

Selected Issues for the Master Athlete and the Team Physician: A Consensus Statement

DEFINITION

Team physicians often treat injured active patients aged 50 yr and older. There are various definitions of master athletes. For the purpose of this document, master athletes will be defined as active individuals aged 50 yr or older. They desire optimal levels of performance or wish to exercise for general health and have high expectations for sports medicine care, including return to sport or activity. In addition, to the more common general illnesses and injuries seen in athletes, master athletes can experience specific illnesses and injuries owing to their physiology. This may require customized treatment to address the complexity of these conditions. This document will examine selected illnesses and injuries commonly seen in master athletes.

GOAL

The goal of this document is to help the team physician improve the care of the master athlete by understanding medical and musculoskeletal factors common in this age group. To accomplish this goal, the team physician should have knowledge of and be involved with the following:

- physiological considerations, including cardiopulmonary function, muscle strength, and balance;
- medical considerations, including preparticipation evaluation and cardiovascular disease; and
- musculoskeletal considerations, including Achilles tendon rupture, lateral elbow and rotator cuff tendinopathy, lumbar spinal stenosis, and shoulder, hip, and knee arthritis.

SUMMARY

This document provides an overview of selected medical issues that are important to team physicians who are responsible for the care and treatment of athletes. It is not intended as a standard of care and should not be interpreted as such. This document is only a guide and, as such, is of

a general nature, consistent with the reasonable, objective practice of the health care profession. Adequate insurance should be in place to help protect the physician, the athlete, and the sponsoring organization.

This statement was developed by a collaboration of six major professional associations concerned about clinical sports medicine issues; they have committed to forming an ongoing project-based alliance to bring together sports medicine organizations to best serve active people and athletes. The organizations are the American Academy of Family Physicians, American Academy of Orthopaedic Surgeons, American College of Sports Medicine, American Medical Society for Sports Medicine, American Orthopaedic Society for Sports Medicine, and American Osteopathic Academy of Sports Medicine.

EXPERT PANEL

Facilitator:

Stanley A. Herring, M.D., Chair, Seattle, WA

Primary authors:

W. Ben Kibler, M.D., Lexington, KY

Margot Putukian, M.D., Princeton, NJ

Delegates:

Thomas W. Allen, D.O., Tulsa, OK

John Bergfeld, M.D., Cleveland, OH

Lori Boyajian-O'Neill, D.O., Kansas City, KS

David Cosca, M.D., Sacramento, CA

Rebecca Jaffe, M.D., Wilmington, DE

Walter Lowe, M.D., Houston, TX

David Thorson, M.D., Mahtomedi, MN

MEDICAL CONSIDERATIONS FOR THE MASTER ATHLETE

Physiology

General considerations

- There are physiological changes that occur with aging, which include the following:
 - Cardiopulmonary (cardiac output, blood pressure, $\dot{V}O_{2\max}$, vital capacity)
 - Musculoskeletal (reaction time, strength, muscle endurance, tendon structure, cartilage structure, bone mass, flexibility, fat-free body mass, balance)

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- Metabolic (glucose tolerance, lipids, insulin sensitivity, metabolic rate)
- Physiological changes may be associated with many chronic conditions, such as diabetes, coronary artery disease, hypertension, osteoarthritis, bone loss, and overweight/obesity.
- Exercise may modify age-related changes.
- Medications used by master athletes may have significant adverse effects.

Strength

General considerations

- Independent of activity level, muscle mass declines with age; approximately $1.25\% \cdot \text{yr}^{-1}$ after age 35 yr.
- Muscle mass is directly related to peak strength but not necessarily to performance.
- There is an accelerated decline in peak strength after age 70 yr.
- Muscle power is lost at a greater rate than endurance capacity.
- Rates of decline of strength and performance are similar between men and women.
- There are genetic, chronologic, hormonal, nutritional, and behavioral (exercise) components to muscle aging.
- Resistance training (RT) may modify age-related changes.

Physiology/pathophysiology

- Decrease in strength is due to:
 - Decreased cross-sectional area (CSA) of type II (fast-twitch) muscle fibers (quality and quantity). With aging, the ratio of the CSA of type II to type I changes from 1:1 to 1:2
 - Decrease in contractile rate of force development, the ability to rapidly reach a given magnitude of muscle force during the initial phase of rising muscle force.
- Sarcopenia, age-associated loss of muscle mass, is usually characterized by the replacement of muscle fibers with fat and fibrosis.
 - Contributing factors include disuse, metabolic, neuromusculoskeletal, and neurovascular conditions.
 - Associated with functional decline often manifest in decreased knee extensor strength, postural imbalance, and decreased ability to safely navigate stairs and chairs.
 - Increased fat infiltration is associated with glucose intolerance, diabetes mellitus, poor knee extensor strength, decreased muscle contractility, muscle fiber recruitment, and muscle metabolism.

Treatment

- Age-related declines in strength can be delayed or diminished by consistent RT that slows the decline of muscle mass and strength more effectively than aerobic training (AT).

- The effects of consistent RT include the following:
 - Delayed type II muscle fibers changes
 - Increases in muscle strength
 - Greater power per muscle volume
- Other effects of consistent RT:
 - Decline in fat-free mass, increase in total body mass, reduction in oxidative stress
 - Increased basal metabolic rate
 - Improved insulin sensitivity and glycemic control
 - Increase in bone mineral density

It is *essential* that the team physician understand:

- There is an age-related decline in muscle mass and strength.
- RT modifies these declines, and this should be recommended.
- RT also modifies effects of other age-related medical conditions.

It is *desirable* that the team physician

- Understand and implement an RT program

Cardiovascular Considerations

General considerations

- Regular exercise (aerobic, strength) may lower risk of fatal and nonfatal myocardial infarction, hypertension, and atherosclerotic heart disease.
- However, vigorous physical exertion may trigger myocardial infarction or sudden cardiac death in individuals with underlying heart disease.
- The risk of sudden death associated with high-intensity exercise is imprecise, but it increases with age.
- The benefits of regular exercise outweigh the risks.
- Treatment should be individualized based on cardiac condition.
- Use of cardiac medications is common in this age group.
 - Medications can affect physical and cognitive performance; adverse effects should be considered.
 - Athletes on anticoagulant medication should be counseled about the risks of sports participation, particularly contact and/or collision sports.
- Consistent RT may have a beneficial effect on cardiovascular health.

Physiology

- Age-related changes include the following:
 - Increased peripheral vascular resistance; regular exercise decreases peripheral vascular resistance
 - Decreased $\dot{V}O_{2\max}$
 - $\dot{V}O_{2\max}$ declines at the rate of about 10% per decade beyond age 25 yr; it declines steeply after age 60 yr.

