2010 Injury Report
Australian Football League

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1 Summary

The 19th annual AFL Injury Report [1-3] for 2010 reveals:

- There was 100% participation in the injury survey for all clubs and players, the 14th year in a row that this has been achieved.
- The success of the AFL with ongoing injury prevention research (including surveillance) was recently acknowledged in a World forum. Australian Football was the only sport to be the subject of a specific symposium at the 3rd IOC World Conference on Prevention of Injury and Illness in Sport in Monaco in April, where other world experts were keen to hear of the achievements of the AFL in this field.
- Overall a higher injury incidence and prevalence in season 2010 compared with season 2009, which is a continuation of a consistent but gradual upwards trend in both injury incidence and prevalence since 2003.
- The 'average' status of a club list of 46 players in any given week includes eight players missing through injury. This is an increase from six in 2003-05 and seven in 2006-08.
- The number one injury in the game remains the hamstring strain. Incidence and prevalence rates of this injury remain high. The 2010 figures were slightly down from 2009 but were consistent with the long-term averages. A recurrence rate of 13% for hamstring strains in 2010 was the lowest rate recorded.
- Rates of concussion have been low and steady over the past decade. The AFL Medical Officers Association introduced new guidelines for the management of concussion at the beginning of the 2011 Season. The guidelines promote a conservative approach to managing concussion whereby a player diagnosed with concussion cannot return to the field.
- The most severe of the common injuries is still the knee anterior cruciate ligament (ACL) tear, with slightly lower rates in season 2010 compared with recent seasons. In particular, prevalence (missed time) for ACL injuries was down in 2010. Not all players with ACL injuries in 2010 missed the remainder of the season, which is usually the case. Some (partial) ACL injuries were treated non-surgically and resulted in less missed time as a result. The use of LARS artificial grafts has contributed to the quicker return to play of some ACL injuries and hence lower prevalence. It is still too early to determine whether these grafts will have a good success rate in the longer term, but for circumstances where a quick return is paramount (e.g. older players), then LARS grafts appear to offer an alternative management which allows quicker return to play.

Further surveillance and research is required before they can be recommended as a long-term alternative for younger players.

- Other studies related to the injury survey have reported that interchange use, player speed and tackling have increased similarly to injuries in recent seasons. There appears to be an association between these factors as referred to in the 2009 Injury Report, although the relationship is complicated. Research undertaken in 2010 demonstrated that each interchange is beneficial (from an injury risk viewpoint) for the team that makes it, but is harmful for the opposition team. The potential for further increases in interchange use to increase the risk of injury was one of the reasons (along with congestion and fairness) why a rule change was made at the end of the 2010 Season to reduce the interchange from four to three players and introduce a substitute player. This 2010 injury data has been included in an updated analysis of the 2010 studies on the relationship between injuries and interchange and the original concerns have been fortified.

- The trend in centre bounce PCL injuries has continued to remain at record low levels following the introduction of the ruck rule in 2005. In 2010 there were zero PCL injuries from centre bounces and there have been only four in total since 2005.

2 Introduction

The Australian Football League (AFL, the highest level professional league of Australian Football) has commissioned a continuous annual injury surveillance system since 1992[1 4-10], making the 2010 version the 19th annual report. Injury surveillance is an important obligation of professional football bodies [3 11-14], with various levels of success reported[15]. On a national and international level the AFL Injury Survey model is highly acclaimed, particularly for the annual public release and consistent methodology[16]. The success of the AFL with injury surveillance and injury prevention research efforts was recently acknowledged with Australian Football being the only sport to be the subject of a specific symposium at the 3rd IOC World Conference on Prevention of Injury and Illness in Sport in Monaco, where World experts were keen to hear of the AFL's achievements in this field.

The presentations given in Monaco include:

- Dr Hugh Seward (AFLMOA and AFL Research Board): An introduction to Australian football
- Dr Peter Harcourt (AFL Medical Commissioner): AFL Illicit Drugs Policy and Responsible Use of Alcohol Strategy
- Assoc Prof John Orchard (AFL Injury surveillance coordinator): Injury surveillance in Australian football
- Dr Hugh Seward (AFLMOA and AFL Research Board): The reduction of posterior cruciate ligament knee injuries through rule changes
- Prof Paul McCrory (University of Melbourne): Reducing brain and spinal injuries in Australian football
- Dr Michael Makdissi (Hawthorn FC, University of Melbourne and current recipient of AFL Research funding): Monitoring outcomes of concussion management
- Assoc Prof John Orchard (AFL Injury surveillance coordinator): Identifying ground surface conditions as a risk factor for ACL injury
- Prof Caroline Finch (Monash University and current recipient of AFL Research funding): Knowledge translation and establishing community prevention programs for Australian football
- Dr Ross Smith (AFL Research Board): Choosing a strategic direction and priorities for research

The 5th annual AFL Injury Report was publicly released in 1996[2], believed to be the first occasion worldwide that a professional sport openly tabled its injury data. The National Football League (NFL) in the USA has conducted an injury surveillance system since the 1980s but does not publicly release its data on annual basis (although multiple studies arising have been published in the scientific literature[17-22]). Other bodies known to conduct regular injury surveillance (with various degrees of disclosure) include Cricket Australia[23-24], the

National Rugby League (NRL)[25], the National Collegiate Athletic Association (NCAA)[26-28], Union of European Football Associations (UEFA) [11 29-30] and the Rugby Football Union (RFU)[31-32].

The AFL has shown a long-term investment in high quality and consistent injury surveillance along with other advanced research. The AFL has also demonstrated a willingness to consider and implement rule changes where necessary to improve player safety. An example of this was the centre circle rule change, which has decreased the incidence of ruck-related posterior cruciate ligament (PCL) injuries[33].

The Injury Survey has also had a pivotal position in guiding the AFL Research Board to commission and fund projects that further investigate injuries that are common, severe or increasing in incidence. As the AFL was also the first professional sporting body in Australia to implement a funded research board, it has distinguished itself as the most progressive professional sport in this country with respect to injury research, currently devoting in excess of $300,000 per annum towards injury research.

It is an ongoing aim of the AFL, AFL Clubs, AFL Medical Officers Association (AFLMOA) and AFL Physiotherapists Association to achieve the 'gold' standard of injury surveillance in Australia and equal to the best other surveillance systems worldwide.

3 Methods

The methods of the AFL Injury Survey are now well established and have been previously described in detail [3 6], although minor changes to injury category codes are made on an annual basis.

All teams now have electronic records of injuries. For season 2010, 10 out of 16 teams primarily used an electronic record system provided by Athletic Logic. Other clubs used various other methods and forwarded on their data in alternate formats to the injury survey coordinator.

