EFFICACY OF TARGETED HIP ABDUCTOR MUSCLE STRENGTHENING IN COLLEGIATE RUNNERS WITH ILIOTIBIAL BAND SYNDROME: A PILOT QUASI-EXPERIMENTAL STUDY

Dhana Balaji[1], Mohanraj[2*], Karthikeyan[3], and Kadiervel[4]

Received: August 26, 2025; Revised: September 25, 2025; Accepted: October 07, 2025

Abstract

Iliotibial Band Syndrome (ITBS) is a common overuse injury among collegiate runners, and hip abductor weakness is frequently considered a contributing factor. Although hip abductor strengthening has shown potential benefits in the management of ITBS, evidence regarding its effects on functional performance in collegiate runners remains limited. This pilot study aimed to evaluate the effectiveness of a hip abductor strengthening protocol on functional performance in collegiate male runners with ITBS using a quasi-experimental pre-test–post-test design. Thirty male collegiate runners (mean age 20.3 ± 1.8 years) with clinically confirmed ITBS were recruited through convenience sampling from a single institution. All participants completed a standardized progressive 4-week hip abductor strengthening program consisting of side-lying hip abduction, clamshell exercises, lateral band walks, and single-leg squats under physiotherapist supervision. Functional performance was assessed at baseline and after the intervention using the 20-Yard Shuttle Test (20YST). Significant improvements in functional performance were observed following the intervention. The mean 20YST time decreased from 6.36 ± 0.165 seconds (95% CI: 6.30–6.42) to 5.52 ± 0.104 seconds (95% CI: 5.48–5.56), with a mean difference of 0.84 seconds (95% CI: 0.77–0.91; t = 25.98, p < 0.001; Cohen's d = 0.82, indicating a large effect size). All participants exceeded the minimal detectable change threshold of 0.31 seconds, indicating clinically meaningful improvement. This pilot study provides preliminary evidence supporting the effectiveness of standardized hip abductor strengthening for improving short-term functional performance among collegiate runners with ITBS. The large effect size and observed improvements suggest that this intervention may have therapeutic value in this population.

Keywords: **Collegiate Athletics; Functional Performance; Hip Abductor Strengthening; Iliotibial Band Syndrome; Overuse Injury; Pilot Study**

School of Physiotherapy, Vinayaka Mission's Research Foundation-DU, Vinayaka Mission Puducherry campus, Kirumampakkam, Puducherry. E-mail: anynalab19@gmail.com, ORCID: 0009-0002-8625-0758; mohanraj.gopalakrishnan@avmc.edu.in, ORCID: 0009-0001-2474-2880; karthikeyanmpt13@gmail.com, ORCID: 0009-0001-2317-1465; levvel598@gmail.com, ORCID: 0000-0002-5100-2159*

[*] *Corresponding author*

DOI: https://doi.org/10.55766/sujst11248

Suranaree J. Sci. Technol. 33(2):070103(1-8)

Introduction

Iliotibial Band Syndrome (ITBS) constitutes one of the most prevalent overuse injuries among running populations, accounting for approximately 12-15% of all running-related injuries and representing the leading cause of lateral knee pain in endurance athletes shown in Figure 1. (Baker and Fredericson, 2016; Decker and Hunt, 2018; Wiegand *et al*., 2019) The syndrome's etiology has evolved from traditional friction-based models to contemporary understanding emphasizing proximal biomechanical dysfunction, particularly weakness of the hip abductor musculature (Hutchinson *et al*., 2022; Foch *et al*., 2023; Fredericson and Wolf, 2005).

Hip abductor weakness creates a biomechanical cascade characterized by excessive hip adduction, dynamic knee valgus, and altered lower extremity kinematics during running, thereby predisposing athletes to ITBS development and perpetuation. Collegiate runners represent a particularly vulnerable population due to high training volumes, competitive demands, and developmental factors affecting neuromuscular control patterns (Kim *et al*., 2019; Shen *et al*., 2019).