- With regular exercise, the decline may be as much as half the rate in master athletes as compared with nonathletes.
 - Decreased cardiac output; exercise lessens this decrease
 - Decreased ventilatory anaerobic threshold; exercise lessens ventilatory anaerobic threshold decrease
- The effects of consistent RT on cardiovascular physiology include the following:
 - Decreased blood pressure
 - Decreased resting HR
 - Improved left ventricular function

Cardiovascular conditions

Sudden cardiac death

- Most sudden cardiac death is caused by atherosclerotic CAD.
- Other less common conditions that predispose to sudden death include the following:
 - Hypertrophic cardiomyopathy (HCM)
 - Valvular heart disease
 - Dilated cardiomyopathies
 - Myocarditis
 - Dysrhythmias and conduction abnormalities
- Refer to “Mass participation event management for the team physician: a consensus statement” [*Med Sci Sports Exerc.* 2004;36(11):2004–8] for equipment and medical supplies related to arrhythmias and managing individuals presenting with sudden cardiac arrest.

Atherosclerotic CAD

- The most common cardiac disease in this age group and major risk factor for angina, myocardial infarction, and arrhythmia.
- Acute myocardial infarction occurs in individuals even with minimal coronary artery stenosis.

Treatment

- Individuals with documented CAD (>50% narrowing if angiography has been performed) should not participate in high-intensity sports/activities without further consultation because of increased risk of myocardial infarction and sudden cardiac death.

Hypertension

- Prehypertension (120–139/80–89 mm Hg)
- Stage 1 hypertension (140–159/90–99 mm Hg)
- Stage 2 hypertension (>160/>100 mm Hg)
- Incidence increases with age

Treatment

- Athletes with prehypertension and stage 1 hypertension in the absence of target organ damage should not be restricted from participation in master activities.

- Athletes with stage 2 hypertension should be restricted from static high-resistance sports (e.g., weight training) and should likely be restricted from high-intensity sports until their blood pressure is normalized.

Congenital and valvular heart disease conditions

HCM

- See page 2062, “Selected issues in injury and illness prevention and the team physician: a consensus statement” [*Med Sci Sports Exerc.* 2007;39(11):2058–68].
 - Heterogeneous disorder, in which there is an imprecise means of stratifying risk.
- Dilated cardiomyopathy or arrhythmogenic right ventricular dysplasia
- Mitral valve prolapse (MVP)

Treatment

- Athletes with definitive diagnosis of HCM should be advised to avoid participation in high-intensity sports.
- Individuals with dilated cardiomyopathy or arrhythmogenic right ventricular dysplasia should be restricted from high-intensity sports.
- Most athletes with MVP can participate on an unrestricted basis.
 - Individuals with the following criteria should be restricted to low-intensity sport
 - History of syncope likely secondary to arrhythmia related to MVP
 - Family history of sudden death due to MVP
 - Exercise-induced repetitive supraventricular or complex ventricular arrhythmias
 - Moderate to severe mitral regurgitation

Arrhythmias

- Supraventricular
 - Atrial fibrillation is the most common arrhythmia.
 - Vigorous exertion and endurance training have been reported to increase atrial fibrillation.
- Ventricular arrhythmia is the most common cause of death in those with HCM.

Treatment

- Individuals with controlled atrial fibrillation can participate in sport or activity.

Evaluation

- Refer to Table 1.
- Moderate- to high-risk profiles for CAD include men older than 40 yr and women older than 50 yr or postmenopausal with one or more independent coronary risk factors (hyperlipidemia or dyslipidemia, systemic hypertension, cigarette smoking, diabetes mellitus, family

TABLE 1. AHA 12 element recommendations for preparticipation cardiovascular screening of competitive athletes.

History	Personal history	Exertional chest pain/discomfort Unexplained syncope/presyncope ^a Excessive exertional and unexplained dyspnea/fatigue associated with exercise Previous recognition of a heart murmur Elevated systemic blood pressure
	Family history	Premature death (sudden and unexpected) before age 50 yr due to heart disease in one relative or more Disability from heart disease in a close relative aged ≤50 yr Specific knowledge of certain cardiac conditions in family members: hypertrophic or dilated cardiomyopathy, long QT syndrome or ion channelopathies, Marfan syndrome, or clinically important arrhythmias
Physical examination		Heart murmurs ^c Femoral pulses to exclude aortic coarctation Physical stigmata of Marfan syndrome Brachial artery blood pressure (sitting position) ^b

^a Judged not to be neurocardiogenic (vasovagal) or particular concern when related to exertion.

^b Preferably taken in both arms.

^c Auscultation should be performed in both supine and standing positions (or with Valsalva maneuver), specifically to identify murmurs of dynamic left ventricular outflow tract obstruction.

history of premature CAD). Both should have symptom-limited ECG exercise testing.

It is *essential* that the team physician understand:

- The most common cause for sudden death in master athletes is atherosclerotic CAD.
- The indications for exercise ECG testing.
- The effects and adverse effects of cardiovascular medications on health and performance.
- When to restrict activity or participation among master athletes with cardiovascular issues.
- Automatic external defibrillators should be available at all sanctioned masters sporting events, along with personnel trained in cardiopulmonary resuscitation.

It is *desirable* that the team physician understand:

- How to manage medications in the master athlete with cardiovascular disease.
- Age-related cardiovascular determinants of exercise performance, such that guidelines may be given for exercise training.

Preparticipation Evaluation (PPE)

General considerations

- A PPE should be performed periodically for the athlete who is participating in a vigorous exercise.

- The PPE should emphasize the cardiovascular, musculoskeletal, and neurologic systems and be specific to both the individual athlete and his/her sport or activities.
- The primary goal is to identify patients at risk for cardiovascular complications of exercise, especially with occult disease.
- Other goals include identifying athletes who have relative restriction and need further evaluation/rehabilitation or absolute contraindications.
- The team physician should provide counsel on selection of appropriate sports/activities.
- Cardiovascular evaluation includes exercise testing (see Cardiovascular Considerations).
- Contraindications to exercise testing and/or exercise are given in Table 2.

Components of the PPE

History

- Complete medical history and review of systems
- History of denial or restriction from sports or activity
- Medications (recent fluoroquinolone use: FDA Black Box Warning, supplements, allergies)
- Cardiovascular issues
- Musculoskeletal issues
 - Previous injury involving time loss, diagnostic studies, and treatment
 - Previous surgery
 - Regular use of brace or assistive device
- Neurologic conditions
 - Head injury or concussion
 - Confusion or memory problems
 - Seizures
 - Exertional headaches
 - Balance issues
 - Numbness, tingling, weakness in arms and/or legs
- General concerns (e.g., safety, depression, anxiety, tobacco, alcohol, and recreational drug use)
- Other exercise-related medical issues
 - Heat and cold illness/injuries
 - Vision issues
 - Nutrition issues

TABLE 2. Contraindications to exercise testing and/or exercise training.

