

## Data-driven methods to prevent sports injuries

By Cori Polonski, MS-III

With heart disease and diabetes on the rise significantly in the past decade, the important and numerous benefits of regular physical activity cannot be overstated. While proper diet is important, exercise has its own share of extensive benefits beyond what can be controlled with diet alone. Not only does it cause weight loss, which serves as a preventative measure for these chronic conditions, but it increases the good cholesterol in the body, improves heart health and capacity, and decreases risk of future osteoporosis. Furthermore, regular exercise has been shown to improve executive functioning capacity, as well as increase baseline mood significantly. One study even showed that regular exercise was effective at significantly decreasing rates of suicidality, sadness and effects of bullying in a population of children as compared to controlled peers who did not exercise.

For student-athletes, beyond just the aforementioned benefits of exercise alone, the participation in team sports during school-age years has significant benefits as well. Children who participate in team sports during school years are more likely to be active adults, which significantly decreases their risk for future chronic diseases due to inactivity and obesity. Furthermore, studies have shown that children who compete in team sports report an overall improved quality of life over age-matched controls. This is likely related to that feeling of closeness and social acceptance that often accompanies being part of a team. I know that for me, being a part of a team helped me learn hardwork, perseverance, and how to effectively interact with others to reach a common goal. And so it is for protection of these vital benefits that I will outline some fundamental preventative measures that athletes of all ages can take to decrease the likelihood of developing overuse sports injuries.

At the beginning of a sports season, coaches and athletes are all aware of one of the most common causes of overuse sports injuries – attempting to ramp up training too quickly after inadequate conditioning during offseason. One of the most common overuse injuries attributed to this is shin splints, or medial tibial stress syndrome. Shin splints occur most often with sports that require significant running, such as soccer or cross country running, and are most common at the beginning of the season due to athletes jumping into working out every day after very little training during the time off. Stress fractures, which happens when small breaks occur in the bone (most often in the tibia) are the more severe version of this same process, and can keep athletes sidelined for weeks attempting to recover. When these injuries occur, the time course to recovery varies, and the treatment involves taking time off from the sport to recover. A similar occurrence happens in adults, especially in those who are referred to as the “weekend warriors.” This is a term often used for adults who work during the week and typically do most of their exercising on weekends, during which they may go to the gym, or play sports with friends. They are prone to injuries for similar reasons as athletes at the beginning of season; lack of regular routine exercise sets up for overuse injuries when you do exercise. Some of the common “weekend warrior” injuries include IT band tendonitis, which is inflammation of the band of muscle and connective tissue running from the outside of the hip down to the knee, and plantar fasciitis, which refers to inflammation of the soft tissue on the bottom of the foot. Regular exercise is one of the most important ways to prevent these types of injuries, but it is also important to make sure you are using equipment that fits properly. For example, for plantar fasciitis, one of the inciting factors can often be wearing running shoes or other sneakers that fit improperly. Also, for training, it is important to start

with low-intensity exercise, and to slowly increase by 10% each week, allowing for plenty of time to reach your goal level of exercise. It can be difficult to stick to this guideline but pushing the activity too much too quickly often ultimately leads to more time lost to injury.

Another common problem is that young athletes often do not allow themselves the appropriate rest needed between games, as well as between seasons of sports. While work ethic and dedication to your sport is important in developing as an athlete, athletes of all ages often push this limit to the extreme. This lack of rest and increased repetitive motions are what leads to the majority of tendinopathies, a term referring to the chronic injury to a tendon, which is the connective tissue that holds a bone and a muscle together. The more common tendinopathies seen in sports are supraspinatous tendonitis (one of the muscles that comprises the rotator cuff), Achilles tendonitis, and patellar tendonitis. This is especially a prevalent mechanism of injury in throwing athletes, most notably seen in baseball pitchers. In adults, repetitive overhead throwing tends to cause tendon injury (especially in the muscles of the rotator cuff), but in children, the growth plate is weaker than the tendons, so with repeat stress on the joint, the growth plate can move. This is seen in an injury known as Little League Shoulder, where repeated stress to the shoulder from pitching at a young age causes the growth plate to widen, leading to chronic shoulder pain. For youth pitchers and other athletes undergoing repetitive overhead motion, planned rest days are important. Little league baseball, for example, has come out with guidelines regarding the number of rest days a pitcher should take between games, based on number of pitches thrown as well as the pitcher's age. Furthermore, there has been a shift over the past couple of decades where young athletes begin specializing in one sport very early on in their lives. While this is tempting for those who show athletic promise in a particular sport at a young age, there is considerable benefit to cross-training, or doing different athletic activities in your time off from a sport. The largest benefit would be a decrease in the number of overuse injuries, especially if the cross-training sport uses a different set of muscles or different motions, but cross-training has the added benefit of also helping children become more athletically well-rounded.

