

ORIGINAL ARTICLE

Epidemiology of injuries in the Australian Football League, seasons 1997–2000

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Objective: To describe the epidemiology of injuries in the Australian Football League (AFL) over four seasons.

Methods: An injury was defined as "any physical or medical condition that caused a player to miss a match in the regular season." The rationale for this definition was to eliminate a previously noted tendency of team recorders to interpret injury definitions subjectively. Administrative records of injury payments to players who did not play matches determined the occurrence of an injury.

Results: The seasonal incidence of new injuries was 39 per club (of 40 players) per season (of 22 matches). The match injury incidence for AFL games was 25.7 injuries per 1000 player hours. The injury prevalence (percentage of players missing through injury in an average week) was 16%. The recurrence rate of injuries was 17%. The most common and prevalent injury was hamstring strain (six injuries per club per season, resulting in 21 missed matches per club per season), followed in prevalence by anterior cruciate ligament and groin injuries.

Conclusions: The injury definition of this study does not produce incidence rates that are complete for all minor injuries. However, the determination of an injury is made by a single entity in exactly the same manner for all teams, which overcomes a significant methodological flaw present in other multiteam injury surveillance systems.

Australian football is a unique sport played on natural grass. The primary means of ball progression is punt kicking. Body tackling of the player in possession of the ball is permitted. There are 18 players per team on the field, with up to four players per team on an interchange bench. The size of the field is variable but larger than for all other types of football. The premier professional competition is the Australian Football League (AFL), which maintains its own website (www.afl.com.au) which includes multimedia footage of game highlights. The AFL is a winter league that schedules weekly matches for 16 teams over 22 rounds of a home and away season.

The AFL has conducted a continuous injury survey since 1992.¹ The first comprehensive survey of professional Australian football injuries was performed in 1983.² The AFL is believed to be the world's first professional football league, from 1996 onwards, to publish an annual report in its match day programme that details the entire league injury rates from the previous season.

The scientific literature contains many examples of injury surveys in professional football, usually from single team doctors over a number of seasons, rather than the entire set of teams in a league.^{3–6} Other professional football leagues around the world conduct comprehensive injury surveillance, but there is neither a common method for such surveys nor an obligation to publish the results in the scientific literature. The National Football League (NFL) in the United States has conducted an official injury survey for about 20 years but publishes only specific studies rather than a comprehensive report.^{7–9} The Football Association (FA) in the United Kingdom has recently published a comprehensive summary of injuries,¹⁰ and surveys in rugby league,¹¹ rugby union,¹² and Gaelic football¹³ leagues have led to published injury statistics in recent years.

AFL injury surveillance includes the aims of progression beyond descriptive injury surveillance to an understanding of risk factors for injury and, ultimately, injury prevention.¹⁴ These should be aims of professional football competitions all over the world. To date, however, sustained injury prevention has eluded most of them. One of the explanations for this is the difficulty of

establishing continuing reliable injury surveillance. A further factor that confounds improvements in injury prevention and management is a continuing increase in size of players and speed of the game that tends to drive the injury rates up.¹⁵

Injury definitions and methods have a very strong influence on the injury incidence reported by studies.¹⁶ The original definition of an injury for AFL injury surveillance in 1992 was (a) any injury that caused a player to be unavailable for selection in a match, or participation in a training session; or (b) any other injury that required specific medical treatment, other than routine conservative measures.¹ This definition was complex and took into account two common elements of definitions used in football injury survey: time loss and medical treatment. Other injury definitions automatically include certain specific injuries (such as concussion and fractures) irrespective of time loss.^{17,18}

The major problem of the original AFL injury definition was that teams subjectively interpreted it, and the reported variation in injury incidence between teams was as much as tenfold for minor injuries.¹⁹ The most likely explanation for this variation was that some recorders updated their survey data on a daily basis, whereas others had longer periods between recording sessions and hence may have forgotten minor injuries that quickly recovered. This has been observed in other studies, with the major explanation being a recall bias that may affect 90% of mild injuries.¹⁶ Because of the desire to have injury rates that were directly comparable between teams and from season to season, a major aim of this study was to use an injury definition that would be applied with exactly the same rigour by all teams.

