



CLINICAL EXERCISE SPECIALIST MANUAL

A Fitness Professional's Guide
to Training People with
CHRONIC DISEASE

J. DANIEL MIKESKA DHSc

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**A FITNESS PROFESSIONAL'S GUIDE TO
EXERCISE AND CHRONIC DISEASE**

BY J. DANIEL MIKESKA, DHSC

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CHAPTER 21

COMMON DYSFUNCTIONS OF THE LOWER EXTREMITY

By the end of this chapter you will understand:

- Anatomy
 - Pathologies
 - o Shin splints
 - o Ankle sprains
 - o Achilles Tendinopathy
 - o Plantar Fasciitis
 - Treatment options
 - o Early intervention
 - o Exercise intervention
 - Mobility/stability
 - Movement
 - Precasutions
-

Anatomy

The lower extremity, the shin, ankle, and foot, is an essential structure for mobility and stability, and for any weight bearing activity. The shin is divided into four compartments: anterior, lateral, superficial posterior, and deep posterior. Table 21.1 lists the muscles of each compartment, and the associated movements, and Figure 21.1 provides a cross-sectional view of the lower extremity compartments.

Table 21.1

Compartments and muscles of the lower leg, and their actions

Compartment	Muscles	Actions
Anterior	Anterior tibialis Extensor digitorum longus Extensor hallucis longus Peroneus tertius	Dorsiflexion Inversion Toe extension Eversion and abduction—Peroneus tertius
Lateral	Peroneus longus Peroneus brevis	Plantarflexion Eversion
Superficial posterior compartment	Gastrocnemius Soleus Plantaris	Plantarflexion Knee flexion—Plantaris
Deep posterior compartment	Tibialis posterior Flexor digitorum longus Flexor hallucis longus Popliteus	Inversion Adduction Plantarflexion Supination Toe flexion Internally rotates tibia—Popliteus Assists with knee flexion—Popliteus