Evidence-based rehabilitation approaches increasingly emphasize proximal strengthening strategies targeting hip abductor musculature as both preventive and therapeutic interventions (McKay *et al*., 2020). However, existing literature demonstrates heterogeneous methodological approaches, limited outcome measure standardization, and insufficient attention to collegiate athletic populations, creating gaps in clinical evidence and practice recommendations (Buttinger *et al*., 2024).

Validated Outcome Measures for ITBS Research

The selection of appropriate outcome measures is critical for establishing intervention effectiveness in ITBS research. The 20-Yard Shuttle Test (20YST) represents a validated, reliable, and sport-specific functional outcome measure demonstrating excellent psychometric properties for athletic populations. Eriksson *et al*. (2015) established excellent test-retest reliability, both within the same day (ICC = 0.95) and between days (ICC = 0.91), alongside criterion-related validity (ICC = 0.99) when compared to digital timing systems in competitive athletes (Eriksson *et al*., 2015).

The 20YST's multidirectional movement pattern closely mimics the agility demands of running sports, making it particularly relevant for assessing functional improvements in runners with ITBS. The test's validity is further supported by its ability to detect meaningful changes in neuromuscular control and movement efficiency-key factors affected by hip abductor weakness in ITBS populations (Imeri and Gheitasi, 2020).

Given the limited evidence base regarding standardized hip abductor strengthening protocols in collegiate runners with ITBS, pilot investigation is warranted to establish preliminary effectiveness data, refine intervention protocols, and inform future adequately powered randomized controlled trials. Therefore, this pilot study aims to evaluate the short-term effectiveness of a standardized 4-week hip abductor strengthening protocol on functional performance in collegiate male runners with ITBS.

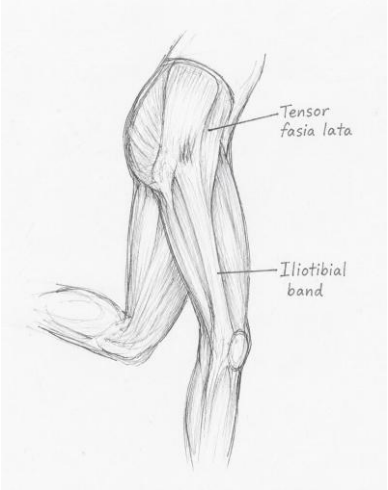


Figure 1. IT Band syndrome

Materials and Methods

Study Design and Ethical Considerations

This investigation employed a pilot quasi-experimental pre-test post-test design to evaluate the preliminary effectiveness of standardized hip abductor strengthening on functional performance outcomes. The quasi-experimental design was selected as appropriate given the pilot nature of this investigation, absence of randomization, and single-cohort evaluation framework. The study was conducted in accordance with the Declaration of Helsinki and received ethical approval from the institutional review board. All participants provided written informed consent prior to enrollment.

Setting and Recruitment

The study was conducted at the School of Physiotherapy, Vinayaka Mission's Research Foundation, Puducherry campus, India, from January to March 2024. Participants were recruited through convenience sampling from the university's collegiate athletic programs and affiliated running clubs.

Participants and Sample Size Justification

As a pilot study, formal power calculation was not performed. The sample size of 30 participants was selected based on established guidelines for pilot feasibility studies in physiotherapy research, providing adequate data for preliminary effectiveness assessment and future trial planning while maintaining practical feasibility within resource constraints.

Inclusion criteria were:
(1) Male collegiate runners aged 18-25 years
(2) Active participation in competitive or recreational running (minimum 20 km/week)
(3) Clinical diagnosis of unilateral ITBS confirmed by qualified physiotherapist
(4) Symptom duration ≥ 4 weeks but ≤ 6 months
(5) Pain intensity ≥ 3-5/10 on Numeric Rating Scale during running activities

Exclusion criteria:
(1) Previous knee surgery or significant lower extremity trauma
(2) Current or recent (≤3 months) physical therapy for ITBS
(3) Concurrent lower extremity musculoskeletal injuries
(4) Systemic inflammatory conditions or neurological disorders
(5) Current use of anti-inflammatory medications or corticosteroids
(6) Inability to commit to complete intervention protocol

Intervention Protocol - Standardized Hip Abductor Strengthening Program

All participants underwent a standardized, progressive 4-week hip abductor strengthening protocol designed according to current evidence-based principles and delivered under direct physiotherapist supervision.