METHODS

The definition of an injury was "any physical or medical condition that prevents a player from participating in a regular

Abbreviations: AFL, Australian Football League; ACL, anterior cruciate ligament

Table 1 Example of a weekly player status record for four players

Player	Week																					
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22
AB	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P
PS	I	I	I	P	I*	I*	P	P	P	P	P	P	I	I	I	P	P	P	P	○	○	○
EJ	P	P	P	P	P	P	P	P	P	P	P	P	P	P	○	P	P	P	P	P	P	P
GP	P	P	P	P	P	I	I	I	I	I	I	I	I	I	I	I	I	P	P	P	P	I

P, player played a match that week; I, player was out with an injury; ○, player was missing for other reasons; I*, player was out with a recurrent injury.

season (home and away) match." The rationale for this definition was that club "senior lists" (player rosters) were kept relatively constant throughout the season and the central AFL administration kept a "player movement" record for every "senior list" player during every round of the season (table 1). Every week (round) a player was either playing a match, not playing because of injury, or not playing for other reasons. Other reasons included suspension, personal reasons, being taken as a travelling emergency player and not used, and not being selected in the AFL team when the player's affiliated lower grade team did not play during that week. The AFL standard player contract required that clubs paid a minimum payment to any player missing a match because of injury, and that these payments were registered with the AFL to ensure that all teams stayed under a "salary cap".

The team medical recorders were required to provide details of all injuries, specifically diagnoses and times of onset, rather than determine which injuries met the survey definition. The team medical recorder was one of the team doctors in 12 teams and one of the team physiotherapists in the other four teams.

If a player was missing through injury as a result of more than one diagnosis, only the primary diagnosis (as assessed by the recorder) was considered an injury for survey purposes. An injury was considered to have recovered when the player returned to match playing. An injury was determined a "recurrence" if the player had suffered an injury of the same type to the same body part, on the same side earlier in the same season.

The players included in the injury survey were all AFL senior listed players, which were specified at the start of the season. Team senior lists varied in size from 38 to 44 players. AFL regulations dictated that no players could be removed entirely from a team's senior list during the regular season. The only additions to the senior list were from a team's "rookie list" of up to six junior players. Rookie list players could only be added to a team's senior list in the event of a long term injury to one of the senior list players. If a rookie was added to the senior list during the season (which was an uncommon event), he became part of the survey population from the round after being added. If a player retired during the middle of the season, he was considered missing for reasons other than injury (if his retirement was for personal reasons) or missing

because of injury (if his retirement was forced by injury). When a case of retirement was questionable, the cause was determined by whether the player received injury payments after his retirement.

The injuries were all coded and categorised according to the Orchard sports injury classification system,²⁰ which was created specifically for this survey.

Injury incidence

Injury incidence represents the number of new injuries divided by the amount of exposure to injury. The major unit of injury incidence reported is the rate of injuries per club per season. The season lasts 22 weeks (rounds), and there are 16 teams (clubs). The standard size club is considered to be 40 players (for the purposes of standardising the size of lists from year to year and team to team).

Injury seasonal incidence equals the number of new injuries multiplied by 40 and divided by the number of player seasons. Seasonal incidence is effectively very close to the number of injuries reported divided by 16 (the number of clubs in the league), because the clubs generally had close to an average of 40 players on their list each season. Therefore, an injury with a seasonal incidence of 1.0 per club per season would mean that approximately 16 injuries per year were reported to the survey. It would also mean that each club could expect to have one player (out of 40) per season to have an injury of this type that would result in his missing a regular season match.

Because injury incidence only took new injuries into account, a recurrence rate for each injury category was calculated as the number of recurrent injuries multiplied by 100 and divided by the number of new injuries.