The standard AFL player contract includes consent for player records to be passed from team medical staff to the independent AFL-approved survey coordinator for the purposes of standard injury surveillance and analysis of de-identified data. For additional studies (e.g. case follow ups of certain injuries) which would require identification of players to obtain extra information, further consent from each player involved is required.

3.1 Injury Definition

From 1997 onwards, the definition of an injury has been an "injury or medical condition which causes a player to miss a match". Although this definition attracts some criticism for not surveying the entire spectrum of injuries, its strength is that a consistent comparison can be made between seasons and most accurately allows long-term trends to be followed.

3.2 Weekly player monitoring

Player movement monitoring essentially requires that all clubs define the status of each player each round to be either: (1) playing AFL football (2) playing football at a lower level (3) not playing football due to injury or (4) not playing football for another reason. The injury survey coordinator can cross-check the data provided by each club after the conclusion of the season with the player movement monitoring done in 'real time' during the season, in order to maximise compliance with the injury survey definition. The details for injuries which result in a status of being unable to participate in a match due to injury are then passed on to the injury surveillance coordinator at the end of the season for recording and analysis. These details include diagnosis, which is subsequently coded [34-35] and onset of injury. Individual player injury details are not revealed in any report of the injury survey. Player movement monitoring has allowed the injury survey to achieve '100% compliance' for all instances of missed player games in the home and away season since 1997 [3 16]. In 2001 this was extended to include rookie listed players and finals matches.

This definition and methodology has been chosen to promote consistency across the sixteen AFL clubs and from season to season[16]. It has been suggested that this definition excludes valid injuries which do not cause a player to miss a match[36]. However, for a longitudinal study such as the current analysis, if a broader definition was used there may be a concern about changing thresholds for reporting an injury by team medical staff over time [16].

The definition of a condition "causing a player to miss a match" includes illnesses and injuries caused outside football, although these injuries are considered in separate categories when grouped by diagnosis.

3.3 Injury Categories

Injury categories are amended slightly on an annual basis depending on which specific diagnoses (using OSICS codes version 9 [35 37]) are included within each category. Where changes have been made they have been made retrospectively for all previous survey years. Therefore, some of the category data presented in this report for previous years varies slightly from what is apparently the same data that has been published before in the previous reports.

3.4 Injury Rates

The major measurement of the number of injuries occurring is seasonal injury incidence measured in a unit of new injuries per club per season (where a club is defined as 40 players and a season is defined as 22 rounds). Since the average club now has approximately 46 players on the list and plays for slightly greater than 22 rounds (including finals), the exact number of injuries occurring per club is slightly greater than the figures tabulated. For example, a hamstring injury incidence of 6 new injuries per club per season (for 40 players playing 22 weeks) would be equivalent to 7 new injuries per club per season (for 46 players over 23 weeks). The modification is required so that the year-to-year figures are comparable, because average list size changes from year-to-year (and in fact the number of weeks played increased in 2010 due to the drawn Grand Final).

The major measurement of the amount of playing time missed through injury is injury prevalence measured in a unit of missed games per club per season, or alternatively percentage of players unavailable through injury.

The recurrence rate is the number of recurrent injuries expressed as a percentage of the number of new injuries. A recurrent injury is an injury in the same injury category occurring on the same side of the body in a player during the same season. Therefore, by this definition, an injury of one type that recurred the following season was defined as a new injury in that next season.

All injury rates are adjusted to account for differing player list sizes and number of matches per club in each season, so that the injury rates reported each season represent a hypothetical club with 40 listed players participating in 22 matches.

4 Results

Key indicators for the past twelve years are shown in Table 1. The injury incidence (number of new injuries per club per season) for 2010 was the highest (38.6 new injuries per team per season) it has been in the last decade. Injury prevalence was the highest it has been since 1997 and continued the upward trend since 2003. Despite these increases, the rate of recurrent injuries (4.7 per team per season or 12%) was close to the long-term average.

Table 1 – Key indicators for all injuries over the past ten seasons

All injuries	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	Average
Incidence (new injuries per club per season)	35.8	34.4	34.1	34.8	35.3	34.0	34.7	36.9	37.8	38.6	35.6
Incidence (recurrent)	5.5	4.4	4.6	3.7	4.8	4.1	5.6	5.4	3.6	4.7	4.6
Incidence (total)	41.3	38.7	38.7	38.5	40.1	38.2	40.4	42.3	41.4	43.3	40.3
Prevalence (missed games per club per season)	136.4	134.7	118.7	131.0	129.2	138.3	147.1	147.1	151.2	153.8	138.8
Average injury severity (number of missed games)	3.8	3.9	3.5	3.8	3.7	4.1	4.3	4.0	4.0	4.0	3.9
Recurrence rate	15%	13%	14%	11%	14%	12%	16%	15%	10%	12%	13%

4.1 Injury Incidence

Table 2 (on the following page) details the incidence of the major injury categories. Notable findings to report for injury incidence in 2010 include a higher than usual incidence of groin strains/osteitis pubis and ankle sprains. However, the vast majority of injury categories exhibited incidence close to or slightly above the long-term (10-year) average.

Table 2 – Injury Incidence (new injuries per club per season)

