In the past quarter century, traditional “free play” situations for youth in neighborhood settings have largely been replaced by organized sports programs. Year-round training, sport specialization, and participation with multiple teams have replaced recreational activities which traditionally have provided young athletes opportunity to develop a wide range of skills. Consequently, as youth sports participation has become more specialized, the incidence of overuse injuries in children and adolescent athletes has been increasing.

The purpose of this review is to provide clinicians an overview for educating young athletes, parents, and coaches about the causative factors, early recognition, and strategies for prevention of sports-related overuse injuries.

**Overuse Injuries: Definition and Causation**

Overuse injuries occur when repetitive stress is applied to a muscle, tendon, or bone, ultimately resulting in microtraumatic damage when adequate time to heal or repair has not been allotted. Nearly 50% of injuries presenting to pediatric sports medicine practices are related to overuse.

Causative factors for overuse injuries can be categorized into intrinsic and extrinsic factors.

**Intrinsic Factors**

**Anatomic**

Several “physiologic” malalignments of the lower extremities can predispose young athletes to overuse injuries. These include medial femoral anteversion, internal tibial torsion, and foot overpronation. Individually or collectively, these conditions can contribute to tracking abnormalities of the patella, stress injuries, and other chronic conditions of the hip, knee, and ankle for young athletes participating in sports that are particularly demanding of the lower extremities, such as running and soccer. Additionally, leg length discrepancies can contribute to chronic back and lower extremity pain, leading to compensatory changes in gait and posture which may contribute to overuse injuries associated with lower limb malalignment.

**Growth and Development**

The adolescent growth spurt predisposes the young athlete to a multitude of overuse injuries. Long bone growth advances rapidly, leaving inadequate time for compensatory elongation and flexibility of the accompanying muscle tendon units. Consequently, tightness of the quadriceps, hip flexors, hamstrings, and gastrocnemius-soleus complex often afflict the peripubescent athlete. Clinical manifestations can include acute avulsion fractures of the pelvis and overuse physeal (growth plate) injuries. The overuse physeal injuries can be further categorized as involving the tendinous attachments of the physis (traction apophysitis) as well as overload to the long bone physis. Examples of traction apophysitis include Osgood-Schlatter disease, Sinding-Larsen-Johansson syndrome, and Sever disease. Injuries to the long bone physis include distal radial physeal injury in the young gymnast due to repetitive loading, and Little Leaguer’s Shoulder, which represents an injury to the proximal humeral physis due to traction and rotational stresses encountered during repetitive throwing. All of these injuries are unique to the developing athlete due to the susceptibility of the growth plate to injury during periods of rapid growth. Because the growth cartilage is the weak link in the developing joint—the physis may be too small to accommodate the surrounding fibrous tissue—it is more susceptible to shear and tension forces, and therefore less resistant than adjacent bone and ligament to injury. Consequently, a child is more likely to sustain a physeal injury rather than a ligament tear or joint dislocation, injuries commonly seen in adults. In fact, approximately 15% of all fractures in children involve the physis.5,6

Loss of flexibility and rapid growth can also contribute to muscle-tendon imbalance. Sport participation or poorly designed strength and conditioning programs may result in muscle bulk or strength imbalances on opposite sides of a joint. Such imbalances may result in tendinitis and impingement syndromes.

**Nutrition**

In the growing child and adolescent athlete, caloric intake must exceed both basal and exercise energy expenditure in order for an anabolic state to be maintained. Certain sports such as gymnastics, distance running, and dance may emphasize and encourage slenderness, ultimately compromising the growth of a young athlete. Disordered eating, menstrual dysfunction, and altered bone mineral density—otherwise known as the female athlete triad—can be the deleterious result of participation in sports which reward thinness. Overuse injuries in this population can range in spectrum from mild to severe, with stress fractures to femoral neck stress fracture.

Suboptimal calcium and vitamin D intake in the child and adolescent athlete can also lead to overuse injuries related to bone health, such as stress fractures. A recent study by Gordon et al.6 discovered that 42% of New England adolescents were vitamin D-insufficient. Athletes who lack adequate sun exposure, choose restrictive diets such as vegan, or don't ingest enough vitamin D-rich foods such as fortified milk, cereal, or oily fish, are particularly prone. Currently, bone health physicians suggest vitamin D intake of ≥1000 IU per day to improve vitamin D status in at-risk individuals, particularly those living at higher latitudes and during winter months. Dietary calcium intake recommendations in the United States currently are 800-1200 mg daily for six to ten year-olds, and 1200-1500 mg daily for 11 to 18 year-olds.