Even with the proper training mentality, another important aspect of injury prevention that is essential is being careful to have proper form and mechanics during training. This is especially a prevalent source of injury for those undergoing strength and conditioning training with weights. Lower back pain is one of the most common musculoskeletal injuries seen by sports medicine physicians, and it can easily become a chronic issue, especially with increasing age. One of the most common ways athletes injure their backs is using improper form when lifting weights. This is especially prominent with exercises such as back squats or deadlifts. In order to squat down lower during lifts, people with poor form often round out their backs by bending forward at the hips and then use the strength of their lower backs to do the majority of lifting on the way back up. This can be due to poor instruction by coaches during strength and conditioning sessions, or poor form due to attempting to increase weight too quickly. The proper mechanics of any kind of lift involve keeping your back and upper body straight, and bending at the knees, keeping the weight more squarely on the legs. It is important to make sure to practice sound mechanics, and to not attempt to push the weight you can lift if you cannot do so with proper form.

Another mechanism which ties in with proper form and mechanics is the idea that the unequal development of muscles around joints can be a significant cause of sports injuries. The joints of the body are held strong by both the connective tissue that supports them as well as the muscles which connect to either side of the joint and move the joints in a coordinated fashion. For every muscle (or group of

muscles) that flexes a joint, there is another muscle (or group of muscles) that extends that joint. This balance is essential for maintaining the health of the joint. A common mistake that many athletes, and active adults, make is they focus in on training one set of muscles without also strengthening the muscles that oppose those motions. For example, many people may have tightness and increased strength of the pectoral muscles and other muscles which elevate the scapula and draw it forward, but then have a relative weakness of the back muscles which draw the scapula down and in towards the spine, such as the infraspinatus or the serratus anterior. This is then further exacerbated by poor posture, where your shoulders are rounded and leaned forward at rest, which is seen in a large proportion of people. This imbalance places people at an increased risk of developing an overuse injury termed impingement syndrome, where you experience pain with overhead motions due to decreased space underneath the acromion (the portion of the shoulder blade that connects to the clavicle). This decreased space can be caused by inflammation and swelling from a tendon injury (most commonly the supraspinatus tendon of the rotator cuff which runs under the acromion), from bone spurs growing off the posterior portion of the acromion seen in osteoarthritis due to aging, or it can be a functional decrease in space from the aforementioned muscle imbalance. The treatment of impingement syndrome is often physical therapy which focuses on strengthening the muscles which expand the subacromial space, which incidentally are the ones which are seen to be weakened in functional causes of the syndrome. Therefore, taking care to equally strengthen the complementary sets of muscles surrounding joints can be an invaluable asset in helping to prevent some of these future joint injuries.

An area currently under a significant amount of research is the use of balance or neuromuscular training programs for athletes to prevent sports injuries, especially lower extremity injuries. These injury prevention programs have significant implications, and appear to be the most promising in decreasing the rates of ankle sprains and knee ligament injuries. The anterior talofibular ligament, on the outside of the ankle connecting to the bottom of the foot, is the most commonly injured ligament in the body, often referred to as a “sprained ankle.” This can be seen across all sports, as well as the general population outside of sports, but has been studied significantly in basketball and soccer, where a number of injury prevention programs have been suggested for coaches. These programs focus on a concept of proprioception, which refers to your body’s innate ability to sense where in space your limbs are in relation to one another. For example, when you trip on something, your brain quickly analyzes the proprioceptive input to attempt to correct the fall and regain balance. Proprioceptive enhancing training programs have been shown to decrease ankle sprains in those with a history of a prior ankle sprain, but have not shown significant benefit for prevention of initial sprains. However, with the high prevalence of ankle sprains, these programs would likely be useful for a large proportion of athletes.