Program Structure:
Duration: 4 weeks
Frequency: 3 sessions per week (Monday, Wednesday, Friday)
Session Duration: 45-60 min
Supervision: Direct supervision by licensed physiotherapist with musculoskeletal specialization
Equipment: Therabands (light to medium resistance), ankle weights (1-2 kg), exercise mats.

Week 1-2 (Foundation Phase):
Light Resistance Theraband used
- Side-lying hip abduction
- Clamshells
- Lateral band walks
- Single-leg squats

Progression: Day 1-3: 2 sets × 10 repetitions → Day 4-6: 3 sets × 12 repetitions
Rest: 60 sec between sets

Week 3-4 (Strengthening Phase):
Medium Resistance Theraband and Ankle weights (1-2 kg based on individual tolerance) were used.
- Side-lying hip abduction
- Clamshells
- Lateral band walks
- Single-leg squats

Progression: Day 1-3: 3 sets × 12 repetitions → Day 4-6: 3 sets × 15 repetitions
Rest: 60 sec between sets

Progression Criteria:
- Advancement to next level when participant completed all sets/repetitions with proper form
- Pain levels maintained ≤3/10 during exercises
- No adverse events or symptom exacerbation
- Individual modifications applied based on participant tolerance and physiotherapist clinical judgment

Primary Outcome Measure

20-Yard Shuttle Test (20YST) - Validated Functional Performance Assessment:

The 20YST was selected as the primary outcome measure based on established validity and reliability for athletic populations, particularly its relevance to ITBS-related functional deficits.

Validation Evidence:
Test-retest reliability: ICC = 0.95 (within-day), ICC = 0.91 (between-day)
Inter-rater reliability: ICC = 0.99
Criterion-related validity: ICC = 0.99 compared to digital timing systems

Clinical relevance: Multidirectional movement patterns challenge hip abductor stabilization function during dynamic activities similar to running demands.

Test Protocol:
Course Setup: Three parallel lines 5 yards apart (total 10-yard distance)
Equipment: Digital timing system with manual stopwatch backup, traffic cones, non-slip indoor surface
Instructions: Start at center line in athletic stance, sprint to right line and touch with hand, immediately sprint to left line and touch with hand, return to center line
Timing: Electronic timing gates positioned at center line, activated by participant movement
Trials: Three trials with a 3-minute rest between attempts to prevent fatigue effects
Scoring: Best time recorded to the nearest 0.01 sec

Test Administration Standardization:
Warm-up protocol: Standardized 10-minute dynamic warm-up (light jogging, leg swings, lunges)
Assessor training: Single trained assessor conducted all testing to minimize inter-rater variability
Post-intervention blinding: Assessor blinded to intervention phase in order to reduce measurement bias.

Clinical Significance Assessment: Minimal Detectable Change (MDC) threshold established using the formula: MDC = $1.96 \times \sqrt{2} \times SEM$, where $SEM = SD \times \sqrt{(1-ICC)}$

Clinical Significance Criteria:
MDC95 calculation: Based on test-retest reliability data (ICC = 0.95) and baseline standard deviation
Individual response analysis: Percentage of participants exceeding MDC threshold
Confidence Interval Interpretation: Assessment of clinical meaningfulness based on CI boundaries relative to MDC values

Results

Participant Characteristics and Compliance

Thirty male collegiate runners completed the 4-week intervention protocol with 100% adherence and no adverse events reported. All participants met inclusion criteria and completed both pre- and post-intervention assessments. Baseline characteristics are presented in Table 1.

Table 1. Participant Baseline Characteristics (N=30)

Characteristic	Mean±SD	95% CI	Range
Age (years)	20.3±1.8	19.6-21.0	18-24
Height (cm)	172.5±6.2	170.2-174.8	165-185
Weight (kg)	65.8±7.4	63.0-68.6	55-82
BMI (kg/m^2)	22.1±2.3	21.2-23.0	18.5-26.8
Running experience (years)	4.2±2.1	3.4-5.0	2-9
Weekly running distance (km)	35.6±12.4	31.0-40.2	20-65
ITBS symptom duration (weeks)	8.3±3.2	7.1-9.5	4-16

Statistical Analysis
Statistical analysis was performed using SPSS version 26.0 with significance level set at $\alpha = 0.05$.

