

INJURY REPORT 2004



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Summary

This report presents a summary and analysis of injuries occurring in Australian cricket at the state and national level over nine seasons, with prospective data collection over the final six seasons (1998-99 to 2003-04).

During 2004, a major advance in the approach to cricket injuries internationally has been achieved, with the establishment of a consensus definition of injuries being made by the major Test playing nations. Based on this, the Australian injury survey data has been re-analysed over the past nine seasons to fall into line with the new international definitions. In future seasons, our data can be directly compared with injury statistics from other nations.

Injury definitions:

The consensus regarding definitions was arrived at through a variety of face-to-face meetings, email communication and draft reviews between researchers from six of the major cricket-playing nations. A cricket injury is to be defined as any injury or other medical condition that either: (1) prevents a player from being fully available for selection for a major match or (2) during a major match, causes a player to be unable to bat, bowl or keep wicket when required by either the rules or the team's captain. The consensus statement, shortly to be published jointly in the *British Journal of Sports Medicine*, *Journal of Science and Medicine in Sport*, *New Zealand Journal of Sports Medicine* and *South African Journal of Sports Medicine*, also provides definitions for injury rates such as incidence and prevalence. It will provide a standard which, if followed, will allow meaningful comparison of injury surveillance data from different countries and time periods, which will assist in the possible identification of risk factors for injury in cricket.

Injury rates and trends:

Injury incidence (both match incidence and seasonal incidence), that is the number of new injuries occurring per match or per season, has stayed at a fairly constant level over the past six seasons. Injury prevalence, the percentage of players missing through injury, has increased over the same time period, with a high prevalence rate seen in the Australian team in the 2003-04 season. Fast bowlers miss, through injury, about 16% of all potential playing time, whereas the prevalence rate for all other positions is less than 5%. Part of the reason for the increase in prevalence has been the greater number of matches scheduled during the Australian and international cricket seasons, meaning that with a more crowded calendar, injuries cause players to miss a greater number of games.

Risk factors for bowling injuries:

Injuries affect fast bowlers to a much greater degree than the other player positions in cricket. Broadly speaking, a number of risk factors for bowling injury are already known: (1) Workload (2) Biomechanics (3) Bowler speed. Player age is a risk factor for some bowling injuries, with stress fractures being more prevalent in younger bowlers whereas some degenerative injuries are more prevalent in older bowlers. Some match and schedule-related trends towards injury have been noted, including a



greater risk of injury in the second innings of first class matches (compared to the first), a greater risk of injury in the second game of back-to-back matches and an increased risk of injury in the rare situation of enforcing the follow-on in a Test match. Over the past decade, the Australian Test team may have had an advantage with respect to injury prevention by spending a greater proportion of time batting due to superior bowling quality compared to its opposition. Practical recommendations to limit or reduce injury prevalence in bowlers have been elusive to date due to (1) ever increasing match workload demands because of greater scheduling of matches (2) performance (or the perception that performance) may be a trade-off against injury risk, in any or all of the areas of bowler speed, biomechanics and workload. Because of the difficulty in being able to recommend practical advice that can reduce injury rates using current surveillance methods, it will be very helpful to have international cooperation with respect to surveillance. As different countries use different scheduling of games, for example, we can potential learn more about the type of load that the body can best handle with minimal risk of breaking down. It is apparent that Cricket Australia is likely to hold scheduling of cricket matches at its current level in the foreseeable future, which will allow a greater opportunity to perhaps achieve injury prevention in fast bowlers in the future.

Risk factors for non-bowling injuries:

Batting and fielding injuries occur at an acceptable rate, which makes cricket a much safer sport to play at the elite level for batsmen, fieldsmen, wicketkeepers (and also spin bowlers) than other popular sports. Two identified areas of injury reduction have been acted upon with success. The introduction of the boundary rope has eliminated fence collision injuries and a warning regarding football cross-training has led to a substantial reduction in these injuries.

Future role of the injury survey:

The injury survey has evolved, as predicted, from a simple descriptive study to one which can analyse risk factors based on greater numbers of injuries in the database. The approach of Cricket Australia to injuries has also evolved from a reactive one to a proactive one, with the greatest example of this being the establishment of a research board. The injury survey will be a core component of ongoing cricket research both in Australia and internationally. It not only provides a framework to highlight the most important areas which need further study, but also, in the long-term, allows us to follow trends in injury rates which can be affected by our interventions. The focus on injury prevention in the medium term should remain on bowling injuries in fast bowlers, particularly ongoing injury surveillance, an ongoing workload study and regular biomechanical screening of all first class fast bowlers in Australia.



Introduction

Cricket is one of the world's major team sports. Injuries in cricket are common, particularly to fast bowlers¹⁻⁸. According to Van Mechelen et al., ongoing injury surveillance is a fundamental process behind successful injury prevention⁹. There is general agreement that cricket should follow the Van Mechelen paradigm of injury surveillance being the basis for risk factor and interventional studies which can ultimately lead to injury prevention⁷. However, successful ongoing injury surveillance in even major sports has proven elusive, partially because of the difficulties in forming consistent injury definitions¹⁰. This lack of consensus has severely limited the ability to compare injury rates between countries and to ascertain risk factors for injury.

Injury surveillance in professional cricket in Australia has been prospectively undertaken continuously since the start of the 1998-99 season¹. Data from seasons 1995-96 to 1997-98 is available in the current database as a result of retrospective survey using a number of different methods¹. The only known attempt at previous injury surveillance in Australian cricket was performed by Hoy and Payne in the mid-1980s.^{11 12}

With the establishment by Cricket Australia of a research board, the injury survey is now an ongoing core component of cricket research in Australia. It will not only continue to provide a framework to highlight the most important areas which need further study, but also, in the long-term, injury surveillance can follow trends in injury rates to test the interventions which are recommended by other studies.^{9 13}



Methods

The methods for choosing the new international definitions are detailed in this report. Collaborators (authors) for the international definition project were chosen to represent those Test-playing nations where injury surveillance is currently being undertaken or proposed. To minimise the difficulty in forming a consensus, it was decided to limit authorship to one person per country. Where applicable, the official injury surveillance coordinator (as appointed by the national board) was invited to participate. No person invited to join the group of authors refused. The final group (John Orchard, Australia; David Newman, England; Richard Stretch, South Africa; Warren Frost, New Zealand; Akshai Mansingh, West Indies; Andrew Leipus, India) are amongst the most-published authors in the cricket injury surveillance literature and represent the countries from which the vast majority of cricket injury surveillance studies have originated.