Knee ligament injuries are another area of high prevalence in athletes, which has been studied most significantly in sports such as football and soccer. The ACL is a common knee injury in both sports and while there is less that can be done about contact ACL injuries, neuromuscular retraining programs have shown promising results for prevention of noncontact ACL injuries, as seen when athletes pivot on their knee to quickly change direction. The knee joint is protected by two sets of stabilizers – static (ligaments) and dynamic (muscles and tendons surrounding the joint). The dynamic stabilizers provide proprioceptive support and keep the knee from bending in positions which would cause damage to the joint and the static stabilizers. Neuromuscular retraining programs focus on increasing effectiveness of these stabilizers by practicing certain movements (jumping, landing, and pivoting) and “teaching” your muscles and tendons to react in an effective way that can prevent future knee injuries. Research has

proven these types of injury prevention programs (specifically FIFA 11+ prevention program) effective in reducing the incidence of lower extremity injuries in professional soccer teams over in Europe, and studies are currently underway evaluating their effectiveness for high school and college athletes in the US. Furthermore, these programs are simple and easy to learn warmup routines that take only 15-20 minutes per day, further increasing the likelihood of compliance.

With the recent positive swing of the general public gaining a renewed interest in physical fitness, it is important to remember that prevention is the best treatment for overuse injuries that can occur with athletics. Some preventative measures include starting slow in training and ramping up activity carefully, making sure to take specified rest days and/or cross-train in another sport. Proper form and mechanics are also very important, especially during strength and conditioning, as injuries can easily occur when exercises are not performed in the correct manner. Ensuring to equally condition opposing muscles around all joints can help with overall stabilization and protection of joints. Lastly, discussing with coaches about implementation of certain proprioception or neuromuscular re-training programs might be a way to prevent injuries, especially those of the lower extremity. Together, these methods can be effective in avoiding sports injuries, to preserve the ability of athletes to continue participating in the sports they love.

#### References:

1. Watson K and Baar K. "mTOR and the health benefits of exercise." *Seminars in Cell and Developmental Biology*. 2014 Dec; 36: pp. 130-139.
2. Wilson MG, Ellison GM, Cable NT. "Basic science behind the cardiovascular benefits of exercise." *Heart*. 2015 Jan; 101: pp. 758-765.
3. Tenforde AS, Sainani KL, Sayres LC, Milgrom C, Fredericson M. "Participation in Ball Sports May Represent a Prehabilitation Strategy to Prevent Future Stress Fractures and Promote Bone Health in Young Athletes." *PM&R*. 2015, 7: pp. 222-225.
4. Guiney H and Machado L. "Benefits of regular aerobic exercise for executive functioning in healthy populations." *Psychonomic Bulletin & Review*. 2013 Feb; 20(1): pp. 73-86.
5. Szabo A. "Acute psychological benefits of exercise: reconsideration of the placebo effect." *Journal of Mental Health*. 2013 Oct; 22(5): pp. 449-455.
6. Sibold J, Edwards E, Murray-Close D, Hudziak JJ. "Physical activity, sadness, and suicidality in bullied US adolescents." *Journal of the American Academy of Child & Adolescent Psychiatry*. 2015 Oct; 54(10): pp. 808-815.
7. Smith L, Gardner B, Aggio D, Hamer M. "Association between participation in outdoor play and sport at 10 years old with physical activity in adulthood." *Preventive Medicine*. 2015 Feb; 74: pp. 31-35.
8. Vella SA, Cliff DP, Magee CA, Okely AD. "Sports participation and parent-reported health-related quality of life in children: longitudinal associations." *Journal of Pediatrics*. 2014 Jun; 164(6): pp. 1469-1474.
9. Eime RM, Young JA, Harvey JT, Charity MJ, Payne WR. "A systematic review of the psychological and social benefits of participation in sport for children and adolescents: informing development

of a conceptual model of health through sport." *International Journal of Behavioral Nutrition and Physical Activity*. 2013; 10: 98.

