

Sports Injury and Arthritis

Stephen W. Marshall, PhD; Yvonne M. Golightly, MS, PT

*“... Then come home my children, the sun is gone down
And the dews of the night arise...”*

William Blake, 1757–1827

A major theme in William Blake’s poetry is the transformation of youth’s innocence and simplicity into disfigurement, pain, and bitterness in old age. The “dews of the night” that arise in today’s society are largely chronic diseases such as arthritis. In this commentary, we explore the connection between acute sports injury, which occurs during the playful period of early life, and arthritis, a widely prevalent later-life chronic condition with high impact on quality of life.

Relationship Between Sports Injury and Arthritis

It is helpful to begin by comparing the basic descriptive epidemiology of these two apparently divergent conditions. Nationally, the incidence of sports injury rises dramatically through the middle and high school years and then subsides throughout adult life.¹ (See Figure 1.) This is largely a reflection of the fact that children and youth play a greater amount of high-intensity sports than adults. Likewise, the incidence is higher in males than females in large part because boys have greater participation in full-contact sports (eg, football, wrestling, and some martial arts) and these sports have a higher risk of injury.

Trauma from sports injury is most closely linked with osteoarthritis. Reliable national data for osteoarthritis is not readily available, but national

prevalence data for overall arthritis is available. Osteoarthritis comprises over 50% of the more than 100 types of arthritis in the United States, and thus arthritis prevalence is a reasonable proxy for osteoarthritis prevalence. The prevalence of arthritis is essentially zero for adolescents and young adults (when sports injury incidence is at its peak), but steadily rises with increasing age. (See Figure 2.) Arthritis is more prevalent in women than in men.

How are the curves in Figures 1 and 2 related? It is widely believed that if we could drive down the spike in sports injury incidence during adolescence (eg, through prevention programs), the arthritis curve would be shifted further to the right—that is, pushed further into later life—because there would be less early-onset osteoarthritis.

Is this belief correct? A strong association between injury and osteoarthritis is widely acknowledged in the biomedical community, but the epidemiologic evidence for this relationship is surprisingly sparse. For the knee, several epidemiologic studies have suggested that a history of injury is positively associated with an increased occurrence of knee osteoarthritis.^{2,4} However, the few studies published on injury and osteoarthritis of the

“... based on the available evidence, it appears that programs addressing the prevention and care of sports injury will pay dividends in terms of preventing early onset of osteoarthritis.”

Stephen W. Marshall, PhD, is an associate professor in the Department of Epidemiology, associate professor in the Department of Orthopedics, adjunct associate professor in the Department of Exercise and Sport Science, and senior biostatistician in the Injury Prevention Research Center, the University of North Carolina at Chapel Hill. He can be reached at smarshall@unc.edu or the University of North Carolina at Chapel Hill, Campus Box 7435, Chapel Hill, NC 27599-7435.

Yvonne M. Golightly, MS, PT, is a doctoral student in the Department of Epidemiology and a graduate research assistant in the Thurston Arthritis Research Center, the University of North Carolina at Chapel Hill.

hip^{5,6} and the hand^{2,7} present conflicting results. There is no research on the association between injury and osteoarthritis at body sites other than the knee, hand, and hip.

Despite the limited epidemiologic data, there is a strong biological basis for linking injury to early onset of osteoarthritis, at least at load-bearing joints. Trauma to the soft tissues (eg, tendons, ligaments, cartilage, and muscles) that surround and support a load-bearing joint such as the knee erodes their ability to absorb and dissipate impact forces. Thus, the cumulative force transmitted to the joint surfaces from simple everyday activities such as walking, running, and jumping is increased. Breakdown of cartilage could result in narrowing of the joint space or fragments of cartilage or other tissues in the joint, common radiographic features of osteoarthritis. Further loss of cartilage may lead to greater contact between the joint surfaces, and bone may respond to this stress by developing osteophytes, another radiographic feature of osteoarthritis. Animal models of meniscus damage⁸ and human studies of surgical removal of the meniscus after knee injury⁹ support the biological rationale of load-bearing tissue defects contributing to knee osteoarthritis.

Youth Sports Injury in North Carolina

Despite the fact that the epidemiologic data is underdeveloped, it is reasonable to assume a causal relationship between sports injury and osteoarthritis based on the available biological information. Thus, from a public health standpoint, we need to ask, *What do we know about sports injury in North Carolina?* There is no surveillance system that adequately captures the extent of the youth sports injury problem in our state. However, by combining data from various sources some portions of the picture come into focus. Some key statistics are presented in the accompanying sidebar.