The consensus statement was arrived at through a variety of face-to-face meetings, email communication and draft reviews between researchers. Initially a draft was prepared between the first two listed authors, who have both prepared official reports for their respective countries using similar definitions, via email communication. The other authors were then invited, in the authorship order listed, by being asked to review a draft of the paper and to recommend any revisions. In particular, the authors were asked to make sure that the recommended methods were applicable to their country (or group of countries, in the case of the West Indies), as all nations vary slightly in the scheduling of their home and away cricket matches.

The following consensus statement was achieved regarding international definitions:

Definition of what constitutes an injury

It is recommended that a cricket injury (or ‘significant’ injury for surveillance purposes) is defined as:

Any injury or other medical condition that either: (1) prevents a player from being fully available for selection in a match or (2) during a major match, causes a player to be unable to bat, bowl or keep wicket when required by either the rules or the team’s captain.

Notes on this definition:

1. A player is not fully available for selection if he/she is injured, and as a result of this injury is only available for selection in a limited capacity. An example is an all-rounder who has an injury which prevents him/her from bowling, but is available to be selected as a batsman only. If this player is not selected in this scenario, he/she is considered missing through injury rather than non-selection.
2. A player who is unavailable for selection for injury prevention reasons, but who would be fully fit to play an entire game, is *not* considered to be suffering a significant injury. This may occur, for example, where a player and/or coach



- considers that a bowler has bowled too many overs recently and would be at excessive risk of injury if he/she was selected in a game. In this situation the player is considered rested (i.e. not selected for reasons other than through injury).
3. With respect to injury surveillance in first class cricket, a 'major' match is a Test match, a One Day International, a first class domestic match or a domestic one day match.
 4. A player who is forced through injury or illness to retire hurt from batting, bat with a runner, or who is unable to finish bowling an over is considered to have suffered a significant injury.
 5. The definition component "...unable to bat, bowl or keep wicket when required by either the rules or the team's captain" is somewhat subjective, but it is expected that applications of this definition will be applied in a reliable manner. A batsman who cannot bat in his/her usual position, a regular wicket keeper who must relinquish the gloves and a bowler who is unable to bowl his/her usual compliment of overs are the typical applications of this clause. However, a fielder (other than the wicketkeeper) who is replaced by the twelfth man for his fielding tasks only (but who is able to bat and bowl fully when required) is *not* considered to have suffered a significant injury.

The definition of an injury presented is limited, and is designed to be limited in such a way that all teams using these methods will apply it equally.

Definition of injury recovery and injury recurrence

An injury is considered recovered once a player has returned to full (unrestricted) participation in at least one match (of any type or grade).

A recurrent injury is one to the same side and body part and of the same injury type as an injury that previously qualified as a significant injury earlier in the same season, but which had recovered. An injury which is not a recurrent injury is a new injury. A recurrent injury does not necessarily need to be an identical injury in grade of severity to be a recurrence. The same 'injury type' requirement means that a rectus femoris muscle strain following a thigh haematoma would be considered a new injury, but following a previous quadriceps muscle strain on the same side would be considered a recurrence.

Definition of seasons, teams and survey matches

Traditionally cricket is played for approximately six months of the year, with this six month period being referred to as a 'season'. International teams now play cricket for many more than six months of the year and although domestic seasons do not last for longer than six months, some domestic players will play two different 'seasons' in different countries during a 12 month period. The months over which a season spans should be defined by each survey, with the suggestion that the northern 'season' generally runs from April 1 until September 30 inclusive, and the southern season generally runs from October 1 until March 31 inclusive. Northern seasons are referred to by the year in which they exclusively occur (e.g. 2003), whereas southern seasons



are referred to by both the calendar years that they span (e.g. 2003-2004). For tours or competitions that cross over the starting date of a new season, it is suggested that all matches in a common series are deemed to have occurred in the season in which the first major match of the series started. For example, a series of three Test matches that occurred over March 2003-April 2003 (when the defined ‘season’ finished on March 31) would be considered to be part of the 2002-2003 season if the starting date of the first Test was March 31 or earlier. Therefore the second and third Tests would be part of the 2002-2003 season even if they were played in April. If only warm-up matches occurred in March and the first Test started on April 1, then the entire series would be considered to be part of the 2003 season (or 2003-04).

With respect to international injury surveillance, teams are divided into international teams (e.g. England, Australia, South Africa, West Indies etc.), domestic first-class teams (e.g. Yorkshire, Queensland, Natal, Jamaica etc.) and other non-first class teams (e.g. 2nd XI teams for a county, state or province, under age teams). It is noted that the domestic first class teams playing in the West Indies actually represent distinct nations (e.g. Jamaica).

Matches are either two-innings matches (generally played over three or more days) or one-innings matches. Effectively, almost all one-innings matches are played on one day with limited overs per team. One-innings matches played over two days without limited overs are possible but do not attract first class or List A status (List A includes one day matches between first class teams, which are not considered ‘first class’ matches), so are not relevant to first class definitions.

	Two-innings match	One-innings (limited over) match
Match between national teams	Test match	One Day International
Match between non-international (but first-class status) teams from the same country	First class domestic match	Domestic one day match
Other match between two first-class teams (e.g. tour match between an international team and a domestic team)	Other first class match	Other List A one day match
Match involving one or more non-first class teams	Non-first class two-innings match	Other non-List A one day match

Table 1 – Schedule of matches (major matches for first class teams shaded)

For national teams, a major match is a Test match or a One Day International. For first class domestic teams, a major match is a first class domestic match or a domestic one day match. Matches between a national teams and a domestic team, although attracting first class status, are not considered to be major matches. For injury surveys involving teams that are not of first class status (e.g. second XI teams) a different definition of a major match must be made.