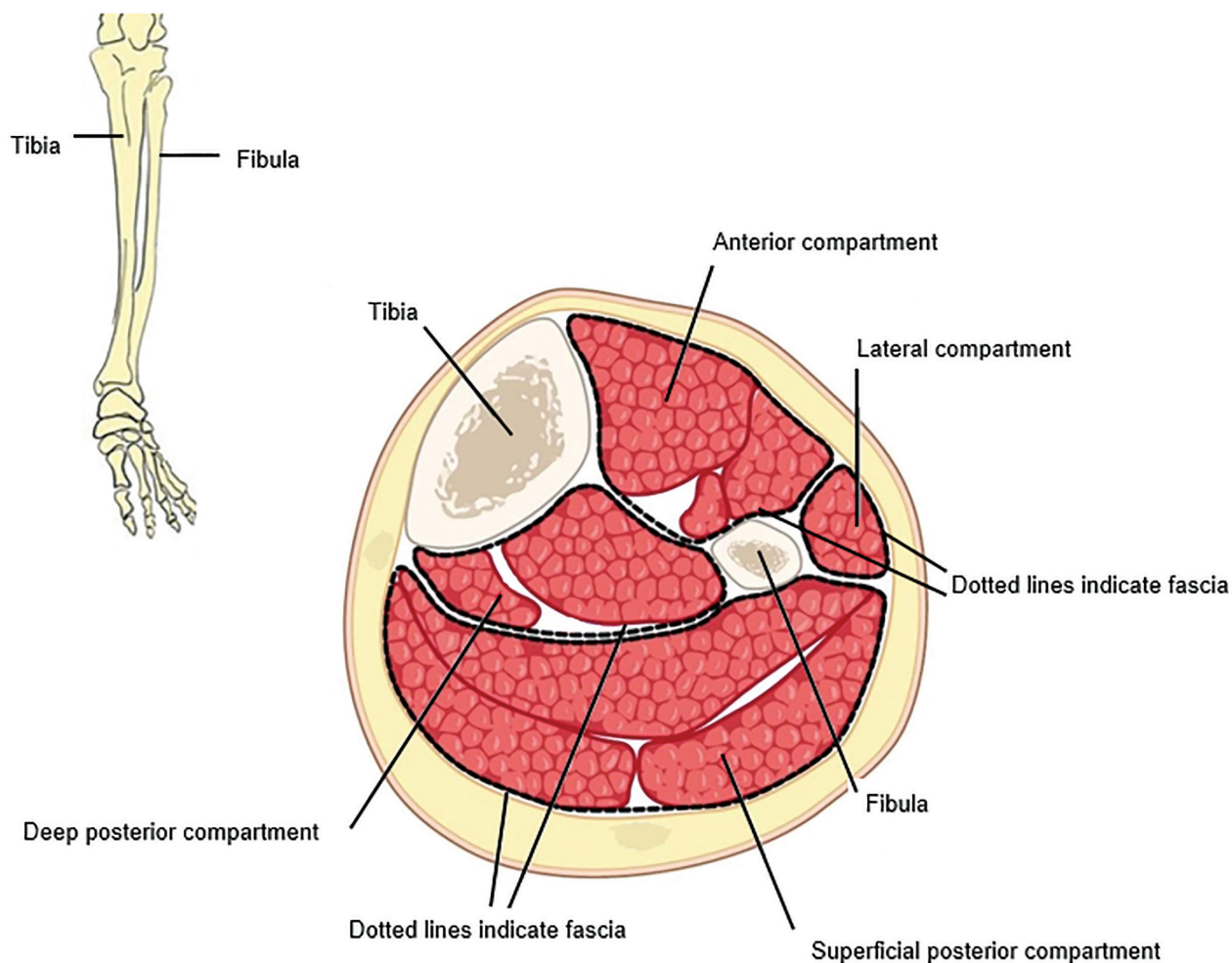


Figure 21.1 Diagram of the shin bones and a cross sectional view of lower extremity

Shin Splints

Shin splint is a generic term used to describe anterior or posterior lower leg pain. Posterior shin splints are also known as *medial tibial stress syndrome* (MTSS). The main cause of MTSS is inflammation of the periosteum, a layer of connective tissue that surrounds bone, or periostitis. However, in addition to periostitis, a range of tibial stress injuries that include tendinopathy and periosteal remodeling can also be a cause, as can dysfunction of the shin musculature (Galbraith & Lavallee, 2009). Anterior shin splints refer to pain in the muscles and fascia of the anterior compartment.

Shin splints are the result of repetitive muscle contraction and tibial strain caused by repetitive loading such as running, structural anomalies such as pes planus, leg length discrepancy, knee valgus or varus, muscular imbalances such as over active calf muscles, or poor biomechanics such as over pronation (Cheatham, 2015; Galbraith & Lavallee, 2009; Mandom & Paul, 2015). Shin splint pain is characterized by a dull ache or diffuse pain along the lower part of the medial tibia for MTSS, or lower anterior shin and compartment for anterior shin splints (Cheatham, 2015; Galbraith & Lavallee, 2009). Pain is often severe at the beginning of an exercise bout and diminishes as the bout continues, but as the condition progresses, the pain becomes continuous.

The best way to alleviate symptoms of shin splints is to stop aggravating activities and rest, particularly in the acute phase of recovery, for up to 7 days. Once a client has been cleared for activity, pain may limit movements, and a client will need to progress slowly. It is prudent to consult a client's physician and physical therapist to determine the appropriate course of action. Table 21.4 details general activity guidelines.

Ankle Sprains

Ankle sprains are one of the most common sports injuries with an estimated 28K injuries occurring daily, accounting for over 225k annual emergency department visits (Cheatham, 2015; Kaminski et al., 2013; Shah, Thomas, Noone, Blanchette, & Wikstrom, 2016). Athletic activities are responsible for almost 50% of ankle sprains, the highest occurring in field hockey, followed by volleyball, football, cheerleading, ice hockey, soccer, gymnastics, and softball (Kaminski et al., 2013). The highest incidence occurs between ages 15-19; for males the highest incidence is between the ages of 15-24. Females after age 30 have a higher incidence than males (Ott, 2013; van den Bekerom, Kerkhoffs, McCollum, Calder, & van Dijk, 2013).