Unstable angina
Uncompensated heart failure
Critical aortic stenosis
Active myocarditis or pericarditis
Recent embolism
Uncontrolled complex arrhythmia
Significant ischemic changes on electrocardiogram
Uncontrolled systemic hypertension
Known cerebral or enlarging abdominal aortic aneurysms
Uncontrolled diabetes mellitus
Acute or unstable musculoskeletal injury
Recent ophthalmologic injury
Severe dementia
Other significant illness

- Female athlete issues; see “Female athlete issues for the team physician: a consensus statement” [*Med Sci Sports Exerc.* 2003;35(10):1785–93].

Physical examination

- Complete physical examination with emphasis on cardiac, neurological, and musculoskeletal systems or as directed by history
- Cardiovascular (see previous section)
- Musculoskeletal
 - Spine and joint examination as directed by sport/activity
- Neurologic examination
 - Strength and sensation upper and lower extremity
 - Reflexes
 - Balance and proprioception
- Additional testing to consider dependent on history and physical examination

Clearance issues

- Cleared without restrictions
- Cleared pending further testing or evaluation (additional testing, consultations, follow-up BP, etc.)
- Cleared with restrictions (e.g., collision/contact sports, load-bearing activities, vigorous activity)
- Not cleared for participation

Return-to-play issues

- See “The team physician and return-to-play issues: a consensus statement” [*Med Sci Sports Exerc.* 2002; 34(7):1212–4].
- Is the athlete at increased risk for injury or illness?
- Can this risk be modified to make it acceptable (protective equipment, rehabilitation, medication)?
- Are other participants at risk for injury or illness because of the problem?

It is *essential* that the team physician understand:

- The primary purpose of the PPE is to identify patients at risk for cardiovascular complications of exercise, especially with occult cardiac disease.
- The PPE should emphasize the cardiovascular, musculoskeletal, and neurologic systems and be specific to both the individual athlete and his/her sport or activities.
- Perform a history and physical that clears the athlete for participation or identifies need for further evaluation or referral.

It is *desirable* that the team physician understand:

- Preventive screening for chronic disease in the older athlete.
- Coordinate a multidisciplinary team to care for the master athlete.
- Additional testing to evaluate fitness and exclude cardiovascular disease, major musculoskeletal deficiencies, and neurologic/balance issues.

MUSCULOSKELETAL CONSIDERATIONS FOR THE MASTER ATHLETE

Achilles Tendon Ruptures

Etiologic factors

- Age: There is a higher incidence older than 45 yr
- Fluoroquinolones: FDA Black Box Warning of increased risk
- Activity: Sudden changes in intensity of eccentric athletic activity, which result in tensile overload
- Tendon degenerative changes include the following:
 - Decreased tensile strength and increased stiffness
 - Decreased number of Golgi tendon receptors, which results in altered force regulation feedback to muscle

Clinical presentation

- There are minimal prodromal symptoms. Painful Achilles tendons rarely rupture.
- Acute presentation
 - Pop/snap (sensation of being struck) on sudden eccentric loading, in acceleration, deceleration
 - Impaired ability to walk, to raise up on toes, or to run
 - Physical examination
 - Palpable defect in tendon in the midsubstance or at the distal insertion. Must differentiate this from proximal muscle tendon junction injury.
 - Thompson test (lack of passive foot plantarflexion with gastrocnemius squeeze) is diagnostic.
- Delayed presentation
 - History of injury and subsequent impaired performance in running, jumping, and stair climbing
 - Physical examination
 - Findings include point tenderness with thickened tendon or palpable defect as well as calf atrophy and strength deficit.
 - Positive Thompson test

Imaging

- Plain x-rays: Evaluate for calcific enthesopathy
- Magnetic resonance imaging (MRI) or ultrasound: Rarely needed in acute cases, may be useful in chronic cases

Treatment

- Nonoperative
 - Casting is rarely indicated.
 - Functional bracing: Non-weight bearing for 2–3 wk followed by gradual protected weight bearing.
 - Prohibit dorsiflexion
 - Progressive institution of rehabilitation
 - Casting or bracing are ineffective for chronic ruptures.

- Operative
 - Open repairs with/without augmentation
 - Early intervention (within 2 wk) is optimal.
 - For chronic tears, open repair with allograft augmentation is preferred.
- Outcomes
 - Functional bracing versus operative both have similar high rates of initial tendon healing.
 - Retear rate is higher in braced compared with operative.
 - Beware of certain complications (wound healing, nerve injury) in operative cases.

Risk reduction

- Cautious use of fluoroquinolones
- Maintain muscle strength, balance, and flexibility of the gastroc/soleus complex and the kinetic chain of the lower extremity.
- Functional conditioning and training
 - Balance training
 - Eccentric strength training
- Use caution when transitioning from nonballistic to ballistic activities.

It is *essential* that the team physician:

- Know that fluoroquinolones are associated with increased risk of tendon rupture.
- Recognize the clinical presentation of acute Achilles tendon ruptures.
- Know how to perform a Thompson test.

It is *desirable* that the team physician know:

- The pathophysiology of Achilles tendon rupture.
- The clinical presentation of chronic Achilles tendon rupture.
- The benefits and problems associated with operative and nonoperative treatments.
- The content and implementation of a conditioning program for reducing the risk factors of Achilles tendon rupture.

Osteoarthritis

General considerations

- Degeneration of articular cartilage characterized by loss of cartilage thickness, attempted repair, remodeling, subchondral sclerosis, and osteophytes.
- The most common cause of musculoskeletal pain and disability.

Hip

Etiologic factors

- Age
- Obesity

- History of previous trauma
- Developmental abnormalities: Developmental dysplasia of the hip, femoral anteversion
- Sporting activities
 - Increased risk with soccer, track and field, runners more than 60 miles-wk⁻¹, tennis, and ballet
 - Other sports unknown

Clinical presentation

- Symptoms can be progressive.
- Pain
 - Radiating to groin
 - Increased with weight bearing, rotation
 - May be referred to knee region
- Mechanical symptoms: Locking, catching
- Physical examination
 - Pain to palpation over hip joint
 - Antalgic gait
 - Decreased range of motion (ROM)
 - Hip strength: Weak in flexion, abduction
- Differential diagnosis includes spine, intraabdominal/pelvic pathology, peripheral nerve entrapment, and trochanteric bursitis.