Definition of survey cohort

In order to determine injury incidence and prevalence, a cohort (population) of players to follow must be determined in advance. Therefore, injury rates will consider those players who become injured as well as those who avoid injury.

The cohort to be followed for a given team should be referred to as the 'squad'. A team consists of 12 players (11 active players and the 12th man) whereas a squad for a team contains a varied number of players. The squad to be followed can consist of any number of players, although for comparative purposes the 'standard' squad size is considered to be 25 players. This number is chosen arbitrarily but is necessary to compare injury incidence between squads of different sizes.

A squad (cohort) should be chosen for surveillance purposes at the commencement of the season. The squad is easy to choose if the team contracts players, as all players with a contract can be considered squad members and those without a contract are not included. However, players may need to be added if they are chosen to play for the team from outside the initial squad.

The definition of a squad member for a team may be varied, but for Australia is as follows:

1. Any player under contract to the team in question.
2. Any other player who plays in the team first XI (not including 12th man) or tours overseas with the team, from the time of his/her first game (or the first tour match) until the new round of contracts are awarded in the Australian off-season (usually approximately June-July each year).

There were different definitions for squad members for the retrospective seasons of the Australian injury survey and these definitions have been previously described ¹.

For the purposes of comparing bowlers to batsmen, the cohort should be defined prior to the start of the season. If a definition requires a certain number of overs to be bowled during the season under survey, then an injured bowler may mistakenly be considered to be a batsman. A bowler is defined at the start of each season as a player who averaged more than 5 overs bowled in matches played during any of the previous two seasons. As a result of this definition, most "part-time" bowlers will be defined as "bowlers". It would be possible to further subdivide bowlers into part-time and full-time depending on workload.

Non-bowlers can be subdivided into "wicketkeepers" and "batsmen", based on whether they kept wicket in at least 50% of games played during each season.

Bowlers can be rated as "Fast", "Fast-medium", "Medium" or "Slow/spin" according to player profiles listed by Wisden Cricinfo (<http://www.cricinfo.com/>) which tend to be universally accepted. The major point of contention with respect to these ratings is usually the difference between Fast and Fast-medium, and therefore these categories



can be combined if desired to be considered “Pace” bowlers. The position description of all-rounder is not generally necessary, as all bowlers are required to bat (whether or not they are considered “all-rounders”).

Presentation of injury rates

Descriptive numbers of injuries can be presented, with percentages of various types of injuries shown in tabular form. The two major types of injury rates, which should be calculated where exposure is known, are **injury incidence** and **injury prevalence**.

Calculation of injury incidence

Injury incidence analyses the number of new injuries (or new plus recurrent) occurring over a given time period, and should be measured in either or all of the following major formats:

Injury match incidence considers only those injuries occurring during major matches. This can be calculated in two different types of unit (with a time-based denominator for injuries overall and with a delivery-based denominator when considering batting or bowling injuries separately).

To calculate injury match incidence in total, with a time-based denominator:

The numerator should be number of injuries, and can include either new injuries or injuries in total (new plus recurrent).

For total injury match injuries, the denominator should be number of player hours, with the exposure considered to be *43.333 player hours per team per day for days where 100 overs are scheduled*. The exposure of player hours in each day should be factored up or down where more or less than 100 overs of play are scheduled, with a rate of 15 overs per hour assumed. For a ‘standard’ Test or other first class match day with 90 overs scheduled, it is considered that there will be 39 player hours per team per day actually played. These ‘standard’ figures correspond to 6 hours of play scheduled for first class cricket and 6.667 hours for one-day matches (based on a rate of 15 overs bowled per hour). The average number of players exposed is considered to be 6.5 per team (at any given time there are 13 players exposed to injury, 11 from the fielding team and 2 from the batting team). The exposures to be designated for the most common types of matches are listed in Table 2. Using these standard figures does not take into account occasions where matches are shortened by an early finish or lengthened to make up for slow over rates. However, when entire days of play are lost (through a shortened match or adverse weather) this should be accounted for in exposure (e.g. Test match which has only 3 days of play should be considered 117 player hours per team).



Type of match	Overs scheduled	Players per team	Designated hours of play	Total player hours of exposure per team
One Day 50-over per side match	100	6.5	6.667	43.333
One Day 40-over per side match	80	6.5	5.333	34.667
One Day 20-over per side match	40	6.5	2.667	17.333
First class match played over 3 days (90 overs scheduled per day)	270	6.5	18	117
First class match played over 4 days (90 overs per day)	360	6.5	24	156
First class match played over 5 days (90 overs per day)	450	6.5	30	195
First class match played over 4 days (105 overs per day)	420	6.5	28	182

Table 2 – Exposure (player hours per team) for common match types

To calculate batting and/or bowling injury match incidence, with a delivery-based denominator (where delivery information is available):

The numerator should be number of batting injuries and/or number of bowling injuries, and can include either new injuries or injuries in total (new plus recurrent). The denominator for bowling match injuries should be overs bowled, with a preferred unit of injuries per 1000 overs bowled. The denominator for batting match injuries should be deliveries faced, with a preferred unit of injuries per 10000 balls faced. Although this may seem inconsistent to use overs (six balls) in the denominator for bowlers and balls in the denominator for batsmen, this is how score sheets are maintained in cricket (bowling records indicate overs bowled whereas batting records indicate balls faced). A previous study of bowling injuries has used injuries per 1000 balls bowled (2), which can easily be converted to injuries per 1000 overs bowled by multiplying by six.

Because of the agreed definition of a significant injury, it is *not* recommended that a specific incidence is calculated for fielding, other than wicketkeeping, injuries.

Injury seasonal incidence considers the number of defined injuries occurring per squad per season. This can take into account gradual onset injuries, training injuries and match injuries in the one measurement. A ‘squad’ is defined as 25 players and a ‘season’ is defined as 60 days of scheduled match play. Smaller or larger squads and longer or shorter seasons should have the incidence adjusted so that rates between different squads and years can be compared. The recommended unit of measurement is *injuries per squad per season*.