The onset of injuries was subdivided into three categories: injuries that occurred in the preseason period; injuries that occurred during a regular season match; and injuries that occurred during the regular season but not during a match. Training injuries, injuries with a gradual onset, and injuries occurring outside football (which are counted by this survey) are included in the latter category.

The incidence of preseason injuries is reported in units of injuries per club per season (the same unit as regular season injuries). If a club had four players unavailable to play because

Table 2 Extent of survey and average weekly Australian Football League (AFL) player status (1997–2000)

	1997	1998	1999	2000	Total	Average
Player weeks in survey	14895	14662	14664	14560	58781	
Player seasons in survey	677.0	665.5	666.5	661.8	2671.9	
Average number playing AFL football per week	21.0	22.0	22.0	22.0		21.7
Average number playing lower grade football per week	11.8	11.4	11.4	11.3		11.5
Average number playing per week	32.8	33.4	33.4	33.3		33.2
Average number not playing because of injury per week	7.7	6.7	6.4	6.2		6.7
Average number not playing for other reasons per week	1.9	1.6	1.8	1.8		1.8
Average number not playing per week	9.6	8.3	8.3	8.0		8.5
Average size of senior list (per club)	42.3	41.7	41.7	41.4		41.7
Injury prevalence (%)	18.1	16.1	15.4	15.0		16.1

Table 3 Seasonal injury incidence (new injuries) and recurrence rates by injury category (1997–2000)

Injury category	Injuries per club per season					Recurrence rate (%)
	Total	1997	1998	1999	2000	
Head/neck						
Concussion	0.6	0.6	0.7	0.5	0.6	0
Facial fractures	0.7	0.8	0.7	0.8	0.7	2
Neck sprains	0.1	0.1	0.1	0.2	0.2	10
Other injuries	0.2	0.2	0.3	0.1	0.1	0
Shoulder/arm/elbow						
Shoulder sprains and dislocations	0.8	0.9	0.9	0.7	0.7	17
Acromioclavicular joint injuries	0.9	0.9	0.9	0.6	1.3	2
Fractured clavicles	0.4	0.4	0.4	0.3	0.5	15
Elbow sprains or joint injuries	0.1	0.2	0.1	0.1	0.1	11
Other shoulder/arm/elbow injuries	0.5	0.8	0.5	0.2	0.5	18
Forearm/wrist/hand						
Fractures	1.5	1.1	1.7	1.7	1.4	5
Other forearm/wrist/hand injuries	0.4	0.4	0.4	0.4	0.7	0
Trunk/spine						
Rib injuries	0.7	0.8	0.5	0.8	0.6	5
Lumbar and thoracic spine injuries	2.0	2.2	1.7	1.7	2.4	18
Abdominal strain injuries	0.7	0.7	0.8	0.7	0.8	14
Other trunk/spine injuries	0.3	0.5	0.2	0.4	0.2	5
Hip/groin/thigh						
Groin strains	3.3	4.1	3.1	3.1	2.9	21
Hamstring strains	6.2	6.7	6.2	6.6	5.5	34
Quadriceps strains	2.5	2.5	3.0	2.4	2.0	23
Thigh haematomas	0.9	0.9	1.3	0.9	0.5	5
Other groin/hip/thigh injuries	0.7	0.8	0.4	0.5	0.9	14
Knee						
ACL injuries	0.9	1.4	0.9	0.7	0.5	2
MCL injuries	1.0	0.7	1.3	1.2	0.9	15
PCL injuries	0.5	0.6	0.3	0.7	0.5	14
Knee cartilage injuries	1.1	0.9	1.3	1.1	1.1	25
Patellar tendon injuries	0.7	0.6	0.6	0.7	0.7	20
Patellar instability	0.1	0.2	0.2	0.1	0.1	0
Other knee injuries	1.1	1.4	0.4	1.0	1.5	6
Shin/ankle/foot						
Ankle sprains or joint injuries	2.7	2.8	2.9	2.2	2.8	15
Calf strains	1.9	2.0	2.3	1.4	1.9	19
Achilles tendon injuries	0.4	0.3	0.3	0.5	0.4	23
Leg and foot fractures	0.8	0.5	0.8	1.1	0.6	12
Leg and foot stress fractures	0.7	0.8	0.7	0.8	0.6	18
Other leg/foot/ankle injuries	1.5	1.9	1.7	1.2	1.2	7
Medical illness	2.2	2.5	2.7	1.6	1.9	8
All injuries	39.3	42.5	40.3	36.9	37.5	17

A club is defined as 40 players and a season is defined as 22 matches.