The problem of sports injury is concentrated in youth and in males. Important facts to note are:

- For boys ages 10 to 14 years, sports injuries account for over 50% of all emergency department visits for treatment of an unintentional injury.¹
- For girls ages 10 to 14 years, sports injuries account for nearly 40% of all emergency department visits for treatment of an unintentional injury.¹
- Boys account for 60% of high school athletes in North Carolina but sustain nearly 75% of high school athletic injuries.
- Football accounts for 16% of high school athletes in North Carolina but over 40% of high school athletic injuries.

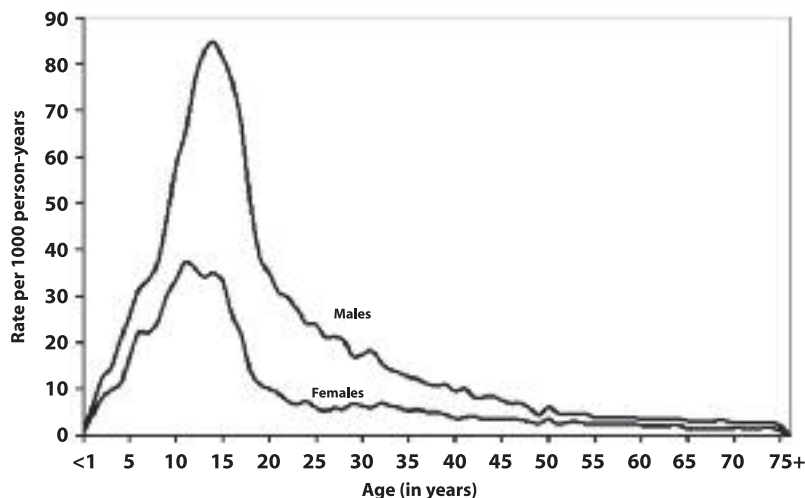
Statistics such as these have stark implications for the burden of osteoarthritis in later life and underscore the need for prevention programs aimed at youth sport injury. Recommendations for preventing youth sports injury include correct preparation and care of playing surfaces, improved physical fitness and conditioning of athletes, care and maintenance of playing equipment, and a requirement for the provision of qualified health care professionals (preferably certified athletic trainers) in all schools. The American Academy of Pediatrics' Committee on Sports Medicine has an extensive set of recommendations on preventing injury in specific youth sports including soccer, hockey, baseball/softball, and horseback riding.¹⁰ The National Athletic Trainer's Association also has an extensive set of online resources addressing youth sports injury prevention.¹¹

Sports medicine professionals are very concerned about the increasingly competitive nature of youth sports. Over the past few decades, youth sport has evolved from informal neighborhood pick-up games into highly-structured and financially-lucrative competitive leagues that, in the case of at least one sport, are nationally televised. Parents are progressively more focused on collegiate scholarships and the high salaries earned in some professional sports, although only a tiny fraction of youth athletes ever compete at the collegiate or professional level.¹²

As an example of this trend, it is worrisome that weight gain is now being emphasized at the junior levels of football. The combination of more weight being placed on weight-bearing joints (such as the knee) and a higher risk of joint trauma (due to increased competitiveness) is likely to be a "double whammy" for developing osteoarthritis in later life.

Parents and coaches need to remember that winning and excelling should be secondary goals in youth sport. Personal

Figure 1.
Incidence of Injury from Sports and Recreational Physical Activity, by Age and Sex



Source: Emergency Department Records (National Electronic Injury Surveillance System All Injury Program), United States, July 2000-June 2001 (reproduced from *MMWR* 2002;51:736-740).

development, increased physical fitness, skills development, and simply having fun are the primary goals.

Obesity Prevention Through Youth Sports

Aside from trauma due to sports injury, another major factor that increases joint loading is body weight. North Carolina, like the rest of United States, has experienced an alarming increase in prevalence of obesity and overweight over the past few decades.^{13,14} The rapid increase in sedentary recreational activities, such as home computers and electronic games, has fueled an equally spectacular growth in our children's body mass index.^{14,15} Increasing academic pressures from schools further limit leisure time for children and youth. Obese/overweight children grow into obese/overweight adults who are more likely than the rest of the population to develop osteoarthritis of the hip and knee in addition to diabetes, cardiovascular disease, and other chronic conditions.^{16,17}