Over 90% of ankle sprains are inversion, or lateral, ankle sprains. This is the classic *rolled ankle* that results in damage to the lateral ligaments, anterior talofibular (ATFL), calcaneofibular (CFL), and posterior talofibular. The most common cause of a lateral ankle sprain is inversion on a plantar flexed foot. Medial, or inversion ankle sprains occur when force is applied during abduction, eversion, and dorsiflexion, and the medial deltoid ligament is damaged (Cheatham, 2015; Kaminski et al., 2013). A grading system identifies the severity of lateral ankle sprains with Grade I = mild and indicting little ligament damage, to Grade III = ligament rupture. Details are in Table 21.2

Table 21.2

Lateral ankle sprain grading system

	Grade I	Grade II	Grade III
Ligaments involved	ATFL	ATFL & CFL	One or more
Ligament damage	Stretched	Stretched	Ruptured
Swelling/Tenderness	Mild	Moderate	Severe
Laxity/Stability	None-little	Abnormal	Substantial

American Academy of Orthopaedic Surgeons, 2019; Cheatham, 2015; Kaminski et al., 2013; Ott, 2013

A sprain heals in three phases and treatment should be adjusted as healing progresses. During Phase I, the initial or inflammatory phase, the RICE protocol (rest, ice, compression, and elevation) is the widely accepted intervention to reduce swelling and induce healing. RICE should be considered for 5-7 days, and the affected ankle should be kept immobile. Phase II is the proliferation phase that can last up to 3 months. During this stage, vascularity increases in the damaged tissue and new collagen forms. Controlled stress is encouraged to align the newly-formed tissue, but inversion should be avoided. Bracing, taping, and wrapping can keep the ankle stable. In Phase III, remodeling takes place, and activity becomes important. The newly-formed collagen is laid as scar tissue, and as this tissue develops, it is vital to stretch the ankle to breakdown scar tissue and align the fibers. The remodeling phase can take up to a year or longer (van den Bekerom et al., 2013).

A CXS can work with a client with a Grade I sprain as early as Week 1; Week 3 for a Grade II sprain, and Week 6 for a grade III sprain. Progressive weight bearing and functional rehabilitative activities may

be a better than complete immobilization for Grades I or II sprains. Due to joint laxity and inhibited proprioception, the primary risk factor for an ankle sprain is a previous sprain. Therefore, it makes sense the best means of prevention and recovery is stability, balance, and neuromuscular training. Wobble boards, BOSUs, foam and air pads, and single leg movements should be performed. As always, check with a client's physician or physical therapist for progression protocol. Guidelines for activity are in Table 21.4.

Achilles Tendinopathy

The rate of incidence of Achilles tendon (AT) injuries is unknown, but ranges between 7–49/100,000, and affects an estimated 1 million athletes annually (Lemme, Li, DeFroda, Kleiner, & Owens, 2018; Shamrock & Varacallo, 2019). AT injuries mostly occur in intermittent athletes (weekend warriors), and most commonly affect middle-aged males. There are numerous intrinsic and extrinsic factors that can lead to AT injury and include:

- Age
- Bodyweight
- Pes planus and pes cavus
- Leg length discrepancy
- Limited calf flexibility
- Ankle instability
- Kidney disease
- Gout
- Diabetes
- Thyroid disorders
- Arthritis
- Infection
- Knee and hip dysfunction (Cheatham, 2015; Lemme et al., 2018; Shamrock & Varacallo, 2019)

Historically, AT pain has been associated with inflammation; however, it is now thought AT pain is more often a result of tendon degeneration, suggesting a more appropriate name may be *Achilles tendinosis*, or the more encompassing term of *Achilles tendinopathy* that indicate pain, swelling, degeneration, and dysfunction (Cheatham, 2015; Sussmilch-Leitch, Collins, Bialocerkowski, Warden, & Crossley, 2012). Symptoms often occur at the mid-line or distal portion of the of the tendon insertion with the calcaneus (Figure 21.2). The associated pain is present in the morning and as the severity of the condition increases, the sharp or burning pain occurs more often. Rest will usually alleviate the symptoms and should be considered as part of any recovery, but conservative physical therapy is the most widely accepted treatment (Sussmilch-Leitch et al., 2012).