Body area	Injury type	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	10yrA
Head/ neck	Concussion	0.7	0.7	0.3	0.3	0.7	0.3	0.3	0.4	0.5	**0.5**	0.5
	Facial fractures	0.4	0.4	0.6	0.8	0.6	0.3	0.4	0.2	0.5	**0.5**	0.5
	Neck sprains	0.1	0.0	0.0	0.1	0.2	0.3	0.1	0.2	0.1	**0.1**	0.1
	Other head/neck injuries	0.3	0.2	0.3	0.2	0.1	0.2	0.2	0.1	0.1	**0.2**	0.2
Shoulder/ arm/ elbow	Shoulder sprains and dislocations	1.1	0.9	1.3	1.0	1.4	1.6	1.0	1.8	1.3	**1.6**	1.3
	A/C joint injuries	0.9	1.1	0.3	1.1	0.8	1.2	0.8	0.7	0.5	**0.8**	0.8
	Fractured clavicles	0.3	0.3	0.2	0.6	0.3	0.3	0.3	0.1	0.2	**0.2**	0.3
	Elbow sprains or joint injuries	0.2	0.1	0.1	0.3	0.1	0.1	0.1	0.1	0.2	**0.2**	0.1
	Other shoulder/ arm/elbow injuries	0.5	0.8	0.5	0.4	0.6	0.3	0.2	0.3	0.1	**0.3**	0.4
Forearm/ wrist/ hand	Forearm/wrist/hand fractures	0.8	1.1	0.8	1.1	1.3	1.1	0.9	1.2	1.1	**1.2**	1.1
	Other hand/wrist/ forearm injuries	0.3	0.4	0.7	0.4	0.3	0.3	0.6	0.4	0.4	**0.3**	0.4
Trunk/ back	Rib and chest wall injuries	0.4	0.9	0.8	0.7	0.4	1.0	0.4	0.7	0.3	**0.6**	0.6
	Lumbar and thoracic spine injuries	1.4	0.9	0.8	1.6	2.1	1.5	1.3	1.5	1.4	**1.7**	1.4
	Other buttock/back/ trunk injuries	0.5	0.4	0.5	0.6	0.4	0.6	0.5	0.7	0.5	**0.4**	0.5
Hip/ groin/ thigh	Groin strains/osteitis pubis	3.5	3.8	2.9	3.1	2.9	3.3	4.1	3.2	3.3	**4.1**	3.4
	Hamstring strains	6.0	4.4	5.7	6.3	5.2	6.4	6.7	6.6	7.1	**6.0**	6.1
	Quadriceps strains	1.6	1.7	2.0	1.9	1.9	1.7	1.8	1.8	2.1	**1.7**	1.8
	Thigh and hip haematomas	0.6	1.0	0.3	1.1	1.0	1.1	0.6	0.5	1.0	**1.1**	0.8
	Other hip/groin/thigh injuries, including hip joint	0.3	0.3	0.4	0.3	0.2	0.3	0.8	0.8	1.0	**0.7**	0.5
Knee	Knee ACL	0.9	0.8	0.6	0.5	0.6	0.9	0.6	0.9	0.7	**0.6**	0.7
	Knee MCL	1.2	0.9	1.0	0.7	1.0	0.8	1.4	1.3	0.7	**0.8**	1.0
	Knee PCL	1.0	0.4	0.5	0.7	0.4	0.3	0.2	0.3	0.3	**0.4**	0.4
	Knee cartilage	1.9	1.3	1.7	1.2	1.3	1.0	1.2	1.6	2.0	**1.7**	1.5
	Patella injuries	0.2	0.4	0.1	0.1	0.3	0.3	0.3	0.2	0.2	**0.5**	0.2
	Knee tendon injuries	0.5	0.8	0.7	0.4	0.7	0.4	0.3	0.3	0.5	**0.4**	0.5
	Other knee injuries	0.8	0.5	0.7	0.7	0.9	0.2	0.8	1.0	1.0	**0.4**	0.7
Shin/ ankle/ foot	Ankle joint sprains, including syndesmosis sprains	2.0	2.5	2.6	2.5	2.5	2.1	2.2	2.5	2.6	**3.3**	2.5
	Calf strains	1.6	2.2	1.6	0.9	1.9	1.6	1.2	2.0	1.3	**1.7**	1.6
	Achilles tendon injuries	0.2	0.4	0.4	0.2	0.3	0.3	0.4	0.6	0.6	**0.4**	0.4
	Leg and foot fractures	1.0	0.8	0.5	0.5	0.4	0.7	0.5	0.5	1.0	**0.9**	0.7
	Leg and foot stress fractures	0.9	0.7	0.9	0.9	0.9	1.1	1.1	0.9	0.9	**1.2**	1.0
	Other leg/foot/ankle injuries	1.7	0.8	1.5	1.7	1.3	1.5	1.3	1.1	1.5	**1.7**	1.4
Medical	Medical illnesses	1.8	2.3	2.4	2.0	2.2	0.7	1.9	2.1	2.9	**2.1**	2.0
Non-football injuries, including pre-existing		0.2	0.3	0.4	0.1	0.1	0.2	0.2	0.3	0.2	0.5	0.2
NEW INJURIES / CLUB / SEASON		35.8	34.4	34.1	34.8	35.3	34.0	34.7	36.9	37.8	**38.6**	35.6

