

Chapter 1

Why is injury prevention in sports important?

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This book is a result of the IOC Medical Commission's increasing emphasis on prevention of sports injuries. The numerous health benefits of physical activity have been well documented, resulting in public health support of regular physical activity and exercise. Although beneficial, exercise and sports also have corresponding risks, including that of musculoskeletal injuries. However, at a time when there is an abundance of medical meetings, journals, and papers, some might argue that the last thing we need is a new book focusing on yet another field of research and clinical practice. What would justify such an emphasis on a new and developing field in medicine? First, it must ask important questions not answered by others. Second, the new research field should have the potential to create truly new knowledge, lead to new ways of thinking and lay the foundation for improved health for our patients. This is usually not possible without a multidisciplinary approach, involving a mixture of basic scientists and clinicians. Third, research results from the new field should be publishable in respected journals, recognized and cited by peers, presentable at high-quality meetings, and fundable on competitive grant review. Let us examine each of these issues to

see if there is sufficient merit in sports injury prevention research.

Is injury prevention important?

First, is injury prevention important? Epidemiological studies show that of injuries seen by a physician, in Scandinavia, every sixth is sustained during sporting activity (Bahr et al., 2002). Among children, every third hospital-treated injury is the result of sports participation (Bahr et al., 2002). During 1997 and 1998, in the United States, annually there were an estimated 3.7 million sports- and recreation-related emergency department visits annually in the United States, representing approximately 11% of all injury related emergency department visits; 2.6 million visits were among persons aged 5–24 years. The medical charges for these visits were estimated at 500 million US\$ annually.

The risk of injury clearly differs between sports, as documented by a study initiated by the IOC Medical Commission in team sports during the 2004 Olympic Games in Athens (Junge et al., 2006). As shown in Table 1.1, while a soccer and handball player suffered one injury every 10th match he or she play, a volleyball player at the elite level only had an injury every 100th match on the average. Not all of these injuries are serious; in fact only about half of all the injuries recorded were

Table 1.1 Injury risk in selected team sports during the 2004 Olympic Games in Athens.

Sport	Total injury rate ¹	Rate of time-loss injuries ²
Football		
Men	109 (85–133)	44 (29–60)
Women	105 (74–136)	44 (24–64)
Handball		
Men	89 (64–114)	40 (23–57)
Women	145 (110–180)	36 (18–53)
Basketball		
Men	64 (40–89)	29 (12–45)
Women	67 (42–91)	24 (9–39)
Field hockey		
Men	55 (37–72)	24 (12–36)
Women	17 (5–29)	4 (0–10)
Baseball (men)	29 (15–43)	13 (3.2–22)
Water polo (men)	30 (16–44)	9 (1.1–16.3)
Volleyball (men)	11 (1.4–21)	9 (0.2–17)

Source: Junge et al. (2006).

¹Injury rate is reported as the number of injuries per 1000 player matches (with 95% confidence intervals).

²Rate of time-loss injuries is reported as the number of injuries expected to lead to time loss from further training and competition.

expected to cause the player not to continue with subsequent training or match time. Nevertheless, when taking injury severity into account, a research group within the English Football Association found that the overall risk to professional athletes is unacceptably high—approximately 1000 times higher among professional football players than for high-risk industrial occupations (Drawer & Fuller, 2002) (Figure 1.1). Although football and handball rank highest in injury rates of the team sports included in the Olympic summer program, there are actually other sports where the injury rate is considerably higher, for example, ice hockey and the other football codes: American football, rugby, and Australian rules football.

Some injury types, such as serious head and knee injuries, are a particular cause of concern. Head injuries are known to have a high incidence among alpine skiers and snowboarders, especially among snowboarders, and the frequency increases year by year in this group. Head injury is the most frequent reason for hospital admission and most common cause of death among skiers and snow-

boarders with an 8% mortality rate among those admitted to hospital with head injuries. Among injuries related to football, 4–22% are head injuries. The reported incidence during matches—1.7 injuries per 1000 player hours—incorporates all types of head injuries including facial fractures, contusions, lacerations, and eye injuries (Andersen et al., 2004). The estimated incidence of concussion—0.5 injuries per 1000 match hours—probably represents a minimum estimate due to the problem of defining and grading concussions (Andersen et al., 2004). Although most athletes with head injuries recover uneventfully following a single concussive episode, repetitive mild head trauma may be implicated in the development of cumulative cognitive deterioration. Based on paper and pencil tests, cumulative effects of repeated concussions have been found to cause deterioration in neuropsychological function among athletes in other sports such as American football and boxing, as well as in non-athletes.