Imaging

- Imaging findings alone do not dictate treatment
- Plain x-rays: Anteroposterior (AP), true lateral
 - Joint space narrowing and osteophytes
- MRI and computed tomography (CT): Usually unnecessary unless associated intra-articular pathology is suspected

Treatment

- Nonoperative
 - Weight loss if indicated
 - Physical therapy
 - Flexibility to improve ROM
 - Strengthening for the gluteus, core
 - Reduces pain, no change in disability
 - Appears to have less benefit than that in knee arthritis
 - Directed home exercise seems to be as effective as structured exercise.
 - Activity modification: Directed at symptom relief only
 - Decreased repetitive impact loading, rotation
 - Exercise as tolerated
 - Pharmacologic: Directed at symptom relief only
 - Acetaminophen is preferred. If ineffective, consider nonsteroidal anti-inflammatory drugs (NSAID) with caution.
 - Intra-articular corticosteroid injections: Used for short-term symptom relief; no scientific basis for long-term benefit.

- Viscosupplementation is not FDA-approved: No evidence of efficacy.
- Glucosamine has not been shown to be effective.
- Operative
 - Arthroscopic
 - Unclear if changes natural history or decreases symptoms
 - Arthroplasty
 - Significant change in pain, ROM, strength
 - Increase in walking speed and stride length
 - Increase in exercise duration and maximum workload
 - Postoperative sports activity is dependent on preoperative activity. Patients who have high levels of performance preoperative have a better chance of resuming that activity, usually with some limitations (Table 3).

It is *essential* that the team physician:

- Know the clinical presentation of hip osteoarthritis.
- Understand medical management is directed toward symptom relief only.
- Understand treatment options.
- Conduct a comprehensive history and physical examination of the hip.

It is *desirable* that the team physician:

- Understand the pathophysiology of osteoarthritis.
- Implement a nonoperative program, including activity modification and weight control if needed.
- Conduct an in-depth history and physical examination to evaluate for other causes of hip region pain.

TABLE 3. Activity after total hip arthroplasty—1999 Hip Society Survey.

Recommended/ Allowed	Allowed with Experience	Not Recommended	No Conclusion
Stationary bicycling	Low-impact aerobics	High-impact aerobics	Jazz dancing
Croquet	Road bicycling	Baseball/softball	Square dancing
Ballroom dancing	Bowling	Basketball	Fencing
Golf	Canoeing	Football	Ice skating
Horseshoes	Hiking	Gymnastics	Roller/inline skating
Shooting	Horseback riding	Handball	Rowing
Shuffleboard	Cross-country skiing	Hockey	Speed walking
Swimming		Jogging	Downhill skiing
Doubles tennis		Lacrosse	Stationary skiing ^a
Walking		Racquetball	Weight lifting
		Squash	Weight machines
		Rock climbing	
		Soccer	
		Singles tennis	
		Volleyball	

^a NordicTrack, Logan, UT.

- Be able to counsel patients regarding risks and benefits of sports activity after operative treatment.
- Interpret imaging.

Knee

Etiologic factors

- Age
- Gender (female > male)
- Obesity
- Joint malalignment
- Previous joint injury (e.g., meniscus, anterior cruciate ligament, articular cartilage) and osteochondritis dissecans
- Muscle weakness/imbalance

Clinical presentation

- Progressive and episodic pain, stiffness, and swelling
- Joint malalignment: Varus/valgus
- Muscle weakness/imbalance
 - Quadriceps/hamstrings
 - Vastus medialis obliquus/vastus lateralis
- Mechanical symptoms may be present
 - Locking, catching, instability

Imaging

- Imaging findings alone do not dictate treatment.
- Plain x-rays
 - Bilateral AP standing, PA standing 45° flexion, lateral, tangential patellar.
- MRI: For suspected associated intra-articular pathology.

Treatment

- Nonoperative
 - Weight loss if indicated
 - Pharmacologic: Directed primarily at symptom relief
 - Acetaminophen is preferred. If ineffective, consider NSAID with caution.
 - Glucosamine remains controversial.
 - Steroid injections: Short-term relief of inflammatory symptoms and should be used infrequently.
 - Viscosupplementation
 - Benefits may last 6 months or longer.
 - Inflammatory reactions may occur.
 - Activity modification
 - Decrease repetitive impact loading, rotation.
 - Encourage low-impact forms of exercise to maintain function.
 - Physical therapy
 - Quadriceps strengthening, especially vastus medialis obliquus
 - Hamstring strengthening
 - Kinetic chain training

- Flexibility (e.g., stretching to address knee contracture)
 - Directed home exercise seems to be as effective as structured exercise.
 - Consistent exercise program results in decreased pain, improvement in function.
- Unloader braces may be effective in unicompartmental disease and correctable malalignment.
- Operative
 - Arthroscopic
 - Ineffective for pain alone
 - May be effective for patients with pain and mechanical symptoms
 - Does not alter the natural history of osteoarthritis
 - Cartilage repair
 - Microfracture, mosaicplasty, autologous cartilage implantation
 - There are specific indications for each use.
 - Meniscal allograft replacement
 - Limited indications; optimal in early osteoarthritis
 - Alignment
 - High tibial, femoral osteotomy for specific malalignment issues
 - Arthroplasty
 - Unicompartmental
 - Total knee replacement
 - Highly successful for pain relief, increased joint function
 - Increases exercise duration and maximum workload
 - Postoperative sports activity dependent on preoperative activity. Patients who have high levels of performance preoperative have a better chance of resuming that activity, usually with some limitations (Table 4).

TABLE 4.

Recommended/ Allowed	Allowed with Experience	Not Recommended	No Conclusion
Low-impact aerobics Stationary bicycling	Road bicycling Canoeing	Racquetball Squash	Fencing Roller blade/ inline skating
Bowling	Hiking	Rock climbing	Downhill skiing
Golf Dancing	Rowing Cross-country skiing	Soccer Singles tennis	Weight lifting
Horseback riding	Stationary skiing ^a	Volleyball	
Croquet Walking Swimming	Speed walking Tennis Weight machines	Football Gymnastics Lacrosse	
Shooting Shuffleboard Horseshoes	Ice skating	Hockey Basketball Jogging Handball	

^a NordicTrack, Logan, UT.

It is *essential* that the team physician:

- Know the clinical presentation of knee osteoarthritis.
- Know that muscle strengthening is a key point in treatment.
- Understand treatment options.
- Understand medical management is directed toward symptom relief.
- Conduct a comprehensive history and physical examination of the knee.