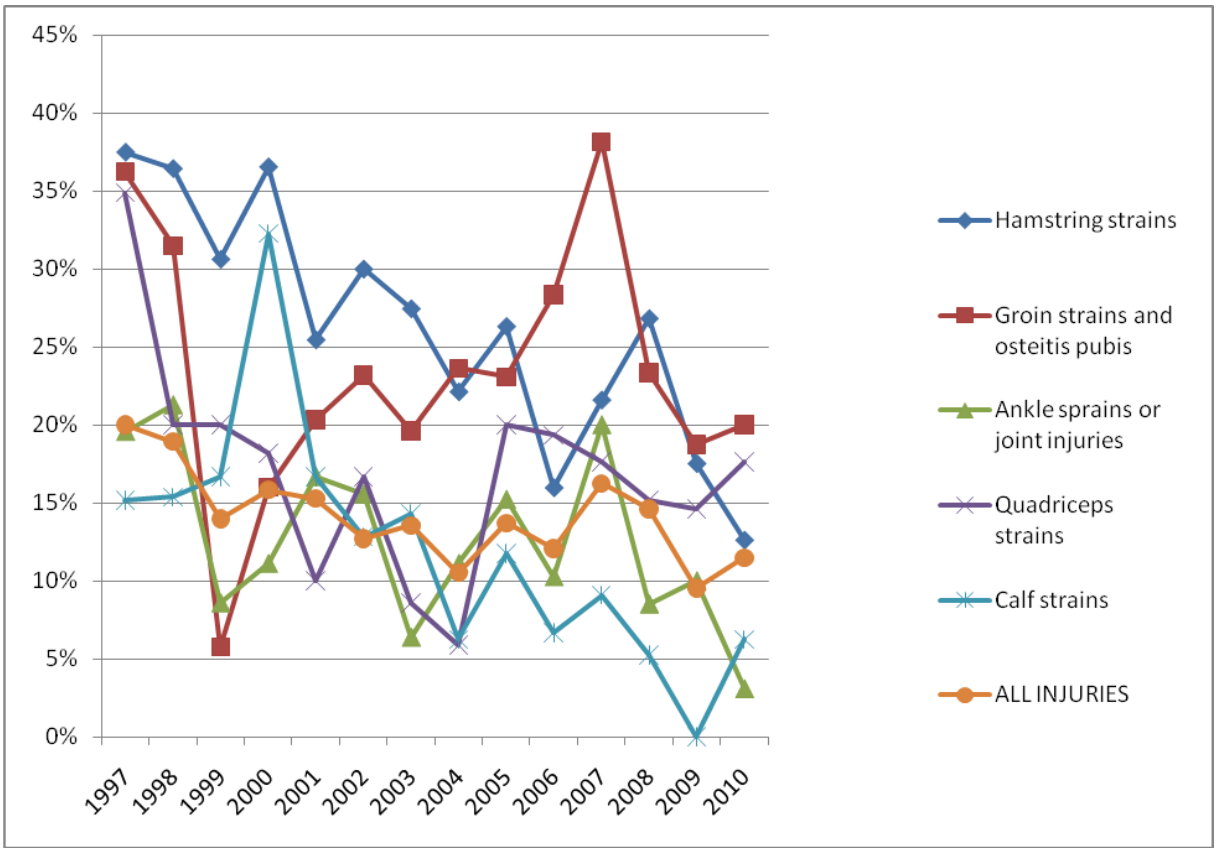
4.2 Injury Recurrence

Table 3 and Figure 1 show the rate of recurrence of some of the common injury types which are prone to high recurrence rate. Most contact-mechanism injuries, such as fractures, concussions and 'cork' injuries have a low recurrence rate. The rate of injury recurrence has been showing a fairly steady decline over the last 10 years, with all of the common muscle strains showing a steady decline in recurrence rate[38]. Across the board there has been a trend for team medical staff to be more conservative with injury management (slower return to play and fewer recurrences).

Table- 3 – Recurrence rates (recurrent injuries as a percentage of new injuries)

Recurrence rates	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	10 yr av
Hamstring strains	25%	30%	27%	22%	26%	16%	22%	27%	18%	**14%**	23%
Groin strains and osteitis pubis	20%	23%	20%	24%	23%	28%	38%	23%	19%	**20%**	24%
Ankle sprains or joint injuries	17%	16%	6%	11%	15%	10%	20%	9%	10%	**5%**	12%
Quadriceps strains	10%	17%	9%	6%	20%	19%	18%	15%	15%	**18%**	15%
Calf strains	17%	13%	14%	6%	12%	7%	9%	5%	0%	**12%**	9%
All injuries	15%	13%	14%	11%	14%	12%	16%	15%	10%	**12%**	13%

Figure 1 – Recurrence rates (recurrent injuries as a percentage of new injuries)



4.3 Weekly player status and injury prevalence

Table 4 details player status on a weekly basis over the past ten seasons. The 'average' status of a club list of 46 players in any given week for 2010 was:

- 35 players playing football per week, 22 in the AFL;
- 8 missing through injury; and
- 3 missing through other reasons (such as suspension, being used as a travelling emergency, team bye in a lower grade, etc).

Table 4 – Average weekly player status by season

All injuries	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
Playing AFL	21.0	22.0	22.0	22.0	22.0	22.0	22.0	22.0	22.0	22.0	22.0	22.0	22.0	22.0
Playing lower grade football	11.8	11.4	11.4	11.3	12.9	12.1	12.0	11.9	12.2	11.8	11.9	11.7	12.8	12.8
TOTAL playing	32.8	33.4	33.4	33.3	34.9	34.1	34.0	33.9	34.2	33.8	33.9	33.7	34.8	34.8
Not playing because of injury	7.7	6.7	6.4	6.2	6.7	6.6	5.7	6.4	6.4	7.0	7.4	7.4	7.9	8.1
Not playing for other reasons	1.9	1.6	1.8	1.8	1.8	2.3	2.5	2.5	2.8	3.1	2.9	3.4	3.5	3.5
TOTAL not playing	9.6	8.3	8.3	8.0	8.5	8.9	8.2	8.9	9.1	10.1	10.4	10.8	11.4	11.6
Players in injury survey (per club)	42.3	41.7	41.7	41.4	43.4	43.0	42.2	42.8	43.3	43.9	44.2	44.6	46.1	46.4
Injury prevalence (%)	18.1%	16.1%	15.4%	15.0%	15.5%	15.3%	13.5%	14.9%	14.7%	15.9%	16.8%	16.7%	17.2%	17.5%

Table 5 (on the following page) details the amount of missed playing time attributed to each injury category. Hamstring injuries remain the number one injury in the game with respect to missed playing time, surpassing both groin injuries and knee anterior cruciate ligament (ACL) injuries. Based on injury prevalence (missed playing time), these three categories are generally the highest categories for injury prevalence. ACL injuries exhibited lower than usual prevalence in 2010 whereas groin injuries, shoulder injuries and knee cartilage injuries exhibited higher than usual prevalence.

Table 5 – Injury Prevalence (missed games per club per season)