Calculation of injury prevalence

Injury prevalence considers the average number of *squad members* not available for selection through injury for each match divided by the total number of *squad members*. Injury prevalence should be expressed as a *percentage*, representing the percentage of players missing through injury on average for that team for the season in question. It is calculated using the numerator of ‘missed player games’, with a denominator of number of games multiplied by squad members.

Injury prevalence should be separately calculated for the different types of cricket (one day matches, three, four and five day matches) and when a combined injury prevalence figure is derived for a team for a season, the units should be converted from missed player games to missed player days, so, for example, that each Test match contributes more to overall injury prevalence than each One Day match.

The injury survey coordinator should keep records of all matches played by squad members and ensure that each team provides an explanation to the survey whenever one of their players was not selected. The common reasons for missing games (with summary codes) are:

I – injury;

U – unavailable due to national team commitments (for domestic squads);

T – selected as twelfth man;

N – not selected (including when rested);

O – not available for other reasons (e.g. suspended or personal reasons).



Injury categories and injury classification

Level one – body region	Level two – body part	Level three – common diagnoses	Level four – specific diagnoses
Head & neck	Head & facial	Fractured facial bones	Specific diagnoses
		Other head & facial injuries	Specific diagnoses
Upper Limb	Neck injuries	Neck injuries	Specific diagnoses
	Shoulder	Shoulder tendon injuries	Specific diagnoses
		Other shoulder injuries	Specific diagnoses
	Elbow/Arm	Arm/forearm fractures	Specific diagnoses
		Other elbow/arm injuries	Specific diagnoses
Wrist & hand	Wrist & hand fractures	Specific diagnoses	
	Other wrist & hand injuries	Specific diagnoses	
Trunk & back	Trunk	Side & abdominal strains	Specific diagnoses
		Other trunk injuries	Specific diagnoses
	Back	Lumbar stress fractures	Specific diagnoses
Lower limb	Groin, thigh & buttock	Other lumbar injuries	Specific diagnoses
		Groin and hip injuries	Specific diagnoses
	Knee	Thigh & hamstring muscle strains	Specific diagnoses
		Buttock & other thigh injuries	Specific diagnoses
		Knee cartilage injuries	Specific diagnoses
	Shin, foot & ankle	Other knee injuries	Specific diagnoses
		Shin and foot stress fractures	Specific diagnoses
Ankle and foot sprains		Specific diagnoses	
Illness	Illness	Other shin, foot & ankle injuries	Specific diagnoses
		Heat-related illness	Specific diagnoses
		Other medical illness	Specific diagnoses

Table 3 – Injury categories for data tabulation

Tabulation by injury category is encouraged. Depending on level of diagnostic accuracy and space this can be done at any or all of the four levels suggested in Table 3. For specific diagnosis, use of the cricket-specific modification of the OSICS system is freely encouraged¹⁴. OSICS is available for download at: <http://www.injuryupdate.com.au/research/OSICS.htm>

Information that should be collected by an injury surveillance system

Items which should be included on an injury survey form (paper, spreadsheet or database) are listed following:

Details for each injury recorded:

1. Player name
2. Player details (e.g. date of birth, bowling type)
3. Injury diagnosis (including code and body region)
4. Injury side (left/right/bilateral/not applicable)
5. New injury/recurrence



6. Time of onset (match/training/other/gradual) including match details
7. Activity of onset (batting/bowling/fielding/gradual), including fielding position.
8. Date of onset
9. Mechanism description (if available)
10. Qualification as a significant injury
11. Details of any surgery required or any other major treatment (if relevant)

Details for player exposure:

1. Player participation in each major match
2. Reasons for not participating for all squad members not playing (i.e. playing at another level, injured, not available for another reason, not selected)
3. Number of overs bowled in each innings (for all players who bowled)
4. Number of deliveries faced in each innings (for all players who batted)
5. Eventual length of the match (in days actually played)

It is preferable to use a database to store injury information, although spreadsheets and other record-keeping formats are alternatives ¹⁵. It is noted that in all international matches, a match referee is present who must prepare a match report. For the purposes of assisting international injury surveillance, this report could include all injury interruptions to the game (players retiring hurt, batting with a runner, being unable to finish bowling an over or relinquishing the wicketkeeping gloves).

Extent of Australian first-class injury surveillance

This report covers injuries from the following cricket seasons:

Year	Season	Dates in current survey	Dates in previous survey (2002-03)
9	2003-04	April 2003-March 2004	Not applicable
8	2002-03	April 2002-March 2003	September 2002 – June 2003
7	2001-02	April 2001-March 2002	October 2001 – June 2002
	2001	Not included as a separate season	May 2001 – August 2001 (Ashes tour)
6	2000-01	April 2000-March 2001	August 2000 – April 2001
5	1999-00	April 1999-March 2000	August 1999 – April 2000
	1999	Not included as a separate season	May 1999 – June 1999 (World Cup)
4	1998-99	April 1998-March 1999	September 1998 – April 1999
3*	1997-98	April 1997-March 1998	September 1997 – April 1998
	1997	Not included as a separate season	May 1997 – August 1997 (Ashes tour)
2*	1996-97	April 1996-March 1997	August 1996 – April 1997
1*	1995-96	April 1995-March 1996	September 1995 – April 1996

Table 4 - Summary of seasons involved in survey

The first three seasons on the Australian surveillance database (* from Table 4) were surveyed retrospectively, the final six prospectively. The difference in accuracy between the two methodologies will be lessened by the adoption of the new



international definitions, which eliminates some of the more minor injuries (that may have been missed with retrospective surveillance) from official consideration.

In order to promote consistency, the starting date for the Australian cricket year has been designated as the start of whichever series commences after April 1st for every season under consideration (Table 4).