It is *desirable* that the team physician:

- Implement a nonoperative program, including activity modification and weight control if needed.
- Be able to counsel patients regarding risks and benefits of sports activity after operative treatment.
- Interpret imaging

Shoulder Osteoarthritis

Etiologic factors

- Age
- Gender (male > female)
- Degeneration is most common causation; it is not necessarily associated with athletic activity.
- After injury
 - Fracture
 - Loss of joint congruity
 - Avascular necrosis
 - Instability
 - Recurrent dislocations
 - Postsurgical: Overtightening, loss of rotation
 - Rotator cuff disease
 - Decompensated massive rotator cuff tear (“cuff arthropathy”)

Clinical presentation

- Gradual onset
- Pain: Worse with activity; frequently worsens at night
- Decreased ROM (rotation, flexion)
- Crepitus and symptoms of popping, catching
- Decreased ability to bear loads
- Strength may or may not be decreased

Imaging

- Imaging findings alone do not dictate treatment.
- Plain x-rays are routine in evaluation.
 - Multiplanar views: True AP (internal and external rotation), axillary, outlet
- MRI is rarely necessary for initial treatment; it is necessary for preoperative planning.

Treatment

- In general, shoulder arthritis is well tolerated.
 - There is commonly minimal significant load bearing through the joint.

- Many activities of daily living can be achieved through small arcs of motion.
- Athletes with higher demands may not tolerate arthritis well and may require more customized treatment.
- Major signs and symptoms to be addressed in treatment:
 - Pain
 - Decreased ROM
 - Painful crepitus/mechanical symptoms
 - Decreased ability to bear loads, with/without strength loss
 - Decreased strength
 - Overhead activities
- Nonoperative treatment
 - Pharmacological
 - Acetaminophen is preferred. If ineffective, consider NSAID with caution.
 - Intra-articular corticosteroid injections: Used for short-term symptom relief; no scientific basis for long-term benefit
 - Viscosupplementation is not FDA-approved; no evidence of efficacy.
 - Physical therapy
 - Capsular mobilization to increase motion
 - Stretching after capsular mobilization
 - Maximize rotator cuff strength
 - Maximize scapular position/motion as part of scapulohumeral rhythm
 - Activity modification
 - Change workouts, lighter weights, different positions
- Operative treatment
 - Arthroscopic
 - Clinically significant intra-articular pathology (e.g., rotator cuff tear, labral pathology) in the arthritic shoulder
 - Arthroscopic capsular release good in demonstrated capsular contracture and for removal of bone spurs with minimal arthritis
 - No lasting benefit for pain alone
 - Arthroplasty
 - Pain relief, increases ROM, increases strength, especially below 90° of abduction
 - Most athletes are unable to return to activities with overhead motions without modification.
 - Modifications may be necessary in certain sports/activities that require motion above 90°.

It is *essential* that the team physician:

- Know clinical presentation of shoulder osteoarthritis.
- Understand not all shoulder joint pain is due to osteoarthritis.
- Understand treatment options.
- Conduct a comprehensive history and physical examination of the shoulder.

It is *desirable* that the team physician:

- Interpret imaging.
- Implement a treatment program.
- Understand the pathophysiology of shoulder osteoarthritis.
- Suggest and implement activity modifications to allow maximum athletic participation within the limits of the arthritis.

Lumbar Spinal Stenosis (LSS)

General considerations

- Natural history in the absence of medical care has not been well studied.
- Stenosis (canal narrowing) can be central, lateral recess, neuroforaminal, or a combination.
- Cause of pain not completely understood. Direct compression of nerve root and disruption of vascular flow hypothesized.

Etiologic factors

- Age
- Stenosis is usually caused by degenerative changes (disk bulging and facet and ligament hypertrophy).
 - Other etiologies include disk herniation, spondylolisthesis, synovial cyst, and epidural lipomatosis.

Clinical presentation

- Symptoms
 - Neurogenic claudication
 - Classic presentation
 - Radiating pain from the back or buttocks into the lower extremities
 - Occurs with walking and is relieved by sitting or bending forward
 - Also occur with prolonged standing
 - Include numbness, tingling, fatigue, and weakness
 - Vary based on the severity, type, and location of the stenosis (e.g., bilateral vs unilateral lower extremity symptoms and different radicular distributions)
 - May wax and wane
 - Progression is typically insidious, although rapid progression may occur.
- Physical examination
 - Reproduction of lower extremity symptoms with lumbar extension
 - Neurological examination is often normal.
 - May have absent ankle reflexes, a common age-related finding
- Differential diagnosis includes vascular disease, peripheral neuropathy, hip pathology, myopathy, myelopathy, and rheumatologic disease (e.g., polymyalgia rheumatica).

Imaging/diagnostic studies

- This is a radiographic diagnosis that must correlate with signs and symptoms.
 - 21% of asymptomatic people aged 60 yr or older have stenosis by MRI.
- X-ray: Weight bearing AP and weight bearing lateral flexion/extension views
- Advanced imaging: Usually MRI; occasionally myelogram/CT
- EMG, vascular studies, and laboratory tests may also be indicated.

Nonoperative care

- Appropriate for patients with mild to moderate symptoms or patients who have medical contraindications to surgery
 - Does not alter the natural history
 - Helps manage symptoms and maintain function
- Pharmacologic
 - Acetaminophen is preferred. If ineffective, consider NSAID with caution.
 - Oral corticosteroids with caution
 - Opiates sparingly
 - Antidepressants and anticonvulsants for neuropathic pain
 - Fluoroscopically guided spinal injections used sparingly as an adjunct to treatment
- Physical therapy
 - Directional preference traditionally toward flexion
 - Aerobic conditioning, strength, and balance training
- Lumbar support for comfort only
- Activity modification usually emphasizing flexion-biased activities (e.g., bicycling vs running)

Operative care

- Appropriate for patients with severe lower extremity symptoms and/or functional limitations without medical contraindications
- Decompression via laminectomy is the most frequently performed surgery.
 - Fusion has been reserved for cases of stenosis with instability or, in some cases, of scoliosis and stenosis.
 - Data on implantable spinous process spacers remain limited.

It is *essential* that the team physician:

- Understand the clinical presentation of LSS.
- Understand the course of LSS is usually insidious and not all cases require surgery.
- Conduct a history and physical examination of the spine.
- Understand treatment options.
- Understand indications and limitations of imaging methods.

It is *desirable* that the team physician:

- Interpret imaging.
- Understand the differential diagnosis of LSS.
- Understand the diagnostic assessment of LSS.
- Understand the indications for nonoperative and operative treatment.