ACL, Anterior cruciate ligament; MCL, medial collateral ligament; PCL, posterior cruciate ligament.

of injury in round 1 (from a list of 40 players), this would equate to 4.0 preseason injuries for that club that season. The incidence of match injuries is reported in units of injuries per 1000 player hours. This is calculated by the number of match onset injuries multiplied by 1000 and divided by the number of player hours. A player match is 1.33 player hours—matches are 80 minutes long (which takes into account only standard playing time and not time added for stoppages). There are 18 players on the field for each team at any given time, with four players on an interchange bench who are regularly moved on and off the field (unless injured).

The incidence of non-match injuries is reported in units of injuries per 1000 player weeks. This was calculated as number of non-match onset injuries multiplied by 1000 and divided by the number of player weeks in the survey. Exposure for in season injuries was considered to be only 21 weeks, rather than 22—injuries occurring in round 22 would not cause players to miss any matches through injury, because there is no match the following week. If a round 22 injury did cause a player to miss round 1 in the following season, it was considered a preseason injury for that next season. A player injured during training in the lead up to week 1 was determined to have a preseason injury rather than a non-match in season injury, so week 1 was not part of the exposure for the non-match injury calculation.

Injury prevalence

Injury prevalence is a measure that combines injury incidence and severity (number of weeks missed). For injuries in total, it is reported as a percentage (the average percentage of players missing through injury each match). This percentage is calculated as the number of games missed through injury multiplied by 100 and divided by the number of player weeks of exposure (possible games played). In this report, for specific injuries, it is reported in units of missed games per club per season, to maintain consistency with injury incidence. This was calculated as the number of games missed through injury multiplied by 40 and divided by the number of player seasons. Injury prevalence in units of missed games per club per season can be converted into an injury prevalence percentage by multiplying by 100 and then dividing by 880 (which is 40 multiplied by 22, the number of weeks in the season).

Injury severity

Injury severity is defined as the average number of games missed per injury. Because the season only lasts for 22 weeks, average injury severity can underestimate the average recovery time for serious injuries. For example, an anterior cruciate ligament (ACL) injury usually requires reconstruction and prevents a player from playing for 6–10 months. In the injury survey, however, a player

Table 4 Injury incidence by activity type (seasons 1997–2000, combined) by injury category