Descriptive Statistics:
- Participant characteristics presented as mean ± standard deviation for continuous variables.
- Normality assessed via Shapiro-Wilk test and visual inspection of histograms.
- Outlier analysis performed using box plots and z-scores (±2.5 standard deviations).

Inferential Statistics:
Primary Analysis: Paired t-test for pre-post intervention 20YST comparison
Effect Size: Cohen's d with established interpretation thresholds (0.2 = small, 0.5 = medium, 0.8 = large)
Confidence Intervals: 95% confidence intervals calculated for all point estimates providing precision information for clinical decision-making

Primary Outcome Results with Statistical and Clinical Significance

Significant improvements in functional performance were observed following the 4-week hip abductor strengthening intervention, with all participants demonstrating clinically meaningful improvements. The pre and post intervention data of 20-Yard Shuttle Test scores along with mean difference, t value, and P value are mentioned in Table 2.

Clinical Significance Analysis:

The mean improvement of 0.84 sec substantially exceeds the established Minimal Detectable Change (MDC) threshold of 0.31 sec, indicating that observed changes exceed measurement error and represent true therapeutic effects.

Table 2. 20-Yard shuttle test performance analysis (N=30)

Measure	20YST Time (sec)
Pre-intervention	6.36±0.165 (95% CI: 6.30-6.42)
Post-intervention	5.52±0.104 (95% CI: 5.48-5.56)
Mean Difference	0.84
95% CI for Difference	0.77-0.91
t-value	25.98
p-value	<0.001
Cohen's d	0.82
Effect Size	Large

Individual Response Analysis: All 30 participants (100%) demonstrated improvements exceeding the MDC threshold.
Magnitude of Improvement: Mean improvement represents 13.2% performance enhancement.

Individual Range: Individual improvements ranged from 0.45 to 1.23 sec (minimum 7.1% to maximum 19.4% improvement).

Lower CI Bound: The lower bound of the 95% CI (0.77 seconds) is 2.5 times greater than the MDC threshold, indicating consistent clinical significance across the plausible range of true effects.

Statistical Assumptions and Data Quality Verification

Normality Assessment:
Pre-intervention 20YST scores: Shapiro-Wilk test $p = 0.342$ (normal distribution confirmed)
Post-intervention 20YST scores: Shapiro-Wilk test $p = 0.158$ (normal distribution confirmed)
Difference scores: Shapiro-Wilk test $p = 0.246$ (normal distribution confirmed)

Outlier Analysis:
No participants identified as outliers beyond ±2.5 standard deviations. All individual responses fell within expected range based on pilot study parameters.

Measurement Reliability:
Test-retest reliability for 20YST administration in our study: ICC = 0.97 (95% CI: 0.94-0.99). Measurement error standard deviation: 0.089 seconds. Coefficient of variation: 1.4%, indicating excellent measurement consistency.

Discussion

This pilot quasi-experimental study provides preliminary evidence supporting the short-term effectiveness of standardized hip abductor strengthening in improving functional performance among collegiate male runners with ITBS. Figure 2 shows the graphical representation of 20 Yard Shuttle Test mean values of pre and post intervention data. The observed large effect size (Cohen's d = 0.82), universal achievement of clinically significant improvements (100% of participants exceeding MDC threshold), and precise confidence intervals suggest meaningful therapeutic benefit warranting further investigation through adequately powered randomized controlled trials.