Body area	Injury type	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	10yrA
Head/ neck	Concussion	1.3	2.0	0.6	0.3	0.9	0.3	0.3	0.5	0.7	**0.8**	0.8
	Facial fractures	1.3	1.4	1.0	2.2	1.4	0.8	0.7	0.5	1.1	**1.4**	1.2
	Neck sprains	0.2	0.0	0.0	0.6	0.3	0.3	1.1	1.1	0.1	**0.1**	0.4
	Other head/neck injuries	1.5	0.2	0.7	0.2	0.2	1.1	1.6	0.1	0.3	**1.3**	0.7
Shoulder/ arm/ elbow	Shoulder sprains and dislocations	5.4	5.9	5.7	5.9	7.7	10.8	6.4	10.2	7.7	**10.9**	7.7
	A/C joint injuries	2.1	2.4	0.7	2.5	1.9	2.7	1.4	1.5	1.2	**1.5**	1.8
	Fractured clavicles	1.6	2.0	1.0	3.5	1.3	1.7	1.8	1.1	0.6	**0.7**	1.5
	Elbow sprains or joint injuries	0.4	0.3	0.4	0.7	0.4	0.7	0.8	0.5	1.5	**0.2**	0.6
	Other shoulder/ arm/elbow injuries	1.3	3.4	1.6	1.6	2.4	1.7	0.7	0.7	1.0	**0.3**	1.5
Forearm/ wrist/ hand	Forearm/wrist/hand fractures	2.7	3.1	2.5	3.9	3.8	4.3	2.3	3.2	4.8	**3.4**	3.4
	Other hand/wrist/ forearm injuries	0.3	2.2	2.9	1.2	1.2	0.5	3.1	1.4	0.8	**1.1**	1.5
Trunk/ back	Rib and chest wall injuries	0.7	1.5	1.7	1.3	0.6	2.2	1.9	1.3	0.6	**1.3**	1.3
	Lumbar and thoracic spine injuries	5.6	5.8	2.1	5.4	6.4	5.4	2.8	5.0	4.6	**6.9**	5.0
	Other buttock/back/ trunk injuries	1.5	1.6	1.6	2.3	0.7	1.3	1.7	1.3	1.2	**1.0**	1.4
Hip/ groin/ thigh	Groin strains/osteitis pubis	13.6	15.7	13.7	13.3	11.2	14.0	18.0	12.4	11.7	**15.3**	13.9
	Hamstring strains	21.3	15.6	18.6	21.6	18.6	21.8	24.3	25.8	21.8	**20.6**	21.0
	Quadriceps strains	3.8	4.3	6.0	4.2	6.4	5.5	5.6	6.5	8.4	**6.3**	5.7
	Thigh and hip haematomas	0.6	1.9	0.5	1.7	1.6	1.4	1.0	0.6	1.2	**1.9**	1.2
	Other hip/groin/thigh injuries, including hip joint	1.7	1.2	1.5	2.6	1.0	2.3	4.5	3.4	6.9	**4.7**	3.0
Knee	Knee ACL	13.6	15.3	10.8	10.1	9.3	14.1	15.1	15.3	11.1	**7.8**	12.3
	Knee MCL	4.8	2.8	2.9	2.9	3.0	1.7	4.7	4.0	2.3	**2.5**	3.2
	Knee PCL	5.9	2.3	2.0	6.5	2.7	1.8	1.6	2.2	1.2	**3.2**	2.8
	Knee cartilage	12.5	6.0	7.0	6.1	7.8	5.7	9.1	8.5	10.7	**13.0**	8.6
	Patella injuries	0.8	2.5	0.6	0.1	0.8	1.2	2.7	1.0	1.8	**2.4**	1.4
	Knee tendon injuries	2.5	3.7	2.9	0.9	2.6	1.8	0.7	1.1	0.8	**0.8**	1.9
	Other knee injuries	2.5	1.0	2.4	1.3	3.8	0.2	2.6	2.7	2.6	**0.9**	2.0
Shin/ ankle/ foot	Ankle joint sprains, including syndesmosis sprains	4.3	5.9	5.3	6.4	9.2	8.1	7.1	7.0	8.9	**9.2**	7.2
	Calf strains	3.4	4.4	3.8	1.7	4.5	3.4	3.1	4.4	3.0	**3.7**	3.5
	Achilles tendon injuries	0.7	0.9	1.5	0.8	1.9	2.1	2.2	4.1	2.2	**3.4**	2.0
	Leg and foot fractures	7.0	7.9	2.9	3.7	2.7	5.7	2.7	3.2	7.5	**7.6**	5.1
	Leg and foot stress fractures	4.4	3.9	5.3	6.3	5.1	8.2	6.8	7.3	11.0	**8.5**	6.7
	Other leg/foot/ankle injuries	4.2	2.3	3.7	4.3	4.2	4.1	4.2	4.6	6.8	**5.7**	4.4
Medical	Medical illnesses	2.6	2.9	3.8	4.2	3.6	0.7	3.1	3.5	3.7	**3.2**	3.1
Non-football injuries, including pre-existing		0.3	2.4	1.0	0.4	0.1	0.5	1.4	1.1	1.3	**2.4**	1.1
MISSED GAMES / CLUB / SEASON		136.4	134.7	118.7	131.0	129.2	138.3	147.1	147.1	151.2	**153.8**	138.8

4.4 Analysis and discussion for significant injury categories

(a) Hamstring injuries

Hamstring injuries are the most common injury in the AFL and are responsible for the highest number of matches missed through injury [3]. They are also common in other sports[39-40]. In sports where positional requirements vary, hamstring strains are far more common in the positions where sprinting is more often required[41].

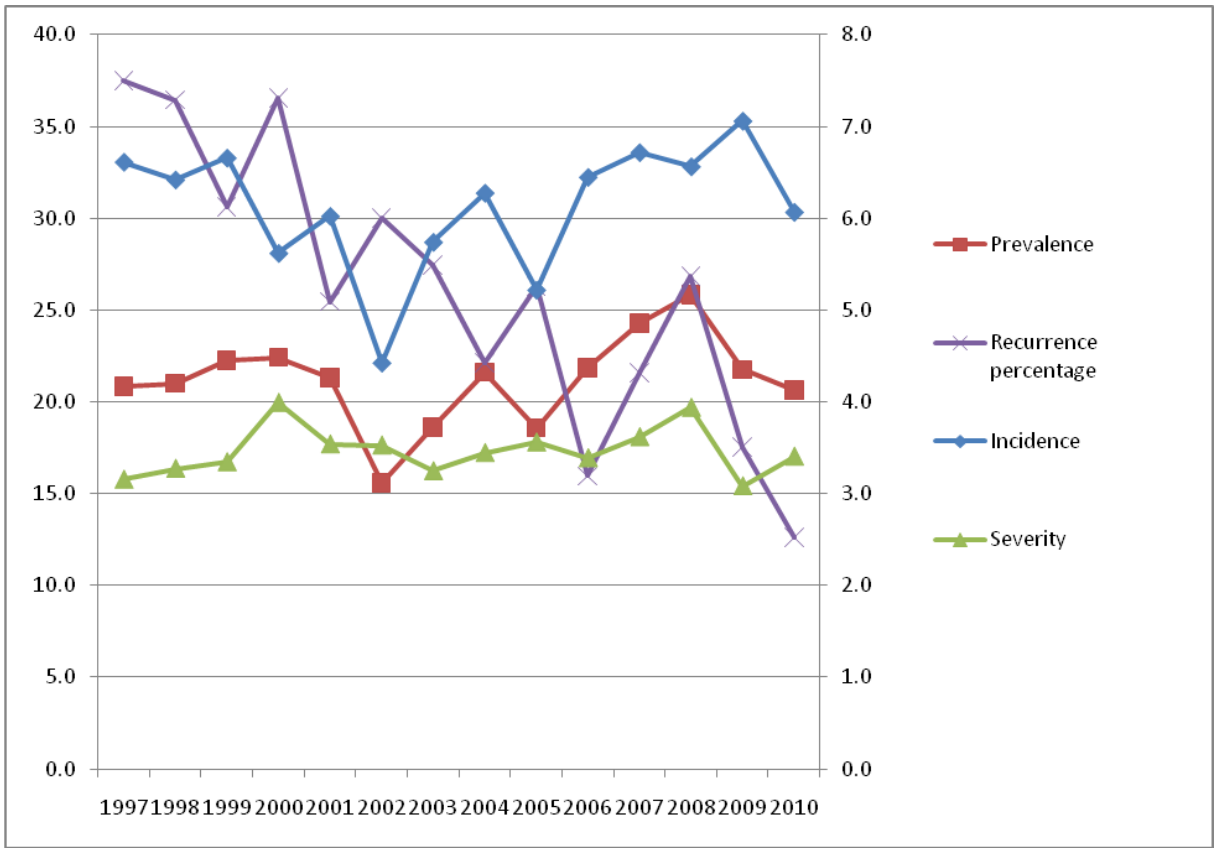
Hamstring injuries can occur acutely from a high intensity event (as per the 100m sprinter tearing the muscle after 40m of running) and also as a gradual onset 'overuse' injury with specific onset being difficult to isolate. The majority of hamstring injuries in Australian football occur in matches although some occur during training sessions or by other means. Known risk factors include player age, past history of hamstring injury, strength deficits, indigenous race and past history of other injury (including calf, knee, ankle and groin injuries) [42-45].