**Pre-existing Conditions**

Pre-existing conditions such as chronic disease states, previous injuries, or inadequately treated fractures can contribute to the incidence of overuse injuries. Underlying conditions such as tarsal coalition and developmental issues such as avascular necrosis of the femoral head (Legg-Calve-Perthes disease) or slipped

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**Overuse Injuries in the Young Athlete**

*Peter Kriz, MD, FAAP*
capital femoral epiphysis can masquerade as overuse injuries such as recurrent ankle sprains or chronic knee or groin pain. Such conditions require an astute clinician to ensure timely recognition.

**Extrinsic Factors**

**Training Errors**

Overtraining, insufficient periods of rest, poor biomechanics or technique, year-round training and competition, and sport specialization are all elements that have contributed to the increased incidence of overuse injuries in recent decades.

While no scientifically-determined guideline to help define how much exercise is beneficial compared to what amount may be harmful to a young athlete exists, injuries tend to be more common during peak growth velocity, and may be influenced by the presence of biomechanical errors. The American Academy of Pediatrics Council on Sports Medicine and Fitness recommends limiting one sporting activity to a maximum of five days per week with at least one day off from any organized physical activity. Additionally, athletes should have two to three month reprieve (minimum) per year from their particular sport to allow adequate time for injuries to heal, and strength and conditioning programs which emphasize cross training and core strengthening should be implemented. Such breaks also serve the purpose of allowing for a mental break from the intensities that accompany the daily routine of competitive athletics—intensities that put the pediatric athlete at high risk of “burnout”.

Biomechanical errors and poor technique can contribute to overuse injuries by placing abnormal stress on musculoskeletal tissues in young athletes. Biomechanical errors can be the result of predisposing conditions such as excessive lumbar lordosis, central core and peripelvic weakness, and hip flexor/hamstring tightness in the young gymnast, or periscapular and rotator cuff weakness in the young baseball pitcher. Any physical condition that alters the components of the kinetic chain, especially one that affects central core strength, will alter more distal segments of the kinetic chain. Examples include shoulder injuries in the throwing athlete and hamstring injuries in runners.

Single-sport specialization and its associated year-round training and competition are becoming increasingly common in youth sports. Despite the fact that only 0.2% to 0.5% of high school athletes ever succeed in making it to the professional level, young athletes and their parents often opt for travel and select teams over less-intense, closer-to-home youth leagues as aspirations of college scholarships and professional contracts provide motivation to excel at the highest level. Physicians caring for youth should be cognizant that motivation behind this involvement often can be parentally induced, and somatic complaints from the young athlete that do not fit typical overuse patterns of injury should be recognized as potential manifestations of “burnout”. The American Academy of Pediatrics Committee on Sports Medicine and Fitness discourages single-sport specialization before adolescence. Youth athletes who engage in a variety of sports have fewer injuries and play sports longer than those who specialize before puberty.

Clinicians play a critical role in the education of parents, coaches, and young athletes regarding the risk of childhood and adolescent sports injuries.

**Overuse Injuries: Prevention**

Clinicians play a critical role in the education of parents, coaches, and young athletes regarding the risk of childhood and adolescent sports injuries. Ample opportunities for providing strategies for injury prevention to young athletes and their caregivers exist as sports-related injuries comprise greater than 25% of adolescent injury visits to primary care settings.

While previous sections of this review have touched upon the American Academy of Pediatrics’ Council on Sports Medicine and Fitness policy statements addressing overuse injuries, intensive training, and sport specialization in youth sports, the following section briefly outlines the salient issues pertaining to resistance training and stretching in youth sports.

**Resistance Training in Young Athletes**

As recently as the 1980s, resistance training (used synonymously with strength training and weight training) was not often recommended for child and adolescent athletes due to presumed high injury risks with this form of exercise. Such recommendations were based on data gathered by the National Electronic Injury Surveillance System (NEISS) of the U.S. Consumer Product Safety Commission. This data was based on patient-reported injuries that were related to resistance exercise and equipment, and assumptions were falsely made that the injuries were due to the resistance exercises themselves rather than poor training technique, inadequate adult supervision, excessive loading, or poorly-designed equipment. Additionally, a few retrospective case reports published in the 1970s and 1980s described growth cartilage injuries in pre-adolescents and adolescents. Similarly, the majority of these injuries were due to improper lifting techniques, maximal lifts, or inadequate adult supervision. Current findings from prospective resistance training studies indicate a low risk of injury in children and adolescents who follow age-appropriate guidelines.

Numerous studies have demonstrated that comprehensive conditioning programs which include resistance and/or plyometric training (defined as exercise involving repeated rapid stretching and contracting of muscles to increase muscle power) are effective for reducing sports-related injuries in adolescents. While these conclusions cannot be safely extrapolated to younger children without additional research, it is possible that similar effects would be observed in pre-adolescents.