10. Swenson DM, Collins CL, Best TM, Flanigan DC, Fields SK, Comstock RD. "Epidemiology of Knee Injuries Among US High School Athletes, 2005/06-2010/11." *Medicine & Science in Sports & Exercise*. 2013 March;45(3): pp. 462-469.
11. Hunt KJ, Hurwit D, Robell K, Gatewood C, Botser IB, Matheson G. "Incidence and Epidemiology of Foot and Ankle Injuries in Elite Collegiate Athletes." *American Journal of Sports Medicine*. 2017 Feb;42(2): pp. 426-433.
12. Valovich McLeod TC, DeCoster LC, Loud KJ, Micheli LJ, Parker JT, Sandrey MA, White C. "National Athletic Trainers' Association Position Statement: Prevention of Pediatric Overuse Injuries." *Journal of Athletic Training*. 2011 Mar-Apr; 46(2): pp. 206-220.
13. Zaremski JL, Krabak BJ. "Shoulder Injuries in the Skeletally Immature Baseball Pitcher and Recommendations for the Prevention of Injury." *PM&R*. 2012 Jul;4(7): pp. 509-516.
14. Erickson BJ, Sgori T, Chalmers PN, Vignona P, Lesniak M, Bush-Joseph CA, Verma NN, Romeo AA. "The Impact of Fatigue on Baseball Pitching Mechanics in Adolescent Male Pitchers." *Arthroscopy: The Journal of Arthroscopic and Related Surgery*. 2016 May; 32(5): pp. 762-771.
15. Holmich P, Larsen K, Krogsgaard K, Gluud C. "Exercise program for prevention of groin pain in football players: a cluster-randomized trial." *Scandinavian Journal of Medicine & Science in Sports*. 2010 Dec;20(6): pp. 814-821.
16. Hickey D, Solvig V, Cavalheri V, Harrold M, Mckenna L. "Scapular dyskinesis increases the risk of future shoulder pain by 43% in asymptomatic athletes: a systematic review and meta-analysis." *British Journal of Sports Medicine*. 2017 May; pp. 1-10.
17. Page P. "Shoulder Muscle Imbalance and Subacromial Impingement Syndrome in Overhead Athletes." *International Journal of Sports Physical Therapy*. 2011 Mar;6(1): pp. 51-58.
18. Challoumas D, Stavrou A, Dimitrakakis G. "The volleyball athlete's shoulder: biomechanical adaptations and injury associations." *Sports Biomechanics*. 2017 June;16(2): pp. 220-237.
19. Andersson SH, Bahr R, Clarsen B, Myklebust G. "Preventing overuse shoulder injuries among throwing athletes: a cluster-randomised controlled trial in 660 elite handball players." *British Journal of Sports Medicine*. 2016 June;51: pp. 1073-1080.
20. De Ridder R, Witvrouw E, Dolphens M, Roosen P, Van Ginckel A. "Hip Strength as an Intrinsic Risk Factor for Lateral Ankle Sprains in Youth Soccer Players: A 3-Season Prospective Study." *American Journal of Sports Medicine*. 2017 Feb;45(2): pp. 410-416.
21. ter Stege MH, Dallinga JM, Benjaminse A, Lemmink KA. "Effect of Interventions on Potential, Modifiable Risk Factors for Knee Injury in Team Ball Sports: A Systematic Review." *Sports Medicine*. 2014 Oct; 44(10): pp. 1403-1426.
22. Wingfield K. "Neuromuscular training to prevent knee injuries in adolescent female soccer players." *Clinical Journal of Sports Medicine*. 2013 Sept;23(5): pp. 407-408.
23. Grimm NL, Jacobs JC, Kim J, Amendola A, Shea KG. "Ankle Injury Prevention Programs for Soccer Athletes are Protective." *Journal of Bone and Joint Surgery*. 2016 Sept; 98A(17): pp. 1436-1443.
24. Longo UG, Loppini M, Berton A, Marinozzi A, Maffulli N, Denaro V. "The FIFA 11+ program is effective in preventing injuries in elite male basketball players: a cluster randomized controlled trial." *American Journal of Sports Medicine*. 2012 May;40(5): pp. 996-1005.
25. Myer GD, Chu DA, Brent JE, Hewett TE. "Trunk and Hip Control Neuromuscular Training for the Prevention of Knee Joint Injury." *Clinics in Sports Medicine*. July 2008;27(3): pp. 425-ix.