One obvious solution to the obesity epidemic is to encourage kids to participate in youth sports. In addition to obesity prevention, youth sports are widely surmised to have beneficial effects in terms of personal development and team skills. But not all youth sports are created equal; some carry a high risk of injury. The expected reductions in arthritis from increased promotion of youth physical activity could be negated if we do not also devote resources to preventing and caring for youth sports injuries. Even when sports injuries cannot be prevented completely, proper treatment and rehabilitation of these injuries is important to restore optimal movement patterns, likely reducing the risk of both reinjury and developing osteoarthritis. Thus, the public health equation is not:

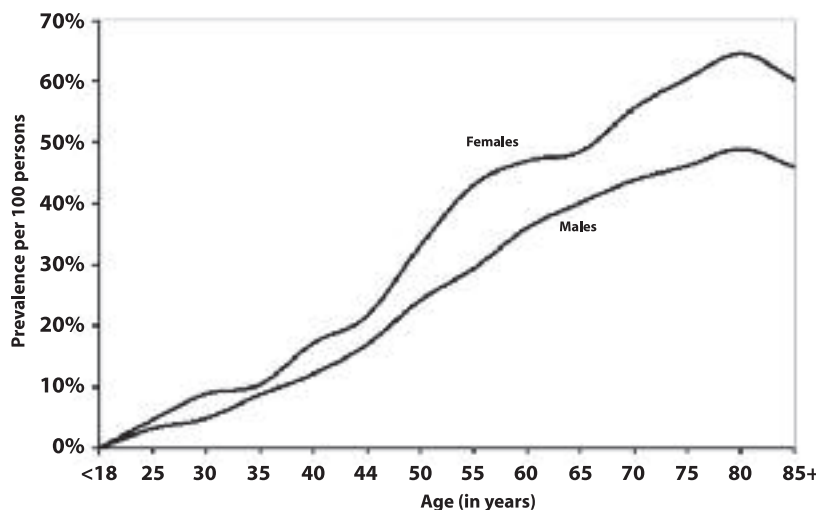
More sports in early life = Fewer adults with lower extremity osteoarthritis

but rather:

*More sports in early life + fewer sports injuries
+ maintenance of healthy body weight
+ good rehabilitation after sports injuries
= Fewer adults with lower extremity osteoarthritis*

Additionally, injury often forces participants into reducing their level of activity. Uninjured participants, on the other hand, are more likely to maintain their activity program.^{18,19} Thus, programs addressing the prevention of sports injury will

Figure 2.
Prevalence of Self-Reported Arthritis, by Age and Sex



Source: National Health Interview Survey, United States, 2001.

increase the public health benefit of physical activity promotion campaigns. Sports injury prevention advice should always be incorporated into physical activity health promotion campaigns.²⁰

Future Directions for Research and Policy

Epidemiologically, the relationship between injury and osteoarthritis needs to be further clarified through additional research. However, based on the available evidence, it appears that programs addressing the prevention and care of sports injury will pay dividends in terms of preventing early onset of osteoarthritis. Reductions in osteoarthritis prevalence can also accrue from obesity prevention through increased sports participation. However, increasing participation in youth sports without addressing the potential for a resultant increase in injury incidence may fail to attain the overall goal of arthritis prevention. One sport of particular concern in this regard is football, not only for its high incidence of injury, but because the sport is increasingly associated with weight gain during the high school years. **NCMJ**

Acknowledgements: Thanks to Karen Gotsch and Julie Gilchrist of the National Center for Injury Prevention and Control, Centers for Disease Control and Prevention, for providing the data for Figure 1, which originally appeared in *Morbidity & Mortality Weekly Report* 2002;51:736-740. Ms. Golightly is supported by a National Institutes of Health National Research Service Award Institutional Research Training Grant (T32) — Arthritis and Immunology AR07416 from the Thurston Arthritis Research Center.

Sports Injury in North Carolina Youth—Key Statistics

- Total number of North Carolina high school athletes ... 175 582
 - Girls: 67 774 (39%)
 - Boys: 107 807 (61%)
 - Football: 28 074 (16% of total)
- Annual number of North Carolina high school sports injuries ... 10 531
 - Girls: 2864 (27%)
 - Boys: 7667 (73%)
 - Football: 4381 (42% of total)
- Annual number of emergency department visits for sports injury in North Carolina ... 123 000
- Proportion of all emergency department visits for treatment of unintentional injury that is due to sport:*
 - Across all age groups: 16%
 - Girls ages 10 to 14 years: 38%
 - Boys ages 10 to 14 years: 52%

Sources:

1. Centers for Disease Control and Prevention. Nonfatal sports- and recreation-related injuries treated in emergency departments, United States, July 2000–June 2001. *Morb Mort Week Rep.* 2002;51(33):736-740
 2. National Federation of State High School Associations (NFHS). 2005-06 High School Athletics Participation Survey. Indianapolis, IN: National Federation of State High School Associations; 2006.
 3. Knowles SB, Marshall SW, Loomis DP, et al. Risk factors for high school sports injury. *Am J Epidemiol.* 2006;164(12):1209-1221.
- * National data. "Sport" includes recreational physical activity.