Previous analysis of hamstring and other muscle strain data shows a high rate of recurrence [38 43 45-50]. The current AFL data shows that management of these injuries has become more conservative over the past decade in the AFL, with recurrence tending to decrease but prevalence and severity tending to increase (Figure 2). This change in management strategy has possibly been led by research showing that recurrence rates remain high for many weeks after the initial injury[46] and that performance of players is often decreased in the matches soon after return from hamstring strain[50]. Hamstring injuries are known to affect older players and those with a past history of injury more often[38 43 45-50] than other players.

Table 6 – Key indicators for hamstring strains over the past decade

Hamstring injuries	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	10yrA
Incidence	6.0	4.4	5.7	6.3	5.2	6.4	6.7	6.6	7.1	6.0	6.1
Prevalence	21.3	15.6	18.6	21.6	18.6	21.8	24.3	25.8	21.8	20.6	21.0
Severity	3.5	3.5	3.2	3.4	3.6	3.4	3.6	3.9	3.1	3.4	3.5
Recurrence rate (%)	25%	30%	27%	22%	26%	16%	22%	27%	18%	14%	23%

Figure 2 – Key indicators for hamstring strains over the past thirteen seasons



(b) Shoulder injuries

Table 9 shows a slight but steady increase in the rates of shoulder injuries over the past decade. In 2010, shoulder injury recurrence rates were the highest they have been on the ten-year record. It is possible that the increased number and ferocity of tackles during this period has contributed to the increased risk of shoulder injury. The increasing speed of the game facilitated through increased use of the interchange, combined with the subsequent increase in collisions and high intensity collisions may also be a contributing factor.

A research project is currently underway examining 1) the evolution of tackling in the modern game; 2) the potential impact this might be having on rates of shoulder injury; and 3) outcomes from past shoulder injury management including surgical outcomes.

In addition to the above, the other factor possibly contributing to the increasing trend in shoulder injuries is the greater tendency for teams to end a player's season somewhat earlier with shoulder reconstruction which is impacting on the observed rates of shoulder injury.

Table 9 – Key indicators for shoulder injuries over the past decade

Shoulder sprains & dislocations	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	10yrA
Incidence	1.1	0.9	1.3	1.0	1.4	1.6	1.0	1.8	1.3	1.6	1.1
Prevalence	5.4	5.9	5.7	5.9	7.7	10.8	6.4	10.2	7.7	10.9	5.4
Severity	4.9	6.7	4.4	5.9	5.6	6.7	6.3	5.8	5.7	6.9	4.9
Recurrence rate	10%	13%	9%	11%	20%	13%	16%	9%	12%	26%	10%

(c) Knee ligament injuries

The two major knee ligament injuries, anterior cruciate ligament (ACL) and posterior cruciate ligament (PCL) injuries, have shown slightly decreased injury rates in recent years (Table 7). There have been lower rates of PCL injuries since the introduction of the centre circle rule in season 2005, including zero centre bounce PCL injuries in 2010. There has certainly been a long-term decline in the risk of PCL injuries in ruckmen in the AFL[33].

Knee ACL injury incidence has been generally steady over the past few seasons (Table 7) although there was a lower reported prevalence in 2010. Not all ACL injuries in 2010 missed the remainder of the season, which is usually the case. Some (partial) ACL injuries were treated non-surgically and resulted in less missed time as a result. The use of LARS artificial grafts has contributed to the quicker return to play of some ACL injuries and lower prevalence. It is still too early to determine whether these grafts will have a good success rate in the longer term, but for circumstances where a quick return is paramount (e.g. older players), then LARS grafts appear to offer an alternative management which allows quicker return to play. Further surveillance and research is required before they can be recommended as a long-term alternative for younger players.

Table 7 – Key indicators for major knee ligament injuries over the past decade

Knee ligament injuries	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	10yrA
PCL incidence	1.0	0.4	0.5	0.7	0.4	0.3	0.2	0.3	0.3	**0.4**	0.5
PCL prevalence	5.9	2.3	2.0	6.5	2.7	1.8	1.6	2.2	1.2	**3.2**	2.9
No of PCL injuries (total)	18	7	8	13	7	5	3	5	6	**8**	8.0
Number of centre bounce PCL injuries	4	3	2	5	1	0	0	2	1	**0**	1.8
ACL incidence	0.9	0.8	0.6	0.5	0.6	0.9	0.6	0.9	0.7	**0.6**	0.7
ACL prevalence	13.6	15.3	10.8	10.1	9.3	14.1	15.1	15.3	11.1	**7.8**	12.3
No of ACL reconstructions using autografts	17	15	11	9	10	19	13	15	13	**5**	12.7
Pre-existing ACL injuries/non-AFL injuries	0	1	0	0	0	1	1	0	0	**3**	0.6
No of graft ruptures	1	4	0	2	1	4	2	4	1	**0**	1.9
No of LARS reconstructions	0	0	0	0	0	0	0	2	0	**4**	0.6
Partial ACL injuries	0	0	0	0	0	0	0	1	1	**2**	0.4

(d) Concussion

Table 8 shows consistently low incidence and prevalence for concussion (consistently fewer than one injury per team per season which causes a game to be missed). The rates of concussion in the past decade are lower than those reported in the 1990s.

The AFL's stance on reduced tolerance of head-high contact and stricter policing of dangerous tackles along with the introduction of rules to penalise a player who makes forceful contact to another player with his head over the ball has contributed to the low rates of concussion reported in the AFL injury survey. Further tightening of these rules occurred prior to the 2011 Season.

The AFL Injury Report definition of concussion is the one definition most frequently challenged in the context of only capturing those concussions which cause a week to be missed[36]. Any change to the definition of concussion for the survey would compromise the ability to detect long-term trends based on the historical data. There are reports from other codes of football where retired players concede that on some occasions when they received concussions they did not report the full extent of symptoms to team medical staff[51]. For this reason, trying to achieve a record of 'all' concussions for all teams would be very difficult. A separate study is being undertaken to monitor concussion in greater detail this year.