The highest incidence of anterior cruciate ligament (ACL) injuries is seen in 15- to 25-year-old athletes in pivoting sports such as football, basketball and handball. This incidence is three to five times higher among women than men (Griffin et al., 2006). In 1970, Kennedy stated that “the anterior cruciate ligament is the most common cause of the exathlete.” In other words, the treatment offered at the time did not permit athletes to go back to sport. This is no longer the case, at least in the short term, thanks to the advances in sports medicine research, with major improvements in surgical techniques and rehabilitation programs. Today, most elite athletes are initially able to resume their sports career, should they wish to do so. And although the retirement rate may be higher among athletes with a previous ACL injury compared with healthy athletes, the main concern is the dramatically increased risk of long-term sequelae—like abnormal joint dynamics and early onset of degenerative joint disease. Importantly, we still lack evidence to suggest that reconstructive surgery of either menisci or cruciate ligaments decrease the rate of post-traumatic osteoarthritis (OA). After 10 years, approximately half of the patients display signs of OA, and it appears that the majority of the patients will have osteoarthritis after 15–20 years (Figure 1.2) (Myklebust & Bahr, 2005). Thus, whereas

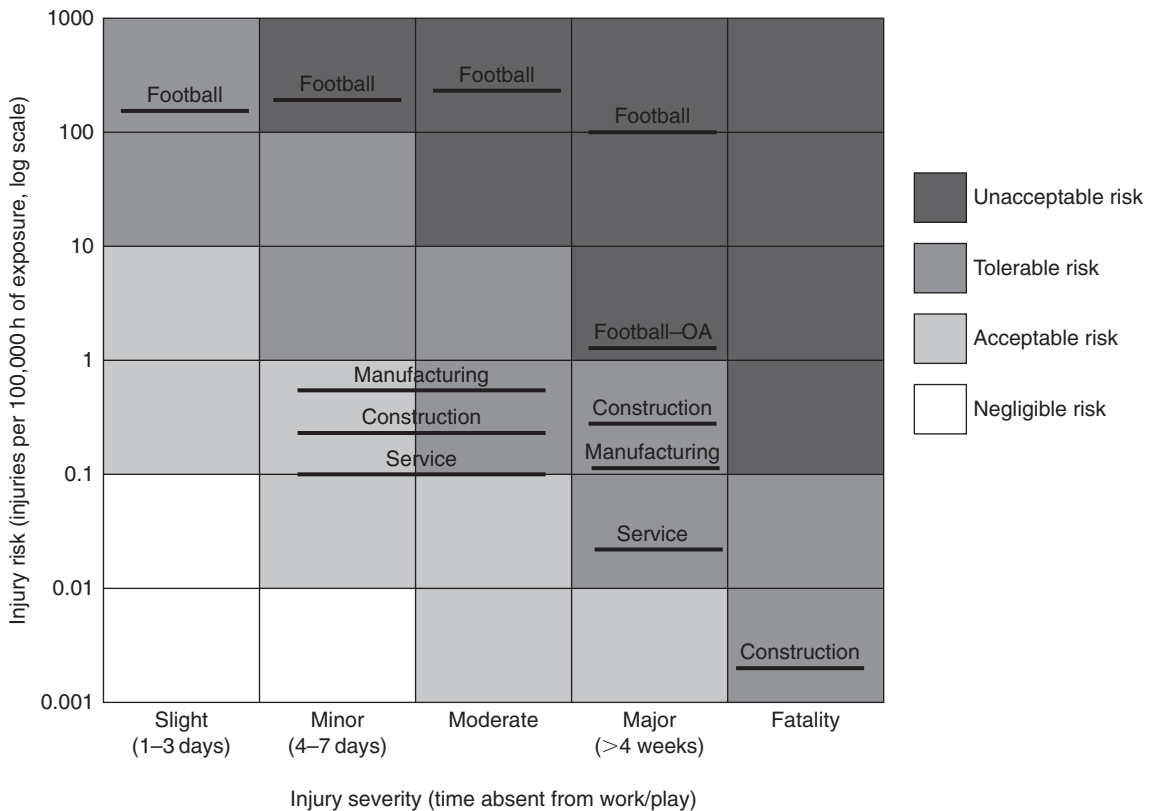


Figure 1.1. Comparison between injury risk (shown on the logarithmic vertical axis as the incidence per 100,000h of player exposure) and injury risk (shown on the horizontal axis as the duration of absence from work/play, from slight through minor, moderate and major to fatalities) in professional football (Premier League), along with data from the manufacturing, construction and service industries for comparisons. Also, the dark gray areas are classified as unacceptable risk when using industrial standards for risk management. Reproduced with permission from Drawer and Fuller (2002)

developing improved treatment methods for injuries, in general, and ACL injuries, in particular, remains an important goal, it may be even more important to prevent injuries.

Is there an evidence base for injury prevention?