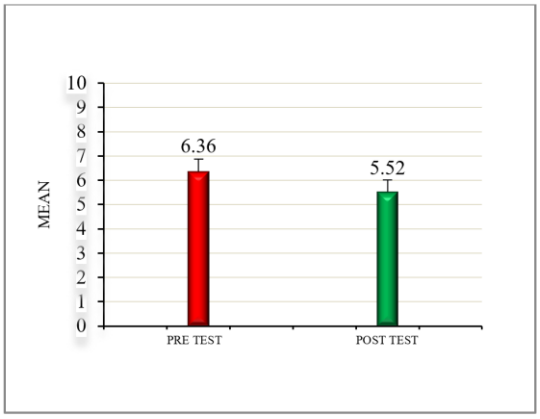


Figure 2. Comparison of 20-Yard Shuttle Test scores between pre- and post-intervention assessments.

Biomechanical Rationale and Evidence Integration

The substantial functional improvements observed align with contemporary understanding of ITBS pathogenesis and therapeutic mechanisms. Hip abductor weakness contributes to altered lower extremity kinematics, including excessive hip adduction and dynamic knee valgus patterns that predispose to ITBS development (Noehren *et al*., 2014; Everhart *et al*., 2019; Foch *et al*., 2023). The standardized strengthening protocol likely addressed these fundamental biomechanical deficits through systematic gluteus medius and tensor fasciae latae strengthening (Mucha *et al*., 2017; Brown *et al*., 2019; Imeri and Gheitasi, 2020), resulting in enhanced neuromuscular control and movement efficiency reflected in 20YST performance improvements.

The 13.2% mean performance improvement observed exceeds typical measurement error margins and represents clinically meaningful enhancement for athletic populations. The consistency of this improvement across all participants (100% achieving MDC) strengthens

confidence in the intervention's effectiveness while acknowledging the preliminary nature of pilot study findings.

Clinical Significance and Confidence Interval Interpretation:

The universal achievement of clinically significant improvements provides robust evidence of intervention effectiveness within the pilot study framework. The 95% confidence interval for mean improvement (0.77-0.91 sec) offers valuable clinical decision-making information, with the lower bound substantially exceeding the MDC threshold of 0.31 sec. This precision suggests consistent therapeutic benefit across the likely range of true effect sizes, supporting clinical confidence in the intervention while acknowledging pilot study limitations.

The standardized protocol demonstrates practical advantages for clinical implementation in collegiate athletic settings (Allen, 2014). The progression-based approach accommodates individual variations while maintaining systematic advancement, and the equipment requirements (resistance bands, ankle weights) are cost-effective and accessible for resource-constrained environments common in collegiate athletics (Baker and Fredericson, 2016).

Validation of 20-Yard Shuttle Test as ITBS-Specific Outcome Measure

The selection of 20YST as the primary outcome measure is supported by comprehensive validation evidence in athletic populations. The excellent test-retest reliability (ICC = 0.95 within-day, ICC = 0.91 between-day) and criterion-related validity (ICC = 0.99) established by Eriksson *et al*. (2015) provide strong psychometric foundation for its use in ITBS intervention research. The sport-specific movement patterns involving acceleration, deceleration, and direction changes closely mirror the functional demands compromised in runners with ITBS, making performance improvements on this test clinically relevant indicators of therapeutic success (Eriksson *et al*., 2015).

The consistency of reliability parameters achieved in our pilot study (ICC = 0.97) confirms the measure's applicability to ITBS populations while supporting the validity of observed improvements as true therapeutic effects rather than measurement error.

Pilot Study Limitations and Methodological Considerations

As a pilot investigation, this study incorporates several methodological limitations inherent to preliminary research phases:

Design Limitations:

Absence of randomization and control group precludes definitive causal attribution and leaves the study susceptible to threats to internal validity including natural recovery, regression to mean, and practice effects. Single-group pre-post design cannot account for concurrent interventions, training modifications, or temporal effects that may contribute to observed improvements. Lack of assessor blinding introduces potential assessment bias despite standardized protocols and objective measurement tools.

Sampling and Generalizability Limitations:

Convenience sampling from single institution limits external validity and introduces potential selection bias. Homogeneous population (male collegiate runners aged 18-25) restricts generalizability to female athletes, recreational runners, older populations, and different competitive levels. Small sample size (n=30) appropriate for pilot investigation but insufficient for definitive clinical recommendations or subgroup analyses.