Specific methods of Australian surveillance

The primary recorder of injuries was the main team doctor at two states and for the Australian team and the main team physiotherapist for four states. Recorders were encouraged to enter as many injuries that presented to medical staff for entry into the database, and to notify which ones qualified according to the survey definition (and by which criteria, which has been helpful now in coping with the slightly changed new definitions). The injury survey coordinator kept records of all matches played by squad members and ensured that each state provided an explanation to the survey whenever one of their players was not selected, in order to keep the spreadsheet results accurate. Insurance forms completed by medical officers were cross-checked to ensure data was also entered as part of the survey. Media and web site reports were regularly checked by the injury survey coordinator as a way of prompting injury recorders to provide a diagnosis. The coordinator of the concurrent fast bowling workload study ¹⁶ also provided details of occurrences when a bowler did not bowl in practice for an extended period, so that the status of the bowler could be checked with team medical staff.



Results

Injury exposure

Table 6 lists the number of matches per team per season, whilst Table 5 lists the number of players in each squad per season. Since 1998-99 the Australian team has contracted 25 players annually prior to the start of any winter tours (i.e. during late May or early June). The Australian squad for a season is greater than 25 players, as it includes (from the date of their first match until the new round of contracts) any other player who tours with or plays in the Australian team. State teams can contract up to 20 other players on regular contracts (outside their Australian contracted players) and up to 5 players on ‘rookie’ contracts. As with the Australian team, any other player who plays with the team in a major match during the season is designated as a squad member from that time on.

Squad name	1995-96	1996-97	1997-98	1998-99	1999-00	2000-01	2001-02	2002-03	2003-04
Australia	18	29	30	31	30	32	30	28	31
New South Wales	26	29	26	30	32	30	35	31	28
Queensland	21	22	22	20	23	26	28	27	30
South Australia	18	22	27	31	23	23	27	31	22
Tasmania	17	18	18	21	20	27	28	26	24
Victoria	27	27	26	26	23	27	31	30	29
Western Australia	19	22	23	23	26	30	30	29	30

Table 5 – Squad numbers per season

Team matches played	1995-96	1996-97	1997-98	1998-99	1999-00	2000-01	2001-02	2002-03	2003-04
ING Cup	36	36	42	42	42	62	62	62	62
Pura Cup	62	62	62	62	62	62	62	62	62
One Day International	17	24	28	23	34	22	22	32	32
Test match	6	9	15	12	13	8	14	8	15
<i>All matches</i>	121	131	147	139	151	154	160	164	171

Table 6 - Team matches under survey from 1995-96 to 2003-04

The format of the Pura Cup (formerly Sheffield Shield) has consistently been that each of six teams plays ten matches each, one home and one away against each of the other teams (60 team matches), followed by a final (2 team matches) at the end of the season. The matches are all scheduled for 4 days, with the final being scheduled for 5 days. Since 2000-01, the ING Cup has followed the same format as the Pura Cup.



The ING Cup (formerly Mercantile Mutual Cup) format from 1995-96 to 1996-97 was a single round of matches for the six teams (30 teams matches) followed by two semi-finals and then a Grand final (6 team matches). During the 1997-98 to 1999-00 seasons, a team from the ACT was entered in the competition, although not included in injury surveillance. Each of the teams played the ACT once in the regular season, adding another 6 team matches.

Competition	1995-96	1996-97	1997-98	1998-99	1999-00	2000-01	2001-02	2002-03	2003-04
ING Cup	36	36	42	42	40	62	62	62	62
Pura Cup	236	246	234	222	232	232	228	220	244
One Day International	17	24	28	23	34	22	21	32	32
Test Match	27	37	66	53	53	33	61	32	69
Total	316	343	370	340	359	349	372	354	407

Table 7 – Team days played under survey 1995-96 to 2003-04

As seen from Table 7, in ING Cup and One Day International matches, the number of team days is generally the same as the number of team matches scheduled. In 1999-00 there was one ING match (two team matches) completely washed out and in 2001-02, there was one ODI match (one team match for Australia) completely washed out, so no days were played. There was also one Pura Cup game in 2000-01 completely washed out. The average number of team days played on average for Pura Cup games is between 3.5 and 4 each year, with the average number of team days in Test matches being between 4 and 5 each year.

Competition	1995-96	1996-97	1997-98	1998-99	1999-00	2000-01	2001-02	2002-03	2003-04
ING Cup	1561	1561	1821	1821	1734	2688	2688	2688	2688
Pura Cup	9204	9594	9126	8658	9048	9048	8892	8580	9516
One Day International	737	1041	1214	997	1474	954	910	1387	1387
Test Match	1053	1443	2574	2067	2067	1287	2379	1248	2691
Total	12555	13638	14735	13543	14323	13977	14869	13903	16282

Table 8 – Designated player hours of exposure in matches each season

As per the new international formula (listed in Table 2), hours of player exposure in matches is calculated by multiplying the number of team days of exposure (Table 7) by 6.5 for the average number of players on the field and then multiplied by the average number of designated hours in a day’s play. For first class matches this is 6 hours per day and for one day matches this is 6.667 hours per day. The exposure (in terms of match hours) was at its highest level in season 2003-04, compared to the previous eight seasons.



Match type	Venue	1995-96	1996-97	1997-98	1998-99	1999-00	2000-01	2001-02	2002-03	2003-04
Domestic one day	Australia	1628	1652	1938	1874	1858	2690	2835	2697	2883
First class domestic	Australia	10514	10803	10617	9945	9704	9837	9833	9224	10311
One day international	Australia	458	385	505	556	451	612	385	627	544
	Away	337	744	812	505	1035	440	595	750	873
	Total	796	1129	1317	1061	1486	1052	980	1377	1417
Test cricket	Australia	1065	772	1113	779	956	739	1055	917	1461
	Away		593	1409	1131	926	608	1188	319	1340
	Total	1065	1365	2522	1910	1882	1347	2243	1236	2802

Table 9 – Overs bowled in matches each season

Table 9 shows that workload in terms of number of overs bowled has stayed steady in first class domestic cricket over the past nine years, but has increased in domestic one day cricket since 2000-01. There was a sharp increase in the number of overs bowled in Test cricket by Australian teams in 2003-04.