While there is no minimum age requirement at which children can begin resistance training, age seven or eight years is generally the age a child is ready for sport participation. Additionally, all participants, regardless of age, must be physically and mentally ready to listen and heed coaching instructions. In compliance with recommendations by the National
Strength and Conditioning Association, an updated position statement outlining youth resistance training has recently been published. Key components of these guidelines include:

- Instruction and supervision of youth resistance training should be provided by qualified adults who are knowledgeable of the physical and psychosocial uniqueness of children and adolescents.
- The exercise environment should be safe and free of hazards.
- Each training session should start with a five to ten minute dynamic warm-up period.
- Correct exercise technique should be emphasized, beginning with light loads.
- A variety of upper- and lower-body strength exercises should be performed, aiming for one to three sets of six to 15 repetitions.
- Abdominal and lower-back region strengthening exercises should be included.
- Symmetrical muscular development and appropriate muscle-balance around joints should be a focus.
- Resistance should be increased gradually (5-10%) as strength improves.
- Resistance training should initially occur two to three times per week on non-consecutive days.

Role of Stretching in Injury Prevention and Performance

A limited number of studies assessing the effect of pre-participation stretching on injury prevention have been conducted; their results vary in quality and have shown mixed findings. Several authors have proposed that the type of sports activity an athlete participates in should perhaps determine whether or not pre-participation stretching is performed. Specifically, “explosive” type sports which utilize many and maximal stretch-shortening cycle (SSC) movements require a muscle-tendon unit which is compliant enough to store and release high amounts of elastic energy. Conversely, for sports activities which contain minimal SSC movements (e.g., cycling, jogging), there is no need for a compliant muscle-tendon unit since the amount of energy absorption remains low. Thus, stretching exercises to improve tendon compliance before sporting activities which do not require ballistic-type movements may have no beneficial effect on injury prevention.

Until future prospective randomized studies assessing pre-participation stretching are available, the following recommendations regarding the role of stretching in injury prevention seem prudent:

- Muscle groups known to be at risk for a particular sport (e.g., adductor and hip flexor strains in ice hockey, hamstring strains in soccer) should be targeted during pre-participation stretching.
- At least four to five 60-second stretches to pain tolerance should be applied to target muscle groups and performed bilaterally, in order to confidently decrease passive resistance to stretch.
- Dynamic pre-participation drills should be performed between pre-participation stretching and actual performance in order to avoid lingering stretch-induced stretch loss.

Conclusion

For primary care physicians, guiding athletes safely through the precarious stages of preadolescence and adolescence, particularly while these individuals subject their growing bodies to high volumes of physical activity at skill levels which increasingly have become more demanding and complex, is an arduous task. Compounded by extrinsic factors such as overtraining and single sport specialization, which often lacks cross training and core strengthening that is inherently integrated into a multisport athlete’s conditioning, intrinsic factors such as loss of flexibility and rapid growth place a skeletally immature athlete at significant risk for growth impairment and microtrauma injuries. Prevention strategies that coordinate the involvement of physicians, parents, coaches, athletic trainers, and therapists are critical to preserving the health and well-being of the young athlete. Lastly, clinicians caring for young athletes should not lose focus of the ultimate goal of youth participation in sports: the promotion of lifelong physical activity, recreation, and skills of healthy competition that can be used in all facets of future endeavors.

References


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REQUEST FOR PROPOSALS
TOWN OF JOHNSTON RETIREMENT BOARD
MEDICAL DIRECTOR

The Town of Johnston Retirement Board ("Board") is seeking fee proposals from licensed and board-certified medical physicians in Rhode Island who do not reside in the Town of Johnston to serve as a medical director to the Board. The medical director shall advise the Board on medical questions pertaining to claims received by the Board concerning Fire Fighter and/or Police Officer pensions, will serve as one (1) of three (3) licensed and board-certified medical physicians who conduct an examination of each disability pension applicant, and will advise on any other matters requiring medical advice that may arise in the administration of the Town Fire Fighter and Police Officer Pension Fund. Sealed proposals will be accepted until 4:00 p.m. on July 29, 2011 at the Office of the Johnson Town Clerk located at 1385 Hartford Avenue, Johnston, RI 02919. The RFP is available at the Office of the Johnston Town Clerk at the above address starting on July 11, 2011, weekdays from 8:30 a.m. to 4:00 p.m., or may be requested electronically from the Town Clerk, Vincent P. Baccari, Jr. at vbaccari@johnston-ri.us. The Town of Johnston Retirement Board reserves the right to reject any or all responses or parts thereof, to waive any informality herein, or accept any proposal deemed in the best interest of the Town.