Rotator Cuff Tendinopathy/Tear

Etiologic factors

- Intrinsic
 - Decreased tensile strength of the tendons
 - Intrinsic tendon degeneration; secondary to apoptosis
 - Direct tendon overload mainly presents as articular-sided injuries.
- Extrinsic
 - Compression against adjacent structures: Subacromial space, coracoacromial arch, coracoid
- In an animal model, extrinsic compression does not cause injury without intrinsic factors.
- Fluoroquinolones: FDA Black Box Warning

Clinical presentation

- This presents in a spectrum of tendinopathy, with the end point being tear.
- Gradual onset of tendinopathy or tear
 - History of chronic “tendonitis/bursitis”
 - Weakness/fatigue, especially in overhead/forward flexed positions
 - Night pain is a dominant feature
- Acute onset of tear
 - Posttraumatic: Most common is fall on outstretched arm
 - Marked weakness to attempted forward flexion/abduction
 - Night pain
- Physical examination
 - (+/-) Atrophy
 - (+) Impingement sign and test (subacromial local anesthetic injection)
 - Painful arc of motion
 - Muscle weakness or pain inhibition
 - Supraspinatus: Forward flexion, horizontal adduction
 - Infraspinatus: External rotation, especially at 90° of abduction
 - Subscapularis: Lift-off test (limited because of pain), belly press test, bear hug test
 - “Lag” signs: Inability to hold upper extremity in position specific for that muscle

Imaging

- Imaging findings alone do not dictate treatment.
- Plain x-rays are routine in evaluation.
 - Multiplanar views: True AP (internal and external rotation), axillary, outlet

- MRI
 - Noncontrast MRI: High accuracy in full-thickness tears, size of tear, amount of retraction, and/or atrophy
 - MRI arthrogram: Good accuracy in partial-thickness tears and is valuable if other pathology is suspected
 - Positive findings may be clinically insignificant.
- MRI may not be necessary for initial treatment; it is indicated in the presence of significant findings of tear or failure of initial treatment.
- Diagnostic ultrasound
 - May be helpful adjunct, although reliability is ultrasound technician-dependent
- CT/CT arthrogram
 - If MRI contraindicated
 - Good to estimate amount of muscle atrophy

Treatment

- Not all full-thickness tears need surgical treatment; some partial tears may need surgical treatment.
- Nonoperative
 - Pharmacologic
 - Acetaminophen is preferred. If ineffective, consider NSAID with caution.
 - Corticosteroid injections used for short-term symptom relief; no scientific basis for long-term benefit.
 - Physical therapy
 - ROM
 - Strengthening of rotator cuff muscle to maximize cocontraction force couples
 - Scapular stabilization
- Operative
 - Indications
 - Tendinopathy/partial-thickness tear not responsive to nonoperative treatment
 - Acute full-thickness tear
 - Chronic full-thickness tear not responsive to nonoperative treatment
 - Surgery may be open or arthroscopic
 - For acute full-thickness tears, best results if repaired within the first 3 wk
 - Less successful results with large chronic tears
 - Must address associated intra-articular or extra-articular pathology

It is *essential* that the team physician:

- Understand the clinical presentation of rotator cuff tendinopathy and tear.
- Understand intrinsic and extrinsic pathophysiological factors.
- Recognize not all full-thickness tears need surgical treatment; some partial tears may need surgical treatment.

- Understand treatment options.
- Understand indications and limitations of imaging methods.
- Conduct a comprehensive history and physical examination of the shoulder.

It is *desirable* that the team physician:

- Interpret imaging.
- Implement a nonoperative treatment program including kinetic chain activation, scapular control, and rotator cuff strengthening exercises.

Lateral Elbow Tendinopathy

Etiologic factors

- Age
- Repetitive strain in the tendons—extensor carpi radialis brevis, extensor carpi radialis longus
- Tendon degenerative changes include the following:
 - Decreased tensile strength and increased stiffness
 - Cellular changes due to apoptosis
- Extrinsic overload owing to overuse, especially in pronation
- Posttraumatic direct blow
- Fluoroquinolones: FDA Black Box Warning of increased risk

Clinical presentation

- Pain with wrist dorsiflexion, shaking hands
- Inability to do pronation activities
- Pain with tennis strokes, backhand
- Differential diagnosis include radial nerve entrapment
- Physical examination
 - Point tenderness anterior and distal to epicondyle
 - Decreased strength to wrist dorsiflexion
 - Pain and/or weakness with resisted supination from a position of pronation
 - Occasional radial nerve findings: Tinel sign, weakness
 - Weakness in shoulder external rotation

Imaging

- Imaging findings alone do not dictate treatment.
- Plain x-rays: AP and lateral
- MRI: Rarely necessary but can demonstrate tendon damage

Treatment

- Pharmacologic
 - Acetaminophen is preferred. If ineffective, consider NSAID with caution.
 - Corticosteroid injections: Used for short-term symptom relief; no scientific basis for long-term benefit

- Multiple injections should be avoided; may cause tendon degeneration.
- Single injections may cause subcutaneous fat atrophy and depigmentation.
- Topical nitroglycerin treatment (adverse effects may limit use)
- Nonoperative
 - Flexibility, especially to improve pronation
 - Local strengthening, especially cocontractions
 - Kinetic chain strengthening, especially shoulder external rotation
 - Modification or change in the mechanics of the sport/activity
 - Limited literature support for efficacy
 - Modalities: Ultrasound, iontophoresis (some literature benefit)
 - Augmented soft tissue mobilization (some literature benefit)
 - Forearm splint: Decrease wrist pronation/palmar flexion
 - Counterforce brace
 - Autologous blood injections, extracorporeal shockwave, prolotherapy

- Operative
 - Indicated for failed nonoperative care
 - Open, arthroscopic
- Prevention
 - Avoid training errors, sudden changes in volume and intensity of wrist/arm activity, especially excessive pronation.
 - Optimize the mechanics of the sport/activity.
 - Proper equipment and fit
 - Upper extremity strengthening

It is *essential* that the team physician:

- Understand the etiologic factors in elbow tendinopathy.
- Understand treatment options.
- Conduct a comprehensive history and physical examination of the elbow.
- Understand the complications related to corticosteroid injection.

It is *desirable* that the team physician:

- Interpret imaging.
- Implement a nonoperative treatment program.
- Understand indications and goals of an operative treatment program.