Injury category	Match injuries per 1000 player hours		Non-match injuries per 1000 player weeks	Preseason injuries per club per season
	AFL matches	Other matches		
Head/neck				
Concussion	0.7	0.6	0.0	0.0
Facial fractures	0.7	0.7	0.0	0.1
Neck sprains	0.1	0.0	0.1	0.0
Other head/neck injuries	0.2	0.1	0.1	0.0
Shoulder/arm/elbow				
Shoulder sprains and dislocations	0.6	0.5	0.1	0.3
Acromioclavicular joint injuries	0.7	1.2	0.1	0.1
Fractured clavicles	0.3	0.4	0.0	0.1
Elbow sprains or joint injuries	0.1	0.1	0.0	0.0
Other shoulder/arm/elbow injuries	0.3	0.5	0.1	0.1
Forearm/wrist/hand				
Forearm/wrist/hand fractures	1.2	1.5	0.1	0.2
Other forearm/wrist/hand injuries	0.3	0.2	0.1	0.1
Trunk/spine				
Rib injuries	0.6	0.9	0.1	0.0
Lumbar and thoracic spine injuries	1.2	1.3	0.8	0.3
Abdominal strain injuries	0.5	0.1	0.4	0.1
Other trunk/spine injuries	0.3	0.4	0.0	0.0
Hip/groin/thigh				
Groin strains	1.5	2.4	1.4	0.6
Hamstring strains	4.3	3.7	2.2	0.8
Quadriceps strains	1.1	1.4	1.1	0.5
Thigh haematomas	0.8	1.2	0.1	0.0
Other groin/hip/thigh injuries	0.4	0.5	0.3	0.1
Knee				
ACL injuries	0.6	0.4	0.0	0.4
MCL injuries	1.0	0.8	0.1	0.1
PCL injuries	0.7	0.4	0.0	0.0
Knee cartilage injuries	0.7	0.8	0.3	0.2
Patellar tendon injuries	0.2	0.4	0.3	0.2
Patellar instability	0.1	0.1	0.0	0.0
Other knee injuries	0.8	1.3	0.2	0.1
Shin/ankle/foot				
Ankle sprains or joint injuries	2.2	2.5	0.4	0.3
Calf strains	1.1	1.1	0.9	0.2
Achilles tendon injuries	0.3	0.1	0.2	0.0
Leg and foot fractures	0.6	0.5	0.1	0.2
Leg and foot stress fractures	0.2	0.3	0.4	0.2
Other leg/foot/ankle injuries	1.2	1.3	0.4	0.1
Medical illness	0.5	0.8	1.8	0.2
All injuries	25.7	28.9	11.9	5.5

A club is defined as 40 players and a season is defined as 22 matches.

ACL, Anterior cruciate ligament; MCL, medial collateral ligament; PCL, posterior cruciate ligament.

with an ACL injury will usually only miss as many matches as there are remaining in the season, which is not always a large number.

Table 1 is a sample status record for a fictional four player segment of a club. There were four player seasons (88 player weeks) of exposure ($88 = 4 \times 22$). The players played in 63 matches (AB, 22 matches; PS, 11; EJ, 21; GP, 9) and were exposed to injury in 61 of these (the other two matches were in the last round of the season). They suffered 4 injuries among them plus 1 recurrence of an injury (PS, 2 new injuries and 1 recurrence; GP, 2 new injuries). There were 21 missed player games as a result of injury (PS, eight games; GP, 13). The size of this club was one tenth of the standard size (four instead of 40). The annual injury incidence was 40 per club per season ($4 \text{ injuries} \times 40/4$). The preseason injury incidence was 10 per club per season ($1 \text{ injury} \times 40/4$). Presuming that the other 3 new injuries all occurred during matches, the match injury incidence was 37 injuries per 1000 player hours ($(3 \times 1000)/(61 \times 1.33)$). The injury prevalence was 23.86% ($21/88$), or 210 matches missed per club per season ($21 \times 40/4$).

RESULTS

During seasons 1997–2000, every AFL team participated in the injury survey, and the weekly status of every senior listed

player (whether playing, injured, or not playing for non-injury reasons) was obtained from AFL records.

Table 2 lists the scope of the survey and the average number of players playing and missing through injury each round of each season. The number playing AFL level football per club per week increased from 21 to 22 in 1998, as the AFL changed the number of players per team on the interchange bench from three to four (the number of players per team on the field stayed constant at 18).

Table 3 documents injury incidence. The most commonly injured body region is the thigh, and the most common type of injury is the muscle strain. Hamstring injuries are a common member of both of these categories, being muscle stress injuries of the thigh and totalling about 6 injuries per club per season. This represents 15% of all injuries. Hamstring injuries have the highest recurrence rate of all injuries, 34% of the incidence of new hamstring strains. Overall, the rate of recurrent injuries is 17% of the rate of new injuries.

