Chapter 6

Risk and protective factors

Information about the characteristics of players at risk of sports injury is crucial for the development of effective injury prevention strategies. Indeed, the identification of both risk and protective factors is essential in the planning and development of strategic public health initiatives for the prevention of sports injuries at the community level. Community sports injury studies are needed for a comprehensive description of the problem across the broad spectrum of injury severity, as injury profiles and associated risk factors are different for professional and community sports.

To date, there has been little aetiological research to identify the risk factors and actual causes of sports injury in community level sport in Australia. When risk factors have been considered, they have generally been examined in elite athletes.

Muscle strains are common in Australian Rules Footballers and Orchard investigated the intrinsic and extrinsic risk factors for such injuries in elite footballers over 83,503 player matches [59]. His study focused mainly on hamstring, quadriceps and calf muscle strains and he found recent history of the same injury to be the strongest risk factor, followed by a past history of the same injury. Age was also found to be a risk factor for hamstring and calf strains. Quadriceps injury risk was related to player stature, leg dominance and rainfall during the previous week. Whether the same factors hold the same level of risk for community level footballers is not known.

Verrall et al [60] conducted a small scale prospective study of hamstring muscle strain injuries in elite Australian Rules Football players. Like other studies, they found previous injury history, particularly prior thigh injury, to be the most important predictor.

Over recent years, there has been increasing attention paid towards the surfaces and ground conditions that sport is played on and its potential to influence injury risk. This has been particularly the case for football codes internationally [61]. A very recent review concluded that the shoe-surface interaction is likely to be one of the major factors in the aetiology of lower limb injury in football, across many codes [61]. Most of the evidence backing this statement comes from studies of high level and elite football competitions. Nevertheless, there are many consistencies across studies with a higher predominance of non-contact injuries earlier in the season and differential injury rates on different surface types (for example, artificial turf vs. natural grass in American football). Although the studies have all been conducted with high-level athlete cohorts, the results are likely to be applicable to lower levels of play. Accordingly, shoe design, ground composition and ground hardness are all factors that need to be investigated further in community level sport.

One of the postulated links with ground conditions is the observation that many injuries occur early in the playing season [61]. The WASIS cohort study found a higher incidence of injuries across four sporting codes during the first month of the study. However, this elevated incidence was not repeated in the 2nd year of the study [24]. The authors considered that this was likely to do with the recruitment of study participants and their enthusiasm for the study protocol in the early stages of the project, rather than a true early season effect.

It has been suggested that one of the factors that has impacted on injury risk in elite Australian Rules Football over time is the increasing speed of the game, as well as changes in player profile characteristics such as player heights and mass [62]. This conclusion was based on an analysis of elite level Australian Rules Football, and whilst the study is yet to be replicated in community Australian Rules Football, the expectation is that a similar change in injury risk due to these factors will also be shown. The study in elite Australian Rules Footballers [62] also suggests that the tempo of the game, and not just the amount of accrued hours of play, needs to be taken into consideration in the calculation of injury risk. In a later study, relating injury occurrence to the evolution of the elite Australian Rules Football game [63], these authors added ground hardness and playing level to their risk factors for injury. The incidence of injuries in the Australian Wallabies (elite) rugby union team has also been shown to correlate with changes in the speed and professionalism of the game [64].

McKay et al [22] conducted a prospective observational study of injuries in one elite and three recreational basketball competitions in Melbourne. A game-side observer recorded injuries. As ankle injuries are the most common injured region in basketballers, a particular focus was on ankle injuries. Three independent significant risk factors for ankle injury were found:

- players with a history of previous ankle injury had an elevated risk of injury Odds ratio (OR)=4.94 (1.95-12.48);
- players with shoes with air cells in the heel were more likely to be injured than those wearing shoes without air cells OR=4.34 (1.51-12.40);
- players who did not stretch before the game were more likely to be injured OR=2.62 (1.01-6.34).

Despite the gaps and inconsistencies in information on sports injuries, enough is known to guide some efforts to reduce the number of injuries and their severity. The current information provides a good understanding of those sporting activities which, because of their intrinsically risky nature or because of the large number of people participating in them (or both), carry a significant risk of injury. This means that sub-groups of participants who are at high risk of injury can be identified. The reports listed in Appendix 1 describe the factors most likely to contribute to injury in the various sports considered and the nature and severity of the injuries likely to be sustained.