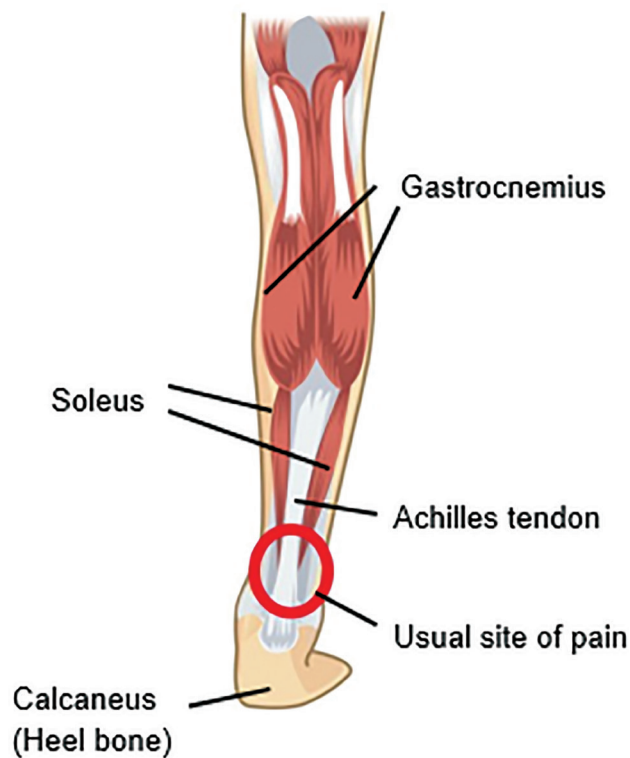


Figure 21.2 Achilles tendonitis.

Early intervention includes rest, oral or injectable anti-inflammatories, modification of risk factors, weight-loss, assessment of footwear or the addition of orthotics, assessment of body mechanics, and physical therapy with a focus on stretching and eccentric strengthening. High-intensity and high-loading activities should be avoided, and restrictions in the type and amount of activity may be necessary. Guidelines for activity are listed in table 21.4.

Plantar Fasciitis

The plantar fascia is a thick band of fibrous tissue that runs from the heel across the arch of the foot and connects to the ball of the foot (Figure 21.3). As the foot flattens, the plantar fascia acts as a shock absorber, or rubber band, and helps return the foot to its original arch (Kirby, 2017). Plantar fasciitis (PF) occurs when the fascia becomes strained or weakened, causing tears, swelling, and pain. More recently, the term *plantar fasciosis* is now used to indicate degeneration and disorganization of fibrous tissue rather than just inflammation. Some of the causes of PF are in Table 21.3.

Table 21.3

Plantar fasciitis risk factors

Intrinsic risk factors	Pes planus
	Pes cavus
	Obesity
	Shortened Achilles tendon
	Increased subtalar pronation
	Age
	Sex
	Overactive calf muscles
	Limited dorsiflexion
Extrinsic risk factors	Walking, standing, or running for long periods of time, especially on hard surfaces
	Improper foot wear
	Walking barefoot
	Sports or physical activity
	Overtraining
	Deconditioning
	Lack of flexibility training

(Bolívar, Munuera, & Padillo, 2013; Memorial Sloan Kettering Cancer Center, 2019; Schwartz & Su, 2014).

Approximately 2 million patients are treated for PF in the United States every year. The most commonly reported symptom of PF is pain in the medial heel at the calcaneal attachment as shown in Figure 21.3. Clients report pain particularly upon rising in the morning and taking a few steps. The pain can be severe at first but may subside after a few minutes of activity. The condition seems to worsen at night, due to increased plantar flexion and an overactive triceps surae (gastrocnemius and soleus) while sleeping (Bolívar et al., 2013). The pain often returns after prolonged standing or activity.

