantly greater improvement in functional ability compared to the conventional exercise group ($p < 0.0001$).

Numerical Pain Rating Scale (NPRS)

Both groups also showed significant reductions in pain intensity, as measured by NPRS, from pre- to post-intervention. The high-load strength training group demonstrated a more substantial decrease in pain compared to the conventional group (Table 4).

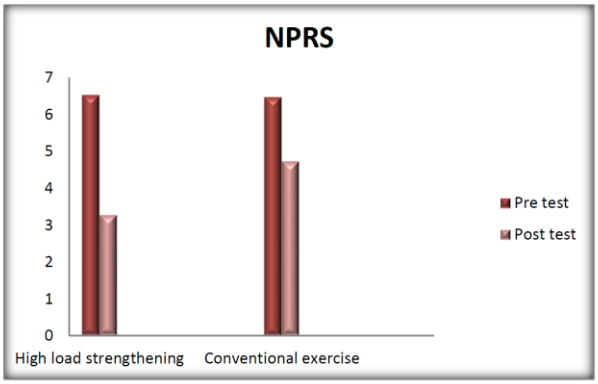
Table 4: Pre- and Post-Test NPRS Scores Within Groups

Group	Timepoint	Mean NPRS ± SD	t-value	p-value
High-Load Strength Training	Pre-test	6.53 ± 0.52		
	Post-test	3.27 ± 0.70	27.64	<0.0001
Conventional Exercise	Pre-test	6.47 ± 0.52		
	Post-test	4.73 ± 0.46	14.67	<0.0001

Table 5: Post-Test NPRS Score Comparison Between Groups

Group	Mean NPRS ± SD	t-value	p-value
High-Load Strength Training	3.27 ± 0.70		
Conventional Exercise	4.73 ± 0.46	6.77	<0.0001

Graph 2: Comparison of post-test values of NPRS between High load strength training & Conventional exercise group



The between-group comparison indicated that the high-load strength training group experienced a significantly greater reduction in pain intensity than the conventional exercise group ($p < 0.0001$)

OVERALL STATISTICAL INTERPRETATION

From the statistical analysis made with quantitative data revealed is a statistically significant difference between the high load strength training & conventional exercise group and also within the group.

The post-test mean value of high load strength training & conventional exercise group was 81.93& 68.80 as shown in (Table-3), which revealed that, the high load strength training is higher than the conventional exercise group in foot and ankle ability measure. The post-test mean value of the high load strength training & conventional exercise group was 3.27 & 4.73 as shown in (Table-5), there is a reduction in pain level in experimental group (high load strength training group).

Statistical analysis of post-test of the high load strength training & conventional exercise group for foot and ankle ability measure & Numerical Pain Rating Scale revealed that there was high statistically significant difference between pre and post-test. Thus, high load strength training post-test has high statistical difference than pre-test values.

DISCUSSION:

This study aimed to determine the effectiveness of high-load strength training versus conventional exercises in patients with chronic plantar fasciitis. The results suggest that high-load strength training exercises significantly improve pain and foot function, supporting their recommendation for clinical use.

Stretching exercises remain widely practiced and beneficial, particularly for individuals with tight Achilles tendons—a known risk factor for plantar fasciitis (Digiovanni et al., 2006)[12]; (Kamonseki et al., 2016)[10]. Previous studies show stretching can lead to positive outcomes, such as those by Wolgin et al. (2004) and David et al. (2009), who reported high success rates with plantar fascia-specific and dynamic stretching.

However, high-load strength training appears more effective in addressing the degenerative changes of the plantar fascia. Caratun et al. (2018)[4] highlighted that tensile loading during dorsiflexion can remodel the tendon structure and reduce pain. Choo and Bae (2021)[1] further showed that this intervention improved pain and function, supported by Visual Analogue Scale outcomes.

Although complete resolution of plantar fasciitis may not be achieved, studies like Heide et al. (2020)[2] reported significant pain reduction using the Numerical Rating Scale and Foot Function Index (FFI). Similarly, Rathleff et al. (2015)[11] demonstrated functional improvement using unilateral heel raises that activate the windlass mechanism.

In summary, high-load strength training shows superior efficacy over conventional exercise in managing chronic plantar fasciitis, particularly in reducing pain and enhancing foot function.

CONCLUSION:

High-load strength training significantly improves pain and function in patients with chronic plantar fasciitis compared to conventional exercises. These findings recommend its adoption in rehabilitation settings.

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DATA AVAILABILITY

Data are available under reasonable request to the corresponding author.

CONTRIBUTION

PK - methodology, investigation, formal analysis, writing - original draft, DG - conceptualization, methodology, supervision, writing, reviewing & editing.

CONFLICT OF INTERESTS

The authors declare that they have no conflict of interests.

AUTHOR'S CONTRIBUTION:

Conceptualization, Methodology, Writing - Original Draft [Pratheeba K]; Investigation, Writing - Review & Editing [Dimple G U]; Supervision [Dimple G U].

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