

Sex Differences in Foot Biomechanics:

Implications for Podiatric Medicine

SYSTEMATIC REVIEW & EVIDENCE SYNTHESIS

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CORE MESSAGE

Biological sex significantly influences foot biomechanics, Achilles tendon morphology, and plantar pressure distribution. Women have substantially higher rates of hallux valgus (58% vs 25%), while men face 2–8× greater Achilles tendon rupture risk. Sex must be integrated into podiatric assessment, orthotics, and rehabilitation.

INTRODUCTION

Sex-related differences in foot biomechanics significantly impact injury patterns, plantar pressure, and outcomes in podiatric practice.

The Achilles tendon (AT) — the body's strongest tendon — stores and releases elastic energy during gait. Sex-based variation in AT morphology drives distinct injury patterns between males and females.

2–8×

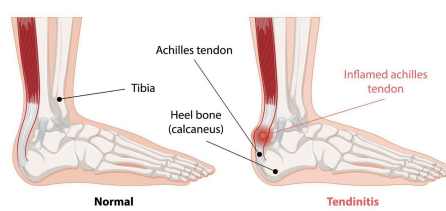
MEN MORE LIKELY TO RUPTURE ACHILLES TENDON THAN WOMEN

OBJECTIVES

- Assess sex-specific differences in AT morphology and mechanical properties
- Assess how sex affects plantar pressure distribution and gait kinematics
- Assess how these differences affect podiatric practice and injury prevention

Achilles Tendonitis

Inflammation or tearing of the Achilles tendon, the large tendon that attaches the calf muscles to the heel bone.



METHODS

A systematic review and evidence synthesis of peer-reviewed literature was conducted. Studies examining sex-based differences in AT morphology, plantar pressure mapping, gait kinematics, and pathology prevalence were identified and analysed. Data were synthesised narratively across biomechanical, clinical, and hormonal domains.

KEY FINDINGS

ACHILLES TENDON MORPHOLOGY

AT MORPHOLOGY

Males have significantly larger AT cross-sectional area (CSA) and greater stiffness. Female tendons show lower stiffness and higher compliance, influenced by oestrogen and relaxin — increasing injury susceptibility.

This hormonal influence is a key factor in the sex-based disparity in tendon injury rates observed clinically.

(Albers et al., 2023; Legerlotz et al., 2017)



vs



Larger CSA
Smaller CSA

HALLUX VALGUS PREVALENCE

HALLUX VALGUS

Hallux valgus in 58% of women vs 25% of men, attributed to footwear habits, osseous anatomy, ligamentous laxity, and first ray hypermobility.

The higher prevalence in women reflects both structural and lifestyle-related biomechanical factors.

(Nguyen et al., 2010; Nix et al., 2010)

Male

25% HV

Female

58% HV

PLANTAR PRESSURE DISTRIBUTION

PLANTAR PRESSURE

Women show significantly higher peak plantar pressure in the hallux, toes, and forefoot. Men show higher pressure-time integrals in the lateral forefoot and heel, linked to step length and cadence.

These differences directly inform orthotic design and footwear recommendations for each sex.

(Okamoto et al., 2020; Lemaire et al., 2022)



Forefoot
(Female)



Heel
(Male)

GAIT & KINEMATICS

GAIT & KINEMATICS

Women demonstrate greater knee valgus, increased hip adduction, and wider step width during walking and running — altering load transmission through the foot and ankle complex.

These gait differences contribute to higher forefoot pressure and altered force distribution across the plantar surface, with implications for overuse injuries.

(Cho et al., 2004; Ferber et al., 2003)

CONCLUSION

Significant sex-based differences exist in foot biomechanics, AT morphology, plantar pressure distribution, and pathology prevalence. These differences are mediated by hormonal, anatomical, and biomechanical factors that affect both injury risk and clinical outcomes.

Integrating sex as a biological variable is essential for personalised podiatric assessment, orthotic prescription, and rehabilitation planning.

CLINICAL IMPLICATIONS

FOOTWEAR & ORTHOTICS
Custom orthotics and footwear must account for sex-specific biomechanical differences between men and women.

INJURY PREVENTION
Sex-specific risk assessment should identify those at risk of AT rupture, hallux valgus, or plantar fasciitis.

CLINICAL ASSESSMENT
Plantar pressure, tendon morphology, and gait analysis must integrate sex as a biological variable.

REHABILITATION
Rehab must account for sex differences in tendon stiffness and hormonal effects on connective tissue healing.