Table 4 compares the match injury incidence for AFL and other (lower grade) matches. The injury incidence rates are generally very similar. It is possible that there is a greater willingness to play with minor injury if the player is playing at AFL level (compared with lower grade level). Given that injuries

Table 5 Injury prevalence by injury category

Injury category	Matches missed per club per season				
	Total	1997	1998	1999	2000
Head/neck					
Concussion	0.6	0.7	0.7	0.5	0.7
Facial fractures	2.2	2.5	2.1	2.3	2.0
Neck sprains	0.8	0.7	0.5	1.7	0.2
Other head and neck injuries	0.4	0.3	0.4	0.2	1.0
Shoulder/arm/elbow					
Shoulder sprains and dislocations	5.2	5.1	5.9	5.6	4.0
Acromioclavicular joint injuries	2.1	2.2	2.1	0.9	3.1
Elbow sprains or joint injuries	0.6	0.7	1.2	0.2	0.1
Fractured clavicles	1.8	1.4	1.6	1.2	3.0
Other shoulder/arm/elbow injuries	1.5	2.6	1.9	0.3	1.3
Forearm/wrist/hand					
Forearm/wrist/hand fractures	5.2	4.1	5.4	5.9	5.6
Other forearm/wrist/hand injuries	1.2	0.7	1.3	0.9	1.8
Trunk/spine					
Rib injuries	1.3	1.7	0.8	1.7	0.9
Lumbar and thoracic spine injuries	8.7	13.0	4.9	8.4	8.6
Abdominal strain injuries	1.5	1.1	1.3	1.4	2.4
Other trunk/spine injuries	1.1	2.7	0.6	0.7	0.5
Hip/groin/thigh					
Groin strains	11.9	17.4	13.2	9.4	7.4
Hamstring strains	21.2	20.8	20.7	21.1	22.2
Quadriceps strains	7.6	8.6	9.5	6.7	5.6
Thigh hematomas	1.4	1.5	1.7	1.2	1.1
Other groin/hip/thigh injuries	2.3	2.6	1.1	3.5	2.1
Knee					
MCL injuries	3.6	3.3	4.3	3.3	3.5
ACL injuries	12.8	19.8	15.8	10.8	4.8
PCL injuries	2.9	2.1	2.2	5.2	2.3
Knee cartilage injuries	6.2	4.3	6.1	5.3	9.2
Patellar instability	0.8	0.5	1.1	0.8	0.7
Patellar tendon injuries	2.9	2.4	1.6	3.9	3.9
Other knee injuries	2.9	3.9	1.2	2.3	4.3
Shin/ankle/foot					
Ankle sprains or joint injuries	6.4	7.2	7.0	4.1	7.1
Calf strains	5.4	5.9	6.4	3.4	5.7
Leg and foot fractures	5.3	2.6	5.4	8.8	4.5
Leg and foot stress fractures	4.9	4.9	4.0	6.7	3.8
Achilles tendon injuries	1.4	1.2	1.4	1.3	1.6
Other leg/foot/ankle injuries	4.5	6.5	5.0	2.9	3.8
Medical illness	3.5	4.2	3.7	3.3	2.8
All injuries	142.3	159.3	141.9	135.9	131.6

A club is defined as 40 players and a season is defined as 22 matches.

ACL, Anterior cruciate ligament; MCL, medial collateral ligament; PCL, posterior cruciate ligament.

that do not cause games to be missed are not considered in this survey, this is a bias that would affect any analytical comparison between the match injury rates for the different levels of play. Table 4 shows that the major injuries that occurred outside matches were medical illnesses and muscle strains. There were an average of 5.5 preseason injuries per club per season.

Table 5 details injury prevalence. In an average season, a club of 40 players suffers 142 missed matches through injury over the 22 rounds, which equates to an injury prevalence of 16% (that is, an average of 16% of senior listed players being unavailable to play through injury in any given round).

Average injury severity is not reported as a specific table. It can easily be calculated for each category by dividing injury prevalence (table 5, units of missed games per club per season) by injury incidence (table 3, units of injuries per club per season), yielding a unit of missed games per injury.

DISCUSSION

The injury definition of this survey is somewhat controversial, because by taking into account only injuries that cause matches to be missed, it is argued that not all important injuries are reported.¹⁶⁻²¹ The counter argument in favour of this injury definition, however, is very strong. Because it is consistent and is—in the context of this survey—assessed reliably and

independently, the injury rates reported by the survey are consistent, reliable, and meaningful.