The second issue relates to the potential for new ideas and improved health outcomes. In May 2000, a PubMed search revealed that out of 10,691 papers on athletic injury, there were only six randomized controlled trials (RCTs) on sports injury prevention (Table 1.2). However, a similar search

of the literature in December 2007 revealed that sports injury prevention research is emerging as a new field in medicine. While the number of studies on athletic injuries has increased by 43% over the last 7 years, clinical studies and RCTs related to sports injury prevention has increased by 200–300% (Table 1.2). Gradually, congresses in sports medicine, orthopedics, and traumatology include an increasing number of symposia, lectures, and instructional courses on injury prevention issues. Research is also improving in quality, not only in quantity. For example, recent issues of high-impact general medical journals such as the *British Medical Journal* and the *Journal of the American Medical Association* have included several papers related to injury prevention; two case-control studies among

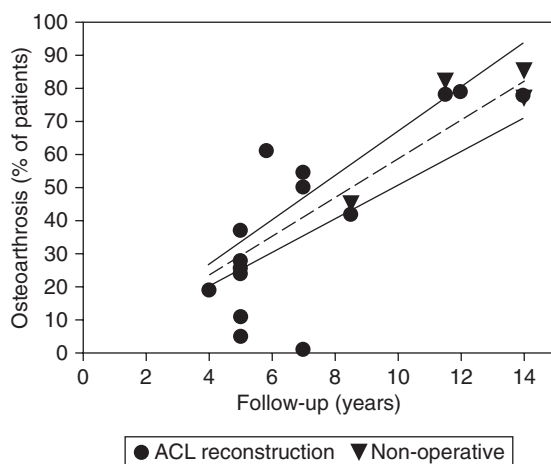


Figure 1.2. Anterior cruciate ligament (ACL) follow-up studies and Osteoarthritis (OA) prevalence. The data illustrate the prevalence of radiographic OA after reconstructive surgery with bone-patella-tendon-bone graft or hamstring graft and after non-operative treatment. The dashed line indicates the forced regression ($y = 6.0t$; $r = 0.85$) between time (t) and OA prevalence (y), with the 95% confidence intervals shown by thin solid lines. Reproduced with permission from Myklebust and Bahr (2005)

skiers and snowboarders indicating a significant reduction in the risk of head injury with helmet use (Hagel et al., 2005; Sulheim et al., 2006), an RCT demonstrating a 47% reduction in knee and ankle injuries from a structured program of warm-up exercises in adolescent team handball players (Olsen et al., 2005), and an ecological study of a nationwide educational injury prevention program indicating a reduced frequency of spinal cord injuries in rugby (Quarrie et al., 2007). Many major public health and specialty journals are currently publishing new studies in this field. The publication of these studies in highly respected medical, physical therapy and nursing journal illustrates that sports injury prevention is an important public health issue.

Is sports participation healthy?