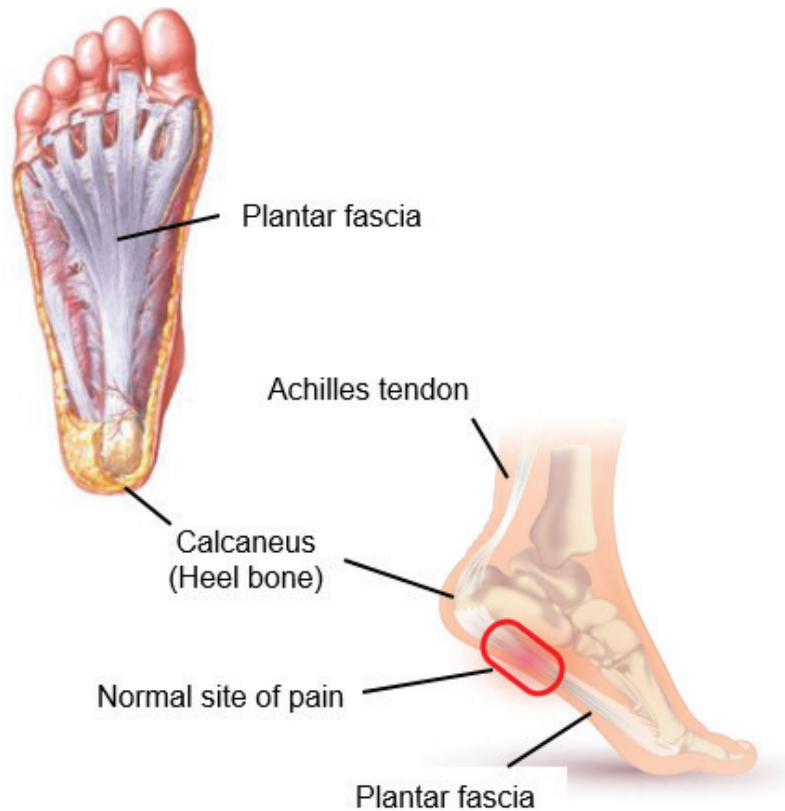


Figure 21.3 Plantar fascia and plantar fasciitis.

Although PF usually resolves on its own in 6 -1 8 months, NSAIDS, orthotics, braces, and splints, and stretching and strengthening exercises may be recommended by a clinician. Because a tight gastrocnemius has been directly associated with PF, calf and hamstring stretching should begin early in intervention. Additionally, rolling the plantar fascia with a can at night and first thing in the morning for 1-3 minutes will help break fascia adhesions. If non-invasive therapies do not provide relief, surgical intervention may be necessary. Stability and mobility exercise should focus on balance and loosening the fascia, as well as strengthening the intrinsic foot muscles, while movement training should emphasize improving ADLs. Exercise guidelines are in Table 21.4.

Table 21.4

General activity guidelines for common injuries of the lower leg, ankle, and foot

Condition	Early intervention	Stability/mobility	Movement	Avoid
Shin splints	Rest Braces, supports, orthotics Taping Anti-inflammatories	Stretch the calf muscles for MTSS Stretch anterior tibialis for anterior shin splints Core strength and stability • Bridging • Bird dogs • Planks Knee strength and stability Balance progression	Movements should initially focus on ADLs Low-loaded Open kinetic chain Closed kinetic chain Low impact cardio Pool-based activity Stationary bicycle	Repetitive loading High-impact landing Inversion

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Ankle sprains	RICE Tapping, bracing, wrapping Progressive weight bearing for Grades I & II	Only perform if there is NO PAIN. Foot and ankle ROM (dorsiflexion, plantar flexion, inversion, eversion) Calf stretching OKC ankle movements with a band (dorsiflexion, plantar flexion, inversion, eversion) CKC movements Straight leg and bent leg calf raises Towel crunches with toes Marble pick up with toes Wobble board balance Balance progression	Single leg movements Reintroduce multiplanar-movements Leg press Wall squats Side steps Low impact cardiovascular training, progressed to higher intensity activity	Multiplanar-movements High impact
Achilles tendinopathy	Rest Oral or injectable anti-inflammatories, Weight-loss, Assessment of foot-wear Orthotics Assessment of body mechanics Physical therapy	Posterior chain stretching below pain tolerance Bi-lateral and unilateral heel drops Balance progression	Closed kinetic chain eccentric exercises • Leg press • Wall squats • Side steps Eccentric, and fast-rebounding heel-rises with increasing speed, ROM, and reps	Jumping Running Stairs
Plantar fasciitis	Rest NSAIDS Night splints Bracing orthotics	Balance progression Calf and hamstring flexibility SMR plantar fascia Towel scrunching Marble pick up	ADLs Toe curls Ankle circles	Running Jumping Stairs

Bolivar, et al., 2013; Cheatham, 2015; Galbraith & Lavallee, 2009; Kaminski et al., 2013; Memorial Sloan Kettering Cancer Center, 2019; Schwartz & Su, 2014; Silbernagel, Brorsson, & Lundberg, 2011; Sussmilch-Leitch et al., 2012; van den Bekerom et al., 2013

Discussion and application

1. What are some common lower leg injuries associated with pes planus, pes cavus, tight calf muscles, and/or excessive pronation? Describe the mechanisms of the injury and the treatment protocols.

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