If this survey had used one of the more comprehensive definitions that relied on factors such as missed training sessions or presentation to team medical staff, then the rates of injury incidence would be biased by team specific factors. For example, if team doctor A attends every training session of his or her team, whereas team doctor B only attends one training session per week, then there would be a bias towards more injuries at team A. Therefore, comparison of injury incidence between teams would not be meaningful, as it would be impossible to determine whether apparent differences were due to bias. In addition, comparison from season to season would also be meaningless, because bias (caused by changes in observation, participation, recall, and/or enthusiasm) may be responsible for any observed differences. This would make it very difficult for such injury surveillance to be used as the backbone of a comprehensive injury prevention paradigm, such as that suggested by van Mechelen *et al.*¹⁴

Other studies that have been based on the AFL injury surveillance system have already benefited from this lack of bias. For example, it has been observed that the incidence of non-contact ACL injuries is higher at more northern (warmer climate) venues, and is higher in early (warmer) months of

the season.^{22, 23} The warm season (northern) bias is also apparent for some other lower limb non-contact injuries.²⁴ These differences are statistically significant at very low levels and therefore highly unlikely to be due to chance. Because of the methods used in this survey to determine injuries, these differences are far less likely to be due to an observational bias—for example, that team doctors in northern cities are more likely to attend training and therefore more likely to report injuries—than if a subjective definition is used.

The fall in ACL injury incidence documented in this paper (table 3) and analysed elsewhere²⁵ is also unlikely to be due to observational bias, and perhaps may be related to changes in ground preparation to attempt to reduce shoe-surface traction.²⁵

Future analysis of risk factors for AFL injuries will involve multivariate analysis of both intrinsic and extrinsic variables.^{22, 26} Unfortunately, it is unlikely that randomised control trials will be permitted within the AFL as a professional competition, so the reversibility of risk factors will need to be tested in lower level competitions.

There are potential ways in which the AFL injury definition could be expanded in the future while remaining independent of the recorders of team medical data. If a central register was kept for all injuries that required the player to be assisted from the field using a stretcher or motorised vehicle, then an instance of this occurrence could be included within the injury definition without compromising its objectivity. Similarly, if the AFL required all occurrences of players being injected with local anaesthetic during a game to be registered as part of doping procedures, then this could also be included within the injury definition.

Currently AFL injury surveillance does not report rates for preseason or finals matches. This is because clubs are not required to complete a “player movement” sheet during these weeks, as match payments are not made. In the preseason period it would be more difficult to determine whether a player who does not play is missing through injury or other reasons, as many players are “rested” for preseason games. During the finals it would be more difficult to determine status for those players not selected at AFL level than during the regular season. In the regular season, fit players who are not selected for their AFL team are eligible to play a match each week with an affiliated lower grade team, but their affiliated team may not be participating during the finals. In the off season (when no matches are scheduled but players sometimes train), injury incidence would be very difficult to calculate as exposure would be very difficult to assess, and the previously mentioned dilemmas in defining an injury would also apply.

Conclusion

The AFL injury surveillance system uses consistent methods for determining injury rates. The most fundamental element is the definition of an injury as a “physical or medical condition that causes a player to miss a game”. This system will serve as a basis for understanding injury risk and injury prevention in the future.

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Take home message

The injury profile for Australian football is comparable to that for soccer and rugby union. There are high incidences of lower limb muscle strains, because of the nature of the game. The AFL uses an injury definition based on players missing games, in order to achieve consistent levels of compliance from all teams in the competition.