- American Academy of Family Physicians (AAFP)
11400 Tomahawk Creek Pkwy
Leawood, KS 66211
800-274-2237
www.aafp.org



- American Medical Society for Sports Medicine (AMSSM)
11639 Earnshaw
Overland Park, KS 66210
913-327-1415
www.amssm.org



- American Academy of Orthopaedic Surgeons (AAOS)
6300 N River Rd
Rosemont, IL 60018
800-346-AAOS
www.aaos.org



- American Orthopaedic Society for Sports Medicine (AOSSM)
6300 N River Rd, Suite 500
Rosemont, IL 60018
847-292-4900
www.sportsmed.org



- American College of Sports Medicine (ACSM)
401 W Michigan St
Indianapolis, IN 46202
317-637-9200
www.acsm.org



- American Osteopathic Academy of Sports Medicine (AOASM)
7600 Terrance Ave., Suite 203
Middleton, WI 53562
608-831-4400
www.aoasm.org

SELECTED READINGS

American College of Sports Medicine, American Academy of Family Physicians, American Academy of Orthopaedic Surgeons, American Medical Society for Sports Medicine, American Orthopaedic Society for Sports Medicine, American Osteopathic Academy of Sports Medi-

cine. Team physician consensus statement. *Med Sci Sports Exerc.* 2000; 32(4):877.

American College of Sports Medicine, American Academy of Family Physicians, American Academy of Orthopaedic Surgeons,

American Medical Society for Sports Medicine, American Orthopaedic Society for Sports Medicine, American Osteopathic Academy of Sports Medicine. Sideline preparedness for the team physician: a consensus statement. *Med Sci Sports Exerc.* 2001;33(5):846–9.

American College of Sports Medicine, American Academy of Family Physicians, American Academy of Orthopaedic Surgeons, American Medical Society for Sports Medicine, American Orthopaedic Society for Sports Medicine, American Osteopathic Academy of Sports Medicine. The team physician and conditioning of athletes for sports: a consensus statement. *Med Sci Sports Exerc.* 2001;33(10):1789–93.

American College of Sports Medicine, American Academy of Family Physicians, American Academy of Orthopaedic Surgeons, American Medical Society for Sports Medicine, American Orthopaedic Society for Sports Medicine, American Osteopathic Academy of Sports Medicine. The team physician and return-to-play issues: a consensus statement. *Med Sci Sports Exerc.* 2002;34(7):1212–4.

American College of Sports Medicine, American Academy of Family Physicians, American Academy of Orthopaedic Surgeons, American Medical Society for Sports Medicine, American Orthopaedic Society for Sports Medicine, American Osteopathic Academy of Sports Medicine. Female athlete issues for the team physician: a consensus statement. *Med Sci Sports Exerc.* 2003;35(10):1785–93.

American College of Sports Medicine, American Academy of Family Physicians, American Academy of Orthopaedic Surgeons, American Medical Society for Sports Medicine, American Orthopaedic Society for Sports Medicine, American Osteopathic Academy of Sports Medicine. Mass participation event management for the team physician: a consensus statement. *Med Sci Sports Exerc.* 2004;36(11):2004–8.

American College of Sports Medicine, American Academy of Family Physicians, American Academy of Orthopaedic Surgeons, American Medical Society for Sports Medicine, American Orthopaedic Society for Sports Medicine, American Osteopathic Academy of Sports Medicine. Concussion (mild traumatic brain injury) and the team physician: a consensus statement. *Med Sci Sports Exerc.* 2006;38(2):395–9.

American College of Sports Medicine, American Academy of Family Physicians, American Academy of Orthopaedic Surgeons, American Medical Society for Sports Medicine, American Orthopaedic Society for Sports Medicine, American Osteopathic Academy of Sports Medicine. Psychological issues related to injury in athletes and the team physician: a consensus statement. *Med Sci Sports Exerc.* 2006;38(11):2030–4.

American College of Sports Medicine, American Academy of Family Physicians, American Academy of Orthopaedic Surgeons, American Medical Society for Sports Medicine, American Orthopaedic Society for Sports Medicine, American Osteopathic Academy of Sports Medicine. Selected issues in injury and illness prevention and the team physician: a consensus statement. *Med Sci Sports Exerc.* 2007;39(11):2058–68.

American College of Sports Medicine, American Academy of Family Physicians, American Academy of Orthopaedic Surgeons, American Medical Society for Sports Medicine, American Orthopaedic Society for Sports Medicine, American Osteopathic Academy of Sports Medicine. Selected issues for the adolescent athlete and the team physician: a consensus statement. *Med Sci Sports Exerc.* 2008;40(11):1997–2012.

Cardiovascular Considerations: Chobanian AV, Bakris GL, Black HR, et al. The Seventh Report of the Joint Commission on Prevention, Detection, Evaluation, and Treatment of High Blood Pressure. *Hypertension.* 2003;42:1206–52.

Heckman GA, McKelvie RS. Cardiovascular aging and exercise in healthy older adults. *Clin J Sport Med.* 2008;18(6):479–85.

Kaplan NM, Gidding SS, Pickering TG, Wright JT. 36th Bethesda Conference: recommendations for determining eligibility for competition in athletes with cardiovascular abnormalities: Task Force 5: systemic hypertension. *J Am Coll Cardiol.* 2005;45:1346–8.

Maron BJ, Araujo CJS, Thompson PD, et al. Recommendations for preparticipation screening and the assessment of cardiovascular disease in masters athletes: an advisory for healthcare professionals from the working groups of the World Heart Federation, the International Federation of Sports Medicine, and the American Heart Association Committee on Exercise, Cardiac Rehabilitation, and Prevention. *Circulation.* 2001;103:327–34.

Pigozzi F, Spataro A, Alabiso A, et al. Role of exercise stress test in master athletes. *Br J Sports Med.* 2005;39:527–31.

Tanaka H, Seals DR. Endurance exercise performance in master athletes: age-associated changes and underlying physiological mechanisms. *J Physiol.* 2008;586:55–63.

Thompson PD, Balady GJ, Chaitman BR, Clark LT, Levine BD, Myerburg RJ. 36th Bethesda Conference: recommendations for determining eligibility for competition in athletes with cardiovascular abnormalities: Task Force 6: coronary artery disease. *J Am Coll Cardiol.* 2005;45:1348–53.

Spine: Amundsen T, Weber H, Nordal HJ, et al. Lumbar spinal stenosis: conservative or surgical management? A prospective 10 year study. *Spine.* 2000;25:1424–36.

Atlas SJ, Keller RB, Wu YA, et al. Long-term outcomes of surgical and nonsurgical management of lumbar spinal stenosis: 8 to 10 year results from the Maine Lumbar Spine Study. *Spine.* 2005;30:936–43.

Boden SD, Davis DO, Dina TS, et al. Abnormal magnetic-resonance scans of the lumbar spine in asymptomatic subjects: a prospective investigation. *J Bone Joint Surg Am.* 1990;72:403–8.

Goh KJ, Khalifa W, Anslow P, et al. The clinical syndrome associated with lumbar spinal stenosis. *Eur Neurol.* 2004;52:242–9.