Match type	Venue	1995-96	1996-97	1997-98	1998-99	1999-00	2000-01	2001-02	2002-03	2003-04
Domestic one day	Australia	45	46	46	45	46	43	46	44	47
First class domestic	Australia	45	44	45	45	42	42	43	42	42
One day international	Australia	46	48	46	46	45	47	48	48	42
	Away	48	47	48	46	43	49	46	39	46
	Total	47	47	47	46	44	48	47	43	44
Test cricket	Australia	39	39	40	39	37	37	38	44	41
	Away		35	37	34	34	47	36	29	41
	Total	39	37	38	36	36	41	37	39	41

Table 10 – Average number of overs bowled each team day of play

Table 10 reveals that prior to 2003-04, there were less overs bowled by the Australian Test team in an average day's play than in other forms of cricket. Generally each team is bowling 40-48 overs per scheduled day, and is presumably in the field for half of each match. The Australian Test teams of the last decade have often had the advantage of superiority to the opposition and as a consequence have spent less time in the field than batting. This decreased workload has probably helped with respect to injury risk.



Team	1995-96	1996-97	1997-98	1998-99	1999-00	2000-01	2001-02	2002-03	2003-04
Australia	414	957	1281	1027	1321	863	1037	1072	1297
New South Wales	416	464	468	510	504	566	688	648	541
Queensland	357	396	396	350	399	494	569	557	658
South Australia	306	330	459	465	387	413	532	574	431
Tasmania	255	270	306	303	308	475	572	454	463
Victoria	405	432	416	455	363	523	560	543	604
Western Australia	342	396	414	367	449	570	588	589	623

Table 11 (a) – Player matches available

Team	1995-96	1996-97	1997-98	1998-99	1999-00	2000-01	2001-02	2002-03	2003-04
Australia	792	1769	2792	2195	2408	1578	2315	1685	2787
New South Wales	1092	1276	1196	1152	1276	1236	1535	1469	1350
Queensland	945	1144	968	907	963	1220	1295	1243	1612
South Australia	864	990	1242	1225	1002	960	1272	1338	1054
Tasmania	731	810	864	751	857	1130	1319	1013	1132
Victoria	1161	1242	1170	1131	1025	1350	1311	1270	1551
Western Australia	969	1100	1081	984	1136	1287	1442	1278	1480

Table 11 (b) – Player days available (for prevalence and seasonal incidence calculations)

Player days per team per season are calculated by multiplying the size of the squads (for each match) by the number of number of days for matches. In previous years, player matches were used as the denominator, but the new international definition has agreed on player days, to take into account that various countries have differing ratios of first class and one day cricket. A technical point is that an uncontracted player who was added to a squad mid-season upon playing his first match was not considered to be at risk of missing this first game through injury (because he was only added to the squad on playing the game).



Injury incidence

Over the nine seasons, there were 793 injuries that qualified as an injury according to the new international definition. There were 674 injuries that qualified as a seasonal injury for one of the state squads and 210 injuries that qualified as a seasonal injury for the Australian squad. Therefore there were 91 injuries that qualified as both a state squad injury and an Australian squad injury (i.e. they were injuries that caused an Australian squad player to miss both games for his state and for the national team). Of the 793 injuries, 728 were new and 65 were recurrences. A total of 413 injuries occurred during major matches, of which 380 were new injuries and 33 recurrences. Of the 413 match injuries, 192 occurred bowling, 87 occurred batting, 91 fielding, 8 wicketkeeping with the remainder either occurring gradual or in an unknown activity.

Injury incidence results are detailed in Tables 12-15. Injury match incidence is calculated in Table 12 using the number of total injuries (Table 12 (a)) or number of new injuries (Table 12(b)) as the numerator and the number of player hours of exposure (Table 8) as the denominator.

Injury match incidence in the units of injuries per 10000 player hours is higher in One Day Internationals than Test matches. There is also a small difference in injury match incidence between domestic One Day matches and first class matches, although not to the same extent as in international cricket. Because first class matches are played over a much longer duration than One Day matches (at both domestic and international level), they produce a higher number of injuries per match, even though the hourly rate is lower. The scheduling format of cricket in Australia tends to produce different biases for injury rates. There is generally less of a break between successive One Day Internationals than Test Matches, so the risk of missing a subsequent match is generally greater in One Day Internationals. However, at domestic level, a one day match is often scheduled soon after a four day match, increasing the risk that an injury from the four day match will caused the subsequent (one day) game to be missed.



Match type	1995-6 to 97-98	1998-99	1999-00	2000-01	2001-02	2002-03	2003-04	Last 6 seasons	
Domestic One Day	26.3	54.9	34.6	48.4	22.3	37.2	67.0	44.0	
First Class Domestic	24.4	32.3	24.3	22.1	45.0	24.5	23.1	28.5	
State matches	Total	24.6	36.3	26.0	28.1	39.7	27.5	32.8	31.7
One Day	Home	39.8	115.3	115.3	53.2	28.8	106.5	17.7	73.5
International	Away	63.4	41.9	38.4	51.3	35.5	48.6	85.0	51.0
	Total	53.5	80.2	61.1	52.4	33.0	72.1	57.7	60.5
Test Match	Home	30.8	38.5	88.8	25.6	18.3	24.4	64.1	45.8
	Away	23.3	15.5	38.0	19.7	38.9	23.3	23.3	27.4
	Total	27.6	24.2	62.9	23.3	29.4	24.0	44.6	36.6
International matches	Total	37.2	42.4	62.1	35.7	30.4	49.3	49.0	45.6
All matches	Total	27.1	37.7	34.9	29.3	37.7	31.6	36.8	34.8

Table 12 (a) - Injury match incidence (injuries/10000 player hours), new and recurrent injuries