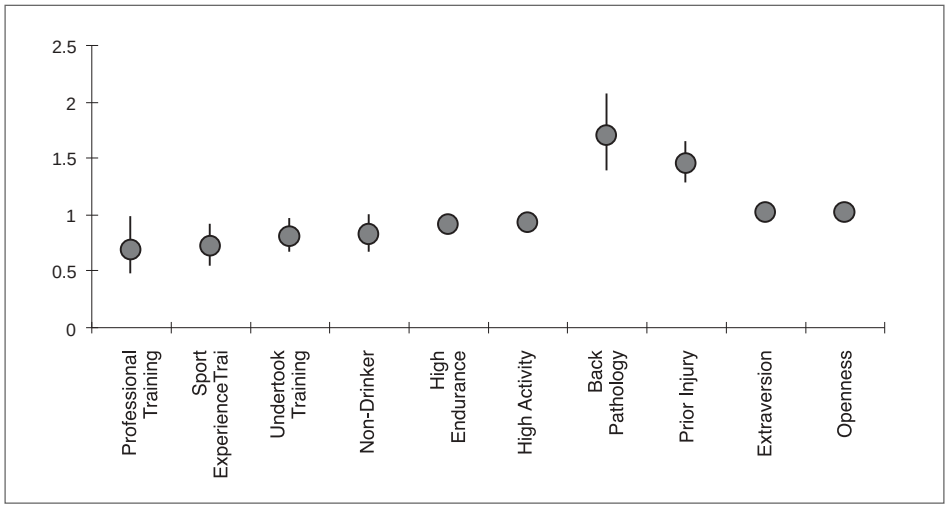
A baseline survey of 1500 participants of Australian Rules Football, basketball, netball and hockey was conducted and injuries monitored prospectively over the following two playing seasons. This study

has shed some important light on both potential risk and protective factors for injury in these four sports played at the community level. Figure 2 shows the incidence rate ratios (IRR) obtained from this study. An IRR greater than 1 indicates an increased risk of injury (i.e. a risk factor) and an IRR significantly less than 1 indicates a protective factor. Three significant risk factors were identified:

- people with back problems were prone to sports injury (IRR=1.69);
- an injury sustained in the previous season increased the risk of further injury (IRR=1.45);
- players who had the personality characteristics of "extraversion" and "openness" were also more at risk.

Figure 2. Incidence rate ratios (95% CI) indicating risk and protective factors for sports injuries in community sports

(Source: Sports Medicine Australia, WA branch, 2001)



The study also identified six overall protective factors [65]:

- participation in a sport specific training program (IRR=0.68), particularly one designed by a qualified exercise/sport professional;
- previous experience in the sport (in the previous season) – i.e. not being a novice (IRR=0.71);
- being a non-drinker (perhaps as a proxy for a healthy lifestyle) (IRR=0.82);
- being generally physically active (IRR=0.92);
- self-rating of having high endurance (perhaps as a proxy for fitness).

In 2001, there was considerable public debate about whether or not pregnant women should participate in sport [66, 67]. This was precipitated by Netball Australia's banning of participation by pregnant women. A discussion of the injury risks to both the mother and unborn child were crucial to this debate. Although trauma to pregnant women is a potential risk during sport, as there is no published information about the magnitude of this risk, it is presumed to be low [68]. Whilst there is an emerging literature about the risk of adverse outcomes following severe and catastrophic trauma to pregnant women, this literature almost exclusively focuses on road trauma victims or the result of assault. An analysis of Australian data confirmed that the risk of

abdominal injury during sport is very low [68] and the author concluded that currently there is not an adequate evidence-base for quantifying the risk of abdominal injuries during sport in women, let alone pregnant women or for justifying a ban of sport on this basis.