Outcome Measurement Limitations:

Single primary outcome measure provides narrow perspective on intervention effects, missing important domains such as pain, strength, biomechanics, and quality of life.

In this study, the pain parameter was not prioritized due to subjective measures. Short-term follow-up prevents assessment of sustained benefits, long-term adherence, or recurrence prevention-critical factors for athletic populations. Absence of sport-specific performance measures (running economy, biomechanical parameters) limits understanding of intervention mechanisms.

Intervention Limitations:

Standardized protocol may not optimally address individual biomechanical variations or specific deficit patterns. A four-week duration may be insufficient for maximal neuromuscular adaptation and strength gains. Absence of control for concurrent activities including training modifications, other therapeutic interventions, or lifestyle factors that may influence outcomes.

Future Research Directions and Sample Size Recommendations

These preliminary findings provide essential foundation data for future adequately powered investigations. Based on the observed effect size (Cohen's d = 0.82) and pilot study outcomes, future randomized controlled trials should incorporate the following methodological enhancements:

Study Design Requirements:

Randomized controlled trial methodology with appropriate control groups (standard care, sham intervention, or waitlist control). Multi-center recruitment enhancing external validity and enabling broader demographic representation.

Sample size calculation based on pilot effect size estimates: assuming $\alpha = 0.05$, $\beta = 0.20$ (80% power), and Cohen's $d = 0.82$, approximately 26 participants per group would be required, accounting for 20% dropout suggesting $n = 32$ per group for future trials.

Methodological Enhancements:

Inclusion of female athletes and recreational runners to assess intervention generalizability across demographic groups. Extended follow-up periods (6-12 months) evaluating sustained functional benefits and recurrence prevention.

Comprehensive outcome assessment including pain scales, objective strength measurement, biomechanical analysis, return-to-sport metrics, and quality of life measures. Dosage parameter optimization investigating frequency, intensity, and duration effects on therapeutic outcomes.

Conclusion

This pilot quasi-experimental study provides preliminary evidence supporting the short-term effectiveness of standardized hip abductor strengthening in improving functional performance among collegiate male runners with ITBS. The observed large effect size (Cohen's $d = 0.82$), universal clinical significance achievement (100% of participants exceeding MDC threshold), and precise confidence intervals (95% CI: 0.77-0.91 seconds improvement) suggest meaningful therapeutic potential that warrants further investigation.

However, the pilot nature of this investigation necessitates cautious interpretation, with several critical limitations requiring acknowledgment. The absence of randomization and control group, single-center recruitment, limited follow-up duration, homogeneous sample demographics, and reliance on single outcome measure restrict the generalizability and definitive nature of these findings. These results should be interpreted as preliminary evidence establishing feasibility and providing foundation data for future research rather than definitive clinical recommendations.

The consistency of improvements across all participants and the magnitude of functional gains support continued investigation of this therapeutic approach through more rigorous experimental designs. Future research should prioritize randomized controlled trial methodology, multi-center recruitment, extended longitudinal follow-up with recurrence prevention assessment, and comprehensive outcome evaluation to establish definitive clinical recommendations for hip abductor strengthening in ITBS management among running populations.

Acknowledgement

The authors acknowledge the collegiate runners who participated in this pilot investigation and the faculty of the Department of Physiotherapy, Vinayaka Mission's Research Foundation, Puducherry, for facilitating data collection and providing institutional support for this research.

References

Allen, D.J. (2014). Treatment of distal iliotibial band syndrome in a long distance runner with gait-retraining emphasizing step rate manipulation. *International Journal of Sports Physical Therapy, 9*(2), 222–231.