REFERENCES

- 1 Centers for Disease Control and Prevention. Nonfatal sports- and recreation-related injuries treated in emergency departments—United States, July 2000–June 2001. *Morb Mort Week Rep.* 2002;51(33):736-740
- 2 Sowers M, Lachance L, Hochber M, Jamadar D. Radiographically defined osteoarthritis of the hand and knee in young and middle-aged African American and Caucasian women. *Osteoarthritis Cartilage.* 2000;8(2):69-77.
- 3 Davis MA, Ettinger WH, Neuhaus JM, Cho SA, Hauck WW. The association of knee injury and obesity with unilateral and bilateral osteoarthritis of the knee. *Am J Epidemiol.* 1989;130(2):278-288.
- 4 Gelber AC, Hochberg MC, Mead LA, Wang NY, Wigley FM, Klag MJ. Joint injury in young adults and risk for subsequent knee and hip osteoarthritis. *Ann Intern Med.* 2000;133(5):321-328.
- 5 Tepper S, Hochberg MC. Factors associated with hip osteoarthritis: Data from the first National Health and Nutrition Examination Survey (NHANES-I). *Am J Epidemiol.* 1993;137(10):1081-1088.
- 6 Cooper C, Inskip H, Croft P, Campbell L, Smith G, McLaren M, Coggon D. Individual risk factors for hip osteoarthritis: obesity, hip injury, and physical activity. *Am J Epidemiol.* 1998;147(6):516-522.
- 7 Jones G, Cooley HM, Stankovich JM. A cross sectional study of the association between sex, smoking, and other lifestyle factors and osteoarthritis of the hand. *J Rheumatol.* 2002;29(8):1719-1724.
- 8 Little C, Smith S, Ghosh P, Bellenger C. Histomorphological and immunohistochemical evaluation of joint changes in a model of osteoarthritis induced by lateral meniscectomy in sheep. *J Rheumatol.* 1997;24(11):2199-2209.
- 9 Roos H, Laurén M, Adalberth T, Roos EM, Jonsson K, Lohmander LS. Knee osteoarthritis after meniscectomy: prevalence of radiographic changes after twenty-one years, compared with matched controls. *Arthritis Rheum.* 1998;41(4):687-693.
- 10 AAP Policy. American Academy of Pediatrics. <http://www.aap.org/policy>. Accessed October 1, 2007.
- 11 Youth Sports. National Athletic Trainers' Association. <http://www.nata.org/youthsports>. Accessed October 1, 2007.
- 12 Estimated probability of competing in athletics beyond the high school interscholastic level. National Collegiate Athletic Association. http://www.ncaa.org/research/prob_of_competing/. Accessed October 1, 2007.
- 13 Devlin L, Plescia M. The public health challenge of obesity in North Carolina. *N C Med J.* 2006;67(4):278-282.
- 14 Ritzman R, Elmore L. Obesity and overweight in North Carolina: prevalence, trends, and risk factors. *N C Med J.* 2006;67(4):329-330.
- 15 Ogden CL, Carroll MD, Curtin LR, McDowell MA, Tabak CJ, Flegal KM. Prevalence of overweight and obesity in the United States, 1999-2004. *JAMA.* 2006;295(13):1549-1555.
- 16 World Health Organization. Obesity: preventing and managing the global epidemic. WHO Technical Report Series, No. 894. Geneva, Switzerland: World Health Organization; 1998.
- 17 US Department of Health and Human Services. *Physical Activity and Health: A Report of the Surgeon General.* Atlanta, GA: US Department of Health and Human Services, Centers for Disease Control and Prevention, National Center for Chronic Disease Prevention and Health Promotion; 1996.
- 18 Finch CF, Owen N, Price R. Current injury or disability as a barrier to being more physically active. *Med Sci Sports Exerc.* 2001;33(5):778-782.
- 19 Hootman JM, Macera CA, Ainsworth BE, Addy CL, Martin M, Blair SN. Epidemiology of musculoskeletal injuries among sedentary and physically active adults. *Med Sci Sports Exerc.* 2002;34(5):838-844.
- 20 Blair SN, Franklin BA, Jakicic JM, Kibler WB. New vision for health promotion within sports medicine. *Am J Health Promot.* 2003;18(2):182-185.