There is increasing concern about the potential cumulative impact of so-called 'minor' concussions, particularly in the sport of American Football[52]. However, return to play strategies in the AFL (including the majority of players not missing a game) have been validated as in line with best practice, including in the American Journal of Sports Medicine[53]. The AFL Medical Officers Association introduced new concussion guidelines at the beginning of the 2011 Season[54]. These guidelines promote a more conservative approach to managing concussion whereby a player diagnosed with concussion cannot return to the field.

In addition to the new concussion guidelines, there are two detailed research projects underway investigating a) the use of advanced neuroimaging techniques to help identify factors associated with more severe injuries and higher risks of complications; and 2) tracking the longer term outcomes in current and former AFL players who have sustained concussions.

Table 8 – Key indicators for concussion over the past decade

Concussion	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	10yrA
Incidence	0.7	0.7	0.3	0.3	0.7	0.3	0.3	0.4	0.5	0.5	0.5
Prevalence	1.3	2.0	0.6	0.3	0.9	0.3	0.3	0.5	0.7	0.8	0.8

(e) Groin injuries

Groin injuries (including osteitis pubis) are consistently one of the three injury categories that cause the most missed playing time in the AFL. As a group, groin injuries represent a number of overlapping diagnoses, including adductor muscle strains, tendinopathy, osteitis pubis and sports hernias. In general these injuries have a high rate of recurrence and a high rate of becoming chronic. Incidence appears to be quite constant from season to season (3-4 new injuries per club per season) but prevalence (missed playing time) and recurrence rates vary from season to season.

Injuries to this region may in fact be increasing slightly more than is appreciated by an analysis of the category of groin injuries. There is an increasing appreciation of the role of hip joint pathology in treating groin pain. A category of 'other hip/thigh region injuries' has gradually shown greater incidence and prevalence over the past decade. Although formal figures have not been kept, it appears that hip arthroscopy and femoro-acetabular impingement procedures have increased in recent years. Some of the so-called groin pain of previous years may actually have been due to hip joint pathology, so the actual rate of groin pain may be increasing at a higher rate than is appreciated.

Table 10 – Key indicators for groin injuries over the past decade

Groin injuries	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	10yrA
Incidence	3.5	3.8	2.9	3.1	2.9	3.3	4.1	3.2	3.3	4.1	3.5
Prevalence	13.6	15.7	13.7	13.3	11.2	14.0	18.0	12.4	11.7	15.3	13.6
Severity	3.9	4.1	4.8	4.4	3.9	4.3	4.4	3.9	3.5	3.7	3.9
Recurrence rate	20%	23%	20%	24%	23%	28%	38%	23%	19%	20%	20%
Other hip	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	10yrA
Incidence	0.3	0.3	0.4	0.3	0.2	0.3	0.8	0.8	1.0	0.7	0.5
Prevalence	1.7	1.2	1.5	2.6	1.0	2.3	4.5	3.4	6.9	4.7	3.0

4.5 Relationship between increasing interchange use and injuries

AFL overall injury incidence and prevalence have slightly but significantly increased over the last seven years. Over this same time period interchange use by AFL teams has substantially increased. There appears to be an association between these factors however the relationship is complicated. An analysis carried out in 2010 further explored the relationship between injuries and interchange[55]. A statistically significant relationship was demonstrated between risk of injury and interchange using a logistic regression model (Table 11) as detailed below.

Each interchange made by the *opposition* increases a team's risk of injury by approximately 0.8% (statistically significant relationship, P=0.005, 95% confidence intervals 0.3% to 1.4%) (Figure 3). Each interchange made by the team itself (in the previous week) decreases their risk of injury by 0.4% (strong trend, P=0.13, 95% confidence intervals +0.1% to -1.0%). This logistic regression model did not find game continuity (as measured by length of the game/percentage of time in play) to be a significant predictor of injury, suggesting that the increases in injury rates in recent years were related to interchange use rather than changes in game continuity.

Although this described link does not fully explain the underlying mechanisms, a simple paradigm which is consistent would be that a player who has just come onto the ground having been interchanged is temporarily less likely to get injured (because he is rested) but his direct opponent is temporarily more likely to get injured (as he is a fatigued player competing against, and trying to run with, a rested player).

There are further consequences of this complex relationship, apart from the increase in injuries for the competition as a whole. There is now a strong incentive for clubs to continue to increase their interchange movements in an 'arms race', because they have perceived (correctly) that there are advantages to making more interchanges than the opposition. This advantage extends to a lower rate of injuries relative to the opposition (Figure 4).

There is also an increased consequence to a team of an injury occurring during a game. Not only does the injury decrease a team's chance of winning that match, but it also restricts the number of interchange rotations that can be made, furthering the likelihood of other injuries.

In addition to the above research, a number of other studies were undertaken to address questions that had been raised throughout the Laws of the Game consultation[59-64]. Four independent reviews of the methodology used in the research were also commissioned[65-68]. Both the further research and the reviews fortified the initial concerns.

Although direct cause and effect could not be proven, the evidence available suggested that if left unchecked interchange would take player speed and congestion to a new level, and there remained concern about potential further increases in collision injuries.

After extensive consultation over a four-year period and throughout 2010 involving clubs, coaches, players, club medical officers, physiotherapists and fitness staff[56-58], the AFL announced that the interchange would be reduced from four to three players, and that a substitute player would be introduced for the 2011 Season.