Lower extremity injuries are the most commonly reported injuries in sport. A review of risk factors for lower extremity injury in sport has recently been published in the British Journal of Sports Medicine [69]. The review considered both intrinsic and extrinsic risk factors and presented the evidence supporting these factors. The range of factors considered reflects the wide disparity of the literature which consists of conflicting study results, low powered studies, inconclusive results, poor case definition and both inconsistent and unvalidated methodologies. Table 6 summarises the major

Table 6: Risk factors for lower limb injuries
(Adapted from information in Murphy et al, 2003)

Injury	Risk factors (with good evidence)
Lower limb injury in general	• Competition settings versus training • Artificial turf versus grass or gravel • Previous injury coupled with inadequate rehabilitation
Anterior cruciate ligament injury	• Reduced femoral intercondylar notch width • Being female versus being male • Wearing boots with edge-style cleats versus other cleat designs
Ankle injury high	• Higher skill levels (for example, collegiate basketball versus school basketball in the USA)
Stress fractures	• High arches or a supinated foot type • Increased age at the onset of menarche • Decreased bone mineral content

conclusions about injury risk factors from this review. In addition to these risk factors, the authors concluded that there is strong evidence for the use of ankle tape or bracing to reduce the risk of ankle injuries. However, in the study of Melbourne basketballers, the trend towards ankle taping reducing ankle injury risk was not significant [22].

Gabbe [70] conducted aetiological research in amateur Australian Rules Football players for the first time. Her particular focus was on identifying predictive factors for the time to occurrence of lower limb injuries in these players, and hamstring injuries in particular. An important finding was that when all lower limb injuries were combined, it was hard to identify predictive factors because of the diversity of injury types (from ankle injuries to knee injuries to thigh haematomas, etc). However, when the outcome of interest was restricted to the time until the first hamstring injuries the following exposure-adjusted risk factors were age (older players more at risk) and quadriceps flexibility (reduced flexibility most at risk).

A number of the recent advances in sports medicine were summarised by Bahr in 2001 [71]. Bahr had used the Medline database to identify relevant literature and three of the six highlighted recent advances he listed were related to injury prevention:

- balance training and taping of the ankle prevents recurrent ankle sprains;
- balance training and strength and agility training can prevent knee injuries;
- balance training may also prevent injuries to the anterior cruciate ligament.

Bahr has, himself, conducted research into the effectiveness of balance training and this may have influenced his highlighting of this prevention measure, in particular.

Over the past five years, the "new" information about sports injury risk factors has largely come from epidemiological studies [22, 59, 61, 65, 72]. Importantly, the findings of these studies, such as the WASIS, all need to be reproduced in further samples. It also needs to be noted that such epidemiological studies can only identify potential risk factors and need to be supplemented by biomechanical/ biomedical research to confirm their role in injury causality and to provide biologically plausible mechanisms for their observed effects. This is akin to most other medical research, which requires both basic biomedical science, and as well as applied research to develop preventive measures to address disease causal factors.

Over recent years, there has been an increasing recognition of the need to combine biomechanical and epidemiological approaches to tackle the sports injury problem [73, 74]. Such partnerships are necessary to both fully understand injury causality and to guide the development and evaluation of countermeasures [75]. An example of such a partnership is a nested case-control study conducted within the WASIS Study [65]. Participants with a knee injury from the larger cohort study were approached and invited to undergo specific biomechanical and other testing of their knees to identify risk factors for knee injuries. Controls were other cohort members who did not have a knee injury. Two independent risk factors were identified for knee injury:

- having weaker hamstring muscles,
- having a history of sports injury (in the previous season).

The strength of these findings is limited because of the study design being a retrospective case-control study. However, they do provide insight for the design of a randomised controlled design to address these risk factors.

6.1 Summary of current status

Epidemiological studies have started to provide evidence for potential sports injury risk factors. The WASIS has provided the best information about risk factors for sports injury in community participants of four sports. Identified risk factors included previous injury, particularly a back injury, and certain psychological profiles. Protective factors were being adequately prepared for the game by participating in formal training, having experience in a sport, being generally healthy and having high physical endurance. However, this study needs to be reproduced in other player cohorts and sports and the identified risk factors explored in further aetiological studies. There is a need to combine epidemiological, biomechanical and medical approaches to take this forward.

Injury history is consistently identified as an injury risk factor, suggesting that poor/inadequate rehabilitation or injury susceptibility (for reasons unknown) need to be addressed.

It has been suggested that lower limb injuries, particularly in elite Australian Rules Football, are related to ground conditions and surfaces or the pace of the game. However, specific examination of these factors in community-level sport has yet to be undertaken.