Match type	1995-6 to 97-98	1998-99	1999-00	2000-01	2001-02	2002-03	2003-04	Last 6 seasons	
Domestic One Day	20.2	49.4	34.6	40.9	18.6	29.8	59.5	38.4	
First Class Domestic	22.6	26.6	22.1	22.1	41.6	24.5	21.0	26.2	
State matches	Total	22.2	30.5	24.1	26.4	36.3	25.7	29.5	28.8
One Day	Home	39.8	96.1	115.3	35.5	28.8	88.7	17.7	63.5
International	Away	51.9	41.9	28.8	51.3	35.5	36.4	85.0	46.1
	Total	46.8	70.2	54.3	41.9	33.0	57.7	57.7	53.4
Test Match	Home	27.4	38.5	88.8	25.6	18.3	24.4	64.1	45.8
	Away	23.3	15.5	38.0	19.7	31.1	23.3	23.3	25.6
	Total	25.6	24.2	62.9	23.3	25.2	24.0	44.6	35.8
International matches	Total	33.5	39.2	59.3	31.2	27.4	41.7	49.0	42.4
All matches	Total	24.4	32.5	32.8	27.2	34.3	28.8	34.4	31.8

Table 12 (b) - Injury match incidence (injuries/10000 player hours), new injuries only

The matches with generally the highest incidence of match injuries are One Day Internationals played in Australia, although this was lower than usual in 2003-04 (Table 12). However, bowling match injuries occur at a lower rate in One Day Internationals than Test matches (Table 15). The majority of home One Day Internationals are played in quick succession as part of the Carlton and United Tri-series (mainly during January and February each summer). From Australia's viewpoint, this is the most crowded time of the international cricket calendar, with the Tri-Series continuing on after back-to-back Test matches in Melbourne and Sydney over the Christmas and New Year period. Therefore, high recent workload is a particularly relevant consideration for the Tri-series.



It should be noted that Tables 12-15 reveal lower injury rates in the three seasons surveyed retrospectively. Because of the methodological differences, some of this difference may be spurious. However, tables 6-9 reveal a much lighter match schedule in these seasons, and there may have been a genuinely lower injury incidence related to the lower bowler match workload over this three year period.

Seasonal incidence (Tables 13) is calculated by number of injuries (a) or new injuries (b) multiplied by 1500 (for a squad of 25 players over 60 days), divided by the number of player days of exposure (Table 11(b)). Tables 13 (a) and (b) shows that over a five season period, there is very little difference in injury incidence between the six Australian states.

Squad name	1995-6 to 97-98	1998-99	1999-00	2000-01	2001-02	2002-03	2003-04	Last 6 seasons
Australia	15.7	18.4	15.5	18.0	15.5	22.2	18.3	17.8
New South Wales	10.9	14.2	11.7	15.6	18.5	9.2	19.9	14.9
Queensland	15.2	13.1	17.0	17.2	25.3	15.7	20.4	18.6
South Australia	12.1	24.3	13.5	23.1	17.6	17.9	19.9	19.4
Tasmania	13.7	17.7	13.9	18.4	16.9	20.5	13.2	16.8
Victoria	13.9	18.6	23.3	16.6	20.5	20.0	18.3	19.4
Western Australia	9.5	21.1	19.7	13.8	16.6	19.8	15.2	17.4
All states	11.2	15.4	13.7	16.6	17.3	16.0	15.4	15.8
All teams	13.2	18.4	16.2	17.3	18.3	17.8	18.0	17.7

Table 13 (a) - Injury seasonal incidence by state (injuries/team/season)

Squad name	1995-6 to 97-98	1998-99	1999-00	2000-01	2001-02	2002-03	2003-04	Last 6 seasons
Australia	14.0	17.0	13.1	17.1	14.8	20.4	17.2	16.4
New South Wales	10.1	14.2	11.7	15.6	16.5	8.1	19.9	14.3
Queensland	14.7	13.1	17.0	15.9	20.7	15.7	16.7	16.7
South Australia	11.1	21.9	13.5	20.0	15.3	15.6	19.9	17.6
Tasmania	12.5	17.7	13.9	18.4	15.7	19.1	7.9	15.3
Victoria	12.6	18.6	21.8	15.5	20.5	18.8	15.4	18.2
Western Australia	8.1	13.6	17.1	11.5	15.6	18.6	15.2	15.3
All states	10.3	14.0	13.1	15.4	15.7	14.9	13.7	14.5
All teams	12.0	16.8	15.0	16.2	16.8	16.5	16.2	16.3

Table 13 (b) – New injury seasonal incidence by state (injuries/team/season)

Table 14 reveals that seasonal incidence by body part has generally been consistent over the past eight seasons. In 2003-04 there was an increase in ankle injuries, but generally the incidence of injuries by body part has remained constant.



Injury category	1995 -6 to 97- 98	1998 -99	1999 -00	2000 -01	2001 -02	2002 -03	2003 -04	Last 6 seasons
Fractured facial bones	0.1	0.0	0.3	0.2	0.3	0.0	0.1	0.2
Other head and facial injuries	0.2	0.2	0.0	0.0	1.0	0.2	0.1	0.3
Neck injuries	0.2	0.0	0.2	0.3	0.0	0.0	0.0	0.1
Shoulder tendon injuries	0.4	1.2	1.4	0.5	0.9	1.1	0.0	0.8
Other shoulder injuries	0.4	0.0	0.0	0.5	0.7	0.3	0.4	0.3
Arm/forearm fractures	0.1	0.4	0.3	0.0	0.0	0.0	0.0	0.1
Other elbow/arm injuries	0.1	0.2	0.2	0.5	0.0	1.1	0.1	0.3
Wrist and hand fractures	0.7	1.1	0.7	1.7	1.7	1.1	1.0	1.2
Other wrist/hand injuries	0.6	0.5	0.7	0.5	0.1	0.6	0.7	0.5
Side and abdominal strains	1.1	1.6	1.0	2.0	1.8	0.5	1.1	1.3
Other trunk injuries	0.1	0.5	0.0	0.2	0.4	0.0	0.5	0.3
Lumbar stress fractures	0.7	0.2	0.5	0.5	0.7	1.4	1.0	0.7
Other lumbar injuries	0.8	1.8	1.0	1.4	0.9	1.9	1.8	1.5
Groin and hip injuries	0.7	2.0	0.7	1.0	0.9	2.2	2.2	1.5
Thigh and hamstring strains	2.6	3.2	1.6	2.6	2.6	1.9	2.9	2.5
Buttock and other thigh injuries	0.2	0.0	0.2	0.9	0.1	0.0	0.8	0.3
Knee cartilage injuries	0.6	0.7	0.9	1.5	1.4	0.6	0.4	0.9
Other knee injuries	0.6	1.6	1.4	0.9	0.6	0.3	0.4	0.8
Shin and foot stress fractures	0.6	0.2	0.2	0.3	0.3	0.8	0.3	0.3
Ankle and foot sprains	0.5	1.1	1.2	1.0	1.1	1.0	1.6	1.2
Other shin, foot and ankle injuries	1.1	1.1	1.2	0.5	2.0	1.6	1.8	1.4
Heat-related illness	0.1	0.0	0.2	0.0	0.0	0.0	0.1	0.1
Other medical illness	0.7	0.9	2.4	0.3	0.9	1.0	0.7	1.0
Total injuries	13.1	18.4	16.2	17.3	18.3	17.8	18.0	17.7