Standaert CJ, Herring SA. What's best for your patient with lumbar spinal stenosis? *Patient Care.* 2006;40(11):14–21.

Truumees E. Spinal stenosis: pathophysiology, clinical and radiologic classification. *Instr Course Lect.* 2005;54:287–302.

Shoulder: Brislin KJ, Savoie FH, Field LD, Ramsey JR. Surgical treatment for glenohumeral arthritis in the young patient. *Tech Shoulder Elbow Surg.* 2004;5:165–9.

Clifford PE, Mallon WJ. Sports after total joint replacement. *Clin Sports Med.* 2005;24:175–86.

Reineck JR, Krishnan SG, Burkhead WZ. Early arthritis in the competing athlete. *Clin Sports Med.* 2008;27:803–20.

Sperling JW, Antuna SA, Sanchez-Sotelo J, Schleck C, Cofield RH. Shoulder arthroplasty for arthritis after instability surgery. *J Bone Joint Surg.* 2002;84:1775–81.

Weinstein DM, Bucchieri JS, Pollock RG, Flatow EL, Bigliani LU. Arthroscopic debridement of the shoulder for arthritis. *Arthroscopy.* 2000;16:471–6.

Strength: Faulkner JA, Davis CS, Mendias CL, Brooks SV. The aging of elite male athletes: age-related changes in performance and skeletal muscle structure and function. *Clin J Sport Med.* 2008;18(6):501–7.

Hawkins SA, Wiswell RA, Marcell TJ. Exercise and the master athlete—a model of successful aging? *J Gerontol A Biol Sci Med Sci.* 2003;58(11):1009–11.

Nelson ME, Rejeski WJ, Blair SN, et al. Physical activity and public health in older adults: recommendation from the American College of Sports Medicine and the American Heart Association. *Med Sci Sports Exerc.* 2007;39(8):1435–45.

Atrophy, Physiology: Best TM, Hart L. A growing concern: the older athlete. *Clin J Sport Med.* 2008;18(6):477–8.

Haaland DA, Sabljic TF, Baribeau DA, Mukovozov IM, Hart LE. Is regular exercise a friend or foe of the aging immune system? A systematic review. *Clin J Sport Med.* 2008;18(6):539–48.

Kettunen JA, Kujala UM, Kaprio J, Sarna S. Health of master track and field athletes: a 16-year follow-up study. *Clin J Sport Med.* 2008;18(6):142–8.

McKean KA, Manson NA, Stanish WD. Musculoskeletal injury in the masters runners. *Clin J Sport Med.* 2008;18(6):149–54.

Powell AP. Issues unique to the master athlete. *Curr Sports Med Rep.* 2005;4(6):335–40.

Petrella RJ, Chudyk A. Exercise prescription in the older athlete as it applies to muscle, tendon, and arthroplasty. *Clin J Sport Med.* 2008;18(6):522–30.

Roubenoff R. Sarcopenia: effects on body composition and function. *J Gerontol A Biol Sci Med Sci.* 2003;58:M1012–7.

Singh MAF. Exercise comes of age: rationale and recommendations for a geriatric exercise prescription. *J Gerontol A Biol Sci Med Sci.* 2002;57:M262–82.

Tanaka H, Seals DR. Endurance exercise performance in masters athletes: age-associated changes and underlying physiological mechanisms. *J Physiol.* 2008;586(1):55–63.

Tarnopolsky MA. Nutritional consideration in the aging athlete. *Clin J Sport Med.* 2008;18(6):531–8.

van Uffelen JG, Marijke JM, Chin A Paw, Hopman-Rock M, van Mechelen W. The effects of exercise on cognition in older adults with and without cognitive decline: a systematic review. *Clin J Sport Med.* 2008;18(6):486–500.

Rotator Cuff: Bokor DJ, Hawkins RJ, Huckell GH, Angelo RL, Schickendantz MS. Results of nonoperative management of full

thickness rotator cuff tears. *Clin Orthop Relat Res.* 1994;294:103–10.

Burkhart SS. Reconciling the paradox of rotator cuff repair versus debridement. *Arthroscopy.* 1994;10:4–19.

Carpenter JE, Flanagan CL, Thomopoulos S, Yian EH, Soslowsky LJ. The effects of overuse combined with intrinsic or extrinsic alterations in an animal model. *Am J Sports Med.* 1998;26:801–7.

McFarland E. *Examination of the shoulder: the complete guide.* New York (NY): Thieme; 2006.

Mehta S, Gimbel JA, Soslowsky LJ. Etiologic and pathogenetic factors for rotator cuff tendinopathy. *Clin Sports Med.* 2003;22:79–812.

Valadie AL 3rd, Jobe CM, Pink MM, Ekman EF, Jobe FW. Anatomy of provocative tests for impingement syndrome. *J Shoulder Elb Surg.* 2000;9:36–46.

Knee: American Academy of Orthopaedic Surgeons [Internet]. Treatment of osteoarthritis of the knee (nonarthroplasty). 2008 [cited 2009 Feb 24]. Available from: <http://www.aaos.org/Research/guidelines/GuidelineOAKnee.asp>.

PPE: American Academy of Family Physicians, American Academy of Pediatrics, American College of Sports Medicine, American Medical Society for Sports Medicine, American Orthopaedic Society for Sports Medicine, and American Osteopathic Academy of Sports Medicine. *Preparticipation Physical Evaluation.* 3rd ed. Minneapolis (MN): Physician and Sportsmedicine; 2005.

Garrick JG. Preparticipation orthopedic screening evaluation [review]. *Clin J Sport Med.* 2004;14(3):123–6.

Maron BJ, Zipes DP, Mitten MJ. 36th Bethesda Conference: eligibility recommendations for competitive athletes with cardiovascular abnormalities. *J Am Coll Cardiol.* 2005;45(8):1314–75.

Maron BJ, Thompson PD, Ackerman MJ, et al; American Heart Association Council on Nutrition, Physical Activity, and Metabolism. Recommendations and considerations related to preparticipation screening for cardiovascular abnormalities in competitive athletes: 2007 update: a scientific statement from the American Heart Association Council on Nutrition, Physical Activity, and Metabolism: endorsed by the American College of Cardiology Foundation. *Circulation.* 2007;115(12):1643–55.

Maron BJ, Douglas PS, Graham TP, Nishimura RA, Thompson PD. Task Force 1: preparticipation screening and diagnosis of cardiovascular disease in athletes [review]. *J Am Coll Cardiol.* 2005;45(8):1322–6.

Rumball JS, Lebrun CM. Preparticipation physical examination: selected issues for the female athlete [review]. *Clin J Sport Med.* 2004;14(3):153–60.