Baker, R.L., & Fredericson, M. (2016). Iliotibial band syndrome in runners. *Physical Medicine and Rehabilitation Clinics of North America, 27*(1), 53–77. https://doi.org/10.1016/j.pmr.2015.08.001

Brown, A.M., Zifchock, R.A., Lenhoff, M., Song, J., & Hillstrom, H.J. (2019). Hip muscle response to a fatiguing run in females with iliotibial band syndrome. *Human Movement Science, 64*, 181–190. https://doi.org/10.1016/j.humov.2019.02.002

Buttinger, J.N., Romero, J.M., Sellon, J.L., Lachman, N., Kruse, R.C., & Boettcher, B.J. (2024). Iliotibial band origin tendinopathy is an underrecognized cause of anterolateral hip pain: A narrative review and clinical commentary. *Current Sports Medicine Reports, 23*(6), 229–236. https://doi.org/10.1249/JSR.0000000000001176

Decker, G., & Hunt, D. (2018). Proximal iliotibial band syndrome in a runner: A case report. *PM&R, 11*(2), 206–209. https://doi.org/10.1016/j.pmrj.2018.06.017

Eriksson, A., Johansson, F.R., & Back, M. (2015). Reliability and criterion-related validity of the 20-yard shuttle test in competitive junior tennis players. *Open Access Journal of Sports Medicine, 6*, 269–276. https://doi.org/10.2147/OAJSM.S86442

Everhart, J.S., Kirven, J.C., Higgins, J., Hair, A., Chaudhari, A. A.M.W., & Flanigan, D.C. (2019). The relationship between lateral epicondyle morphology and iliotibial band friction syndrome: A matched case-control study. *The Knee, 26*(6), 1198–1203. https://doi.org/10.1016/j.knee.2019.07.015

Foch, E., Brindle, R.A., & Pohl, M.B. (2023). Lower extremity kinematics during running and hip abductor strength in iliotibial band syndrome: A systematic review and meta-analysis. *Gait & Posture, 101*, 73–81. https://doi.org/10.1016/j.gaitpost.2023.02.001

Fredericson, M., & Wolf, C. (2005). Iliotibial band syndrome in runners: Innovations in treatment. *Sports Medicine, 35*(5), 451–459. https://doi.org/10.2165/00007256-200535050-00006

Hutchinson, L.A., Lichtwark, G, Willy, R.W., & Kelly, L.A. (2022). The iliotibial band: A complex structure with versatile functions. *Sports Medicine, 52*, 995–1008. https://doi.org/10.1007/s40279-021-01634-3

Imeri, B., & Gheitasi, M. (2020). Hip abductor muscles strengthening's effects on lower extremity function of runners with iliotibial band syndrome. *Journal of Exercise Science and Medicine, 12*(1), 57–68. https://doi.org/10.32598/JESM.12.1.6

Kim, D.Y., Miyakawa, S., Fukuda, T., & Takemura, M. (2019). Sex differences in iliotibial band strain under different knee alignments. *PM&R, 12*(5), 479–485. https://doi.org/10.1002/pmrj.12255

McKay, J., Maffulli, N., Aicale, R., & Taunton, J. (2020). Iliotibial band syndrome rehabilitation in female runners: A pilot randomized study. *Journal of Orthopaedic Surgery and Research, 15*, Article 188. https://doi.org/10.1186/s13018-020-01713-7

Mucha, M.D., Caldwell, W., Schlueter, E.L., Walters, C., & Hassen, A. (2017). Hip abductor strength and lower extremity running-related injury in distance runners: A systematic review. *Journal of Science and Medicine in Sport, 20*(4), 349–355. https://doi.org/10.1016/j.jsams.2016.09.002

Noehren, B., Schmitz, A., Hempel, R., Westlake, C., & Black, W. (2014). Assessment of strength, flexibility, and running mechanics in men with iliotibial band syndrome. *Journal of Orthopaedic & Sports Physical Therapy, 44*(3), 217–222. https://doi.org/10.2519/jospt.2014.4991

Shen, P., Mao, D., Zhang, C., Sun, W., & Song, Q. (2019). Effects of running biomechanics on the occurrence of iliotibial band syndrome in male runners during an eight-week running programme: A prospective study. *Sports Biomechanics, 20*(5), 560–570. https://doi.org/10.1080/14763141.2019.1584235

Wiegand, K., Mercer, J.A., Navalta, J.W., Pharr, J., Tandy, R., & Silvernail, J.F. (2019). Running status and history: A self-report study. *Physical Therapy in Sport, 39*, 8–15. https://doi.org/10.1016/j.ptsp.2019.06.003