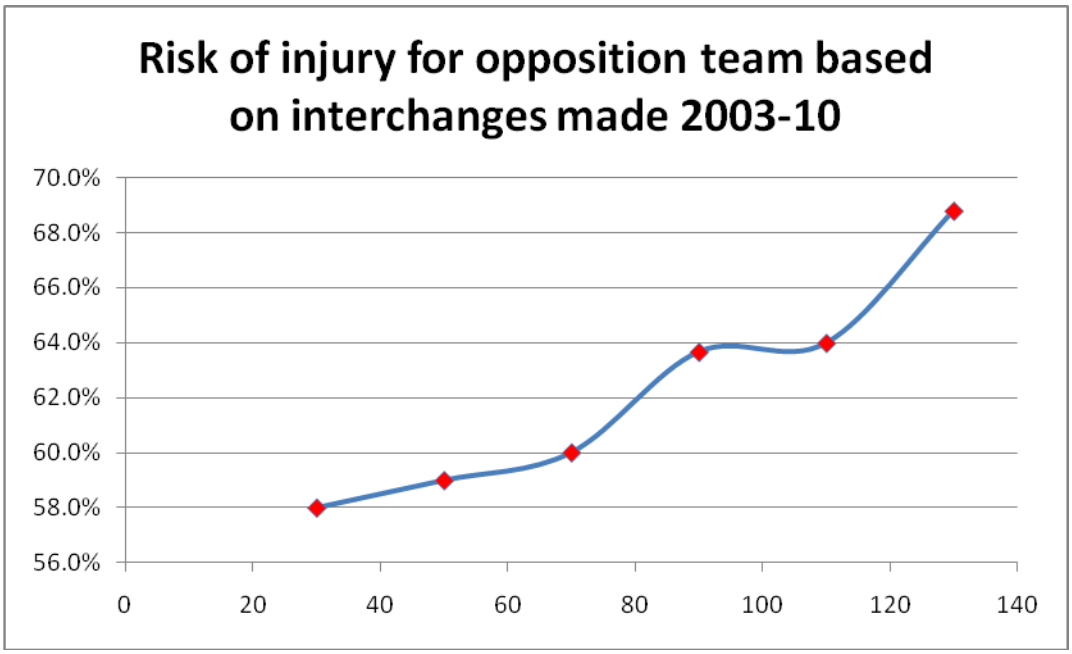


Figure 3 – Risk that there will be an injury for each AFL team squad each week (22 players) based on opposition team number of interchanges made in the match (2003-10 data for home and away season rounds 1-21)*
***** Round 22 not included as it is less likely that a player will miss a match because some teams end their season.**

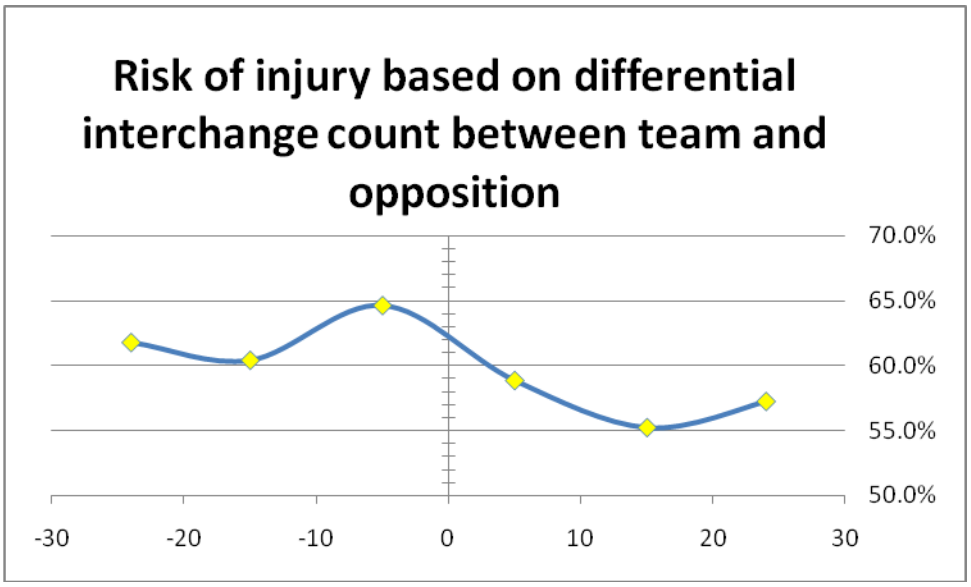


Figure 4 – Risk that there will be an injury for each AFL team squad each week (22 players) based on differential number of interchanges made between own team (previous week) and opposition (current week) (seasons 2003-2010, rounds 2-21)*
***** The previous week is used for own team interchange count because of the confounder that a low number of interchanges is itself a marker of an injury having occurred. Round 1 is also excluded (compared to dataset in Figure 3) as there is no previous week's match to include.**

	B	S.E.	Sig.	Exp(B)	95.0% C.I.for EXP(B)	
					Lower	Upper
Effect of each interchange made by the opposition	.008	.003	.005	**1.008**	1.003	1.014
Effect of each interchange made by the team in the previous week	-.004	.003	.133	**.996**	.990	1.001
Constant	.181	.088	.039	1.198		

Table 11 – Logistic regression model for AFL team risk of suffering at least one injury (i.e. player misses the following week) from a game (seasons 2003-2010, rounds 2-21)*
***** The previous week is used for own team interchange count because of the confounder that a low number of interchanges is itself a marker of an injury having occurred. Round 1 is also excluded (compared to dataset in Figure 3) as there is no previous week's match to include.**

5 Conclusion

There have been increases since 2007 in the incidence and since 2003 in the prevalence of injuries overall, including the most significant non-contact soft tissue injuries such as lower limb muscle strains. These increases have been similar to significant increases in the use of the interchange and subsequent increases in the average speed of players during this period. There appears to be an association between these factors however it is complex. Interchange use appears to assist the team making the interchanges and is linked to increases in the risk of injury in the opposition team. Therefore increased interchange use since 2003 has been associated with increasing overall injury rates.

In terms of general injury statistics, there has been an increase in *incidence* (new injuries per club per season) and *prevalence* (missed games per club per season) in recent seasons. There has also been a gradual lowering of recurrence rates. This decrease in recurrence is likely due to a more conservative and skilled approach by clubs.

On a positive note, there has been a decreasing trend over the past decade with head and neck injuries and knee PCL injuries which have showed reduced rates of incidence following the introduction of the centre circle rule, a reduced tolerance of head-high contact, stricter policing of dangerous tackles and the rough conduct rule enacted through the Laws of Australian Football and the AFL Tribunal. There has been a trend towards reduced missed time due to ACL injuries in the past two seasons.

The AFL injury profile continues to be consistently defined and published in sports medicine scientific literature and in public media releases[3-4 6 69]. The average playing list includes eight players unavailable through injury in any given week which has risen from previous years. Hamstring injuries, knee ACL injuries and groin injuries (including osteitis pubis) are consistently the most prevalent injuries in AFL players:

- Historically, the AFL injury survey is the world's longest running publicly-released injury survey in sport;
- The survey has run for 19 seasons, achieving 100% participation and compliance over the last 14 seasons;
- The survey defines an injury as a 'condition which causes a player to miss a game' striking a balance which has enabled comprehensive analysis without sacrificing compliance[16]; and
- The survey has led directly and indirectly to dozens of published studies[3 6 9 70-75] and interventions which have improved the safety of the AFL competition (e.g. ruck rule changes to decrease PCL injuries).

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