Sports participation is important from a public health perspective. There is no longer any doubt that regular physical activity reduces the risk of premature mortality in general, and of coronary

Table 1.2 Results of PubMed searches on sports injury research related to treatment and prevention.

Search terms	May 2000	December 2007	Increase (%)
Athletic injury	10,691	15,347	43
& treatment	6,606	9,774	48
& Limit: Clinical trials	182	359	97
& Limit: RCT	87	180	107
& prevention	2,064	3,319	61
& Limit: Clinical trials	29	125	330
& Limit: RCT	21	70	233

Note: Results are shown as the number of items resulting from the search terms shown.

heart disease, hypertension, colon cancer, obesity, and diabetes mellitus in particular. The question is whether the health benefits of sports participation outweigh the risk of injury and long-term disability, especially in high-level athletes? A study from Finland has investigated the incidence of chronic disease and life expectancy of former male world-class athletes from Finland in endurance sports, power sports, and team sports (Sarna et al., 2000). The overall life expectancy was higher in the high-level athlete compared to a matched reference group (75.6 versus 69.9 years). They also showed that the rate of hospitalization was lower for endurance sports and power sports compared to the reference group (Kujala et al., 1996). This resulted from a lower rate of hospital care for heart disease, respiratory disease, and cancer. However, the athletes were more likely to have been hospitalized for musculoskeletal disorders. A follow-up study revealed that former team sport athletes had a higher risk of knee OA, and other studies have documented an increased risk of hip and knee arthritis among former football players. Thus, the evidence suggests that although sports participation is beneficial, injuries are a significant side effect. To promote physical activity effectively, we have to deal professionally with the health problems of the active patient. This does not only involve providing effective care for the injured patient, but also developing and promoting injury prevention measures actively.

Injury prevention is a complex process. To prevent injury, scientists must first correctly identify one or several risk factors, the mechanisms of injury, devise an effective intervention to modify it, implement the intervention with sufficient compliance, and study the outcome of the intervention with a method that is sensitive enough to detect reductions in the injury rate which are clinically meaningful. When prevention is successful or fails, it may not always be clear which step in this chain of events was deficient. This complexity makes injury prevention difficult, but not impossible. A number of interventions have shown a reduction in injury rates, that is, ACL injuries in team handball and soccer; ankle injuries in soccer, basketball and volleyball; head injuries in hockey and skiing; wrist injuries in snowboarding; and hamstrings injuries in Australian Rules football and soccer. The list is increasing year by year for the benefit of the athlete and the sports.

The future of injury prevention

Do we need to further develop prevention programs in the future? Year by year we seem to have more information about risk factors and their relative roles. If the relative additional risk of having specific risk factors is known, some individuals should probably be advised against participation in certain sports where the risk factor cannot be eliminated. On the contrary, if the effect of eliminating one risk factor after another is known, individuals may be able to participate in sports with low risk if they are compliant with their specific training program. The goal must be to reach a stage where the risk factors are known and where we can assign a relative risk of an injury to individuals. During the preseason examination, individuals with risk factors can then be assigned training programs that have been validated. Even at this stage, future research in this field is necessary. The nature of sports is always changing—becoming faster and generally more demanding. Just think of the difference in alpine skiing over the last 25 years. In almost any sports the same increase in pace is seen. Thus, research on risk factors

and injury mechanisms must be ongoing and intervention studies crucial.

In an evolving field such as this, international cooperation is critical. The involvement of the IOC, which highlights sports injury prevention research in this book, improves the dissemination of information around the world. In addition, this book initiative has been supported by all of the major sports and sports medicine organizations, which bodes well for the future.