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REFERENCES

- Seward H, Orchard J, Hazard H, *et al*. Football Injuries in Australia at the elite level. *Med J Aust* 1993;**159**:298–301.
- Seward HG, Patrick J. A three year survey of Victorian Football League injuries. *Aust J Sci Med Sport* 1992;**24**:51–4.
- Ekstrand J, Gillquist J. Soccer injuries and their mechanisms: a prospective study. *Med Sci Sports Exerc* 1983;**15**:267–70.
- Nicholas JA, Rosenthal PP, Gleim GW. A historical perspective of injuries in professional football. Twenty-six years of game-related events. *JAMA* 1988;**260**:939–44.
- Gibbs N. Injuries in professional rugby league. A three-year prospective study of the South Sydney Professional Rugby League Football Club. *Am J Sports Med* 1993;**21**:696–700.
- Targett S. Injuries in professional rugby union. *Clinical Journal of Sport Medicine* 1998;**8**:280–5.
- Scranton P, Whitesel J, Powell J, *et al*. A review of selected noncontact anterior cruciate ligament injuries in the National Football League. *Foot Ankle Int* 1997;**18**:772–6.
- Powell J, Schootman M. A multivariate risk analysis of natural grass and astroturf playing surfaces in the National Football League 1980–1989. *International Turfgrass Society Research Journal* 1993;**7**:201–10.
- Powell J, Schootman M. A multivariate risk analysis of selected playing surfaces in the National Football League: 1980 to 1989: An epidemiological study of knee injuries. *Am J Sports Med* 1992;**20**:686–94.
- Hawkins R, Hulse M, Wilkinson C, *et al*. The association football medical research programme: an audit of injuries in professional football. *Br J Sports Med* 2001;**35**:43–7.
- Hodgson Phillips L, Standen P, Batt M. Effects of seasonal change in rugby league on the incidence of injury. *Br J Sports Med* 1998;**32**:144–8.
- Garraway W, Lee A, Hutton S, *et al*. Impact of professionalism on injuries in rugby union. *Br J Sports Med* 2000;**34**:348–51.
- Cromwell F, Walsh J, Gormley J. A pilot study examining injuries in elite gaelic footballers. *Br J Sports Med* 2000;**34**:104–8.
- van Mechelen W, Hlobil H, Kemper H. Incidence, severity, aetiology and prevention of sports injuries: a review of concepts. *Sports Med* 1992;**14**:82–99.
- Norton K, Craig N, Olds T. The evolution of Australian football. *J Sci Med Sport* 1999;**2**:389–404.
- Junge A, Dvorak J. Influence of definition and data collection on the incidence of injuries in football. *Am J Sports Med* 2000;**28**:S40–6.
- Meeuwisse W, Hagel B, Mohtadi N, *et al*. The distribution of injuries in men's Canada West university football. *Am J Sports Med* 2000;**28**:516–23.
- Powell J, Barber-Foss K. Injury patterns in selected high school sports: a review of the 1995–1997 seasons. *J Athl Training* 1999;**34**:277–84.
- Orchard J. Epidemiology of lower limb injuries in the Australian Football League. PhD thesis, University of New South Wales, 1999.
- Orchard J. Orchard sports injury classification system (OSICS). In: Bloomfield J, Fricker P, Fitch K, eds. *Science and medicine in sport*. 2nd ed. Melbourne: Blackwell, 1995:674–81.
- Hodgson Phillips L. Sports injury incidence. *Br J Sports Med* 2000;**34**:133–6.
- Orchard J, Seward H, McGivern J, *et al*. Intrinsic and extrinsic risk factors for anterior cruciate ligament injury in Australian footballers. *Am J Sports Med* 2001;**29**:196–200.
- Orchard J, Seward H, McGivern J, *et al*. Rainfall, evaporation and the risk of non-contact anterior cruciate ligament knee injuries in the Australian Football League. *Med J Aust* 1999;**165**:298–301.
- Orchard J. The ‘northern bias’ for injuries in the Australian Football League. *Australian Turfgrass Management* 2000;**23**:36–42.
- Orchard J. The AFL penetrometer study: work in progress. *J Sci Med Sport* 2001;**4**:220–32.
- Orchard J. Intrinsic and extrinsic risk factors for muscle strain injury in Australian footballers. *Am J Sports Med* 2001;**29**:300–3.