References

- Andersen, T.E., Árnason, A., Engebretsen, L., Bahr, R. (2004) Mechanisms of head injuries in elite football. *British Journal of Sports Medicine* **38**, 690–696.
- Bahr, R., van Mechelen, W., Kannus, P. (2002) Prevention of sports injuries. In M. Kjær, M. Krogsgaard, P. Magnusson, L. Engebretsen, H. Roos, T. Takala & S.L.Y. Woo (eds) *Textbook of Sports Medicine. Basic Science and Clinical Aspects of Sports Injury and Physical Activity*. pp. 299–314. Blackwell Science, Oxford.
- Drawer, S., Fuller, C.W. (2002) Evaluating the level of injury in English professional football using a risk based assessment process. *British Journal of Sports Medicine* **36**, 446–451.
- Griffin, L.Y., Albohm, M.J., Arendt, E.A., Bahr, R., Beynnon, B.D., Demaio, M., Dick, R.W., Engebretsen, L., Garrett Jr, W.E., Hannafin, J.A., Hewett, T.E., Huston, L.J., Ireland, M.L., Johnson, R.J., Lephart, S., Mandelbaum, B.R., Mann, B.J., Marks, P.H., Marshall, S.W., Myklebust, G., Noyes, F.R., Powers, C., Shields Jr, C., Shultz, S.J., Silvers, H., Slauterbeck, J., Taylor, D.C., Teitz, C.C., Wojtys, E.M., Yu, B. (2006) Understanding and preventing noncontact anterior cruciate ligament injuries: a review of the Hunt Valley II meeting, January 2005. *American Journal of Sports Medicine* **34**, 1512–1532.
- Hagel, B.E., Pless, I.B., Goulet, C., Platt, R.W., Robitaille, Y. (2005) Effectiveness of helmets in skiers and snowboarders: case-control and case crossover study. *British Medical Journal* **330**(7486), 281.
- Junge, A., Langevoort, G., Pipe, A., Peytavin, A., Wong, F., Mountjoy, M., Beltrami, G., Terrell, R., Holzgraefe, M., Charles, R., Dvorak, J. (2006) Injuries in team sport tournaments during the 2004 Olympic Games. *American Journal of Sports Medicine* **34**, 565–576.
- Kujala, U.M., Sarna, S., Kaprio, J., Koskenvuo, M. (1996) Hospital care in later life among world class athletes. *Journal of the American Medical Association* **276**, 216–220.

- Myklebust, G., Bahr, R. (2005) Return to play guidelines after anterior cruciate ligament surgery. *British Journal of Sports Medicine* **39**, 127–131.
- Olsen, O.E., Myklebust, G., Engebretsen, L., Holme, I., Bahr, R. (2005) Exercises to prevent lower limb injuries in youth sports: cluster randomised controlled trial. *British Medical Journal* **330**(7489), 449.
- Quarrie, K.L., Gianotti, S.M., Hopkins, W.G., Hume, P.A. (2007) Effect of nationwide injury prevention programme on serious spinal injuries in New Zealand rugby union: ecological study. *British Medical Journal* **334**(7604), 1150.
- Sarna, S., Sahi, T., Koskenvuo, M., Kaprio, J. (2000) Increased life expectancy of world class athletes. *Medicine and Science in Sports and Exercise* **25**, 37–44.
- Sulheim, S., Holme, I., Ekeland, A., Bahr, R. (2006) Helmet use and risk of head injuries in alpine skiers and snowboarders. *Journal of the American Medical Association* **295**, 919–924.

Further reading

- Bahr, R. (2003) Preventing sports injuries. In R. Bahr & S. Mæhlum (eds) *Clinical Guide to Sports Injuries*, pp. 41–53. Human Kinetics, Champaign.
- Caine, D.J., Caine, C., Lindner, K. (1996) *Epidemiology of Sports Injuries*. Human Kinetics, Champaign.
- Caine, D.J., Maffulli, N. (eds) (2005) *Epidemiology of Pediatric Sports Injuries. Individual Sports. Medicine and Sport Science*. Vol. 48. Karger, Basel.
- Khan, K., Bahr, R. (2006) Principles of sports injury prevention. In P. Brukner & K. Khan (eds) *Clinical Sports Medicine*. pp. 78–101. McGraw-Hill, Sydney.
- Maffulli, N., Caine, D.J. (eds) (2005) *Epidemiology of Pediatric Sports Injuries. Team Sports. Medicine and Sport Science*. Vol. 49. Karger, Basel.
- Renström, P.A.F.H. (ed) (1994) *Clinical Practice of Sports Injury Prevention and Care: Olympic Encyclopaedia of Sports Medicine*. Vol. 5. Blackwell Publishing, Oxford.