Table 14 - Injury seasonal incidence 1995-6 to 2003-04 seasons (injuries/team/season)

Table 15 lists incidence of bowling injuries (those 192 of the injuries which occurred in matches whilst bowling, which formed the basis of table 12 (a), multiplied by 1000 and divided by number of overs bowled, seen in Table 8).

Competition	1995- 6 to 97-98	1998- 99	1999- 00	2000- 01	2001- 02	2002- 03	2003- 04	Last 6 seasons
ING Cup	0.6	3.2	2.2	3.7	1.1	1.9	2.1	2.3
Pura Cup	0.9	1.9	0.9	0.9	1.5	1.5	0.9	1.3
One Day International	2.2	2.8	2.0	1.0	0.0	1.5	0.7	1.4
Test Match	1.6	1.0	3.2	2.2	1.8	2.4	2.5	2.2
Total	1.1	2.0	1.5	1.5	1.4	1.7	1.3	1.6

Table 15 – Bowling match injuries (injuries per 1000 overs bowled)



Table 15 shows that the incidence in terms of injuries per overs bowled has actually decreased over the period 1998-99 to 2003-04, although as previously noted the number of overs bowled has gradually increased over this time period.

Injury prevalence

Injury prevalence rates (Tables 16-19) follow a similar pattern to injury incidence, although whereas incidence stayed constant over the past five seasons, prevalence has gradually increased. The difference between the two can be attributed to the increased number of matches, with the ‘average’ injury artificially becoming more severe over recent years because there are more matches to miss (N.B. Injury prevalence = injury incidence x average injury severity).

Team	1995-6 to 97-98	1998-99	1999-00	2000-01	2001-02	2002-03	2003-04	Last 6 seasons
Australia	7.6%	8.6%	8.8%	11.1%	6.7%	6.8%	11.7%	9.0%
New South Wales	7.8%	5.0%	5.6%	6.0%	5.4%	6.7%	15.1%	7.3%
Queensland	10.2%	3.6%	5.2%	8.8%	16.6%	8.8%	14.5%	10.3%
South Australia	6.7%	9.0%	9.8%	12.1%	14.5%	9.3%	10.0%	10.8%
Tasmania	4.3%	7.1%	6.1%	6.5%	8.8%	8.7%	3.3%	6.8%
Victoria	6.2%	8.0%	5.6%	14.5%	12.6%	9.9%	13.7%	11.1%
Western Australia	4.6%	6.9%	9.3%	7.2%	6.9%	10.5%	9.1%	8.4%
Average	6.9%	7.2%	7.5%	9.5%	9.7%	8.5%	11.4%	9.1%

Table 16 – Comparison of injury prevalence between states

Competition		1995-6 to 97-98	1998-99	1999-00	2000-01	2001-02	2002-03	2003-04
Domestic one day		7.1%	7.1%	7.0%	8.0%	11.3%	8.8%	11.9%
First class domestic		6.7%	6.6%	6.9%	9.5%	10.4%	8.9%	11.2%
State	Total	8.9%	6.7%	6.9%	9.2%	10.6%	8.9%	11.3%
One day international	Home	10.4%	15.6%	12.3%	9.3%	8.9%	9.5%	8.8%
	Away	6.0%	11.6%	5.7%	13.0%	9.1%	6.5%	17.7%
	Total	9.8%	13.7%	7.8%	10.8%	9.0%	7.7%	14.1%
Test cricket	Home	6.0%	8.3%	9.9%	14.0%	7.3%	6.6%	13.5%
	Away	8.0%	5.0%	9.7%	7.9%	6.3%	4.7%	8.5%
	Total	6.9%	6.3%	9.8%	11.5%	6.7%	6.0%	11.0%

Table 17– Injury prevalence by match type



Position	1995-6 to 97-98	1998-99	1999-00	2000-01	2001-02	2002-03	2003-04	Last 6 seasons
Batsman	2.1%	3.9%	3.5%	5.4%	4.7%	2.8%	7.2%	4.7%
Keeper	2.1%	2.8%	1.3%	0.8%	0.7%	0.8%	3.5%	1.7%
Pace Bowler	13.5%	11.5%	14.0%	15.1%	19.7%	17.2%	18.7%	16.2%
Spinner	1.7%	4.9%	1.4%	9.9%	1.1%	4.0%	6.8%	4.6%
TOTAL	6.9%	7.2%	7.5%	9.5%	9.7%	8.5%	11.4%	9.1%

Table 18 – Injury prevalence by player position

Injury category	1995-6 to 97-98	1998-99	1999-00	2000-01	2001-02	2002-03	2003-04	Last 6 seasons
Fractured facial bones	0.0%	0.0%	0.1%	0.1%	0.2%	0.0%	0.0%	0.1%
Other head and facial injuries	0.0%	0.0%	0.0%	0.0%	0.1%	0.0%	0.0%	0.0%
Neck injuries	0.0%	0.0%	0.0%	0.2%	0.0%	0.0%	0.0%	0.0%
Shoulder tendon injuries	0.2%	0.6%	0.4%	0.8%	1.4%	0.7%	0.1%	0.7%
Other shoulder injuries	0.2%	0.4%	0.0%	0.3%	0.6%	0.2%	0.4%	0.3%
Arm/forearm fractures	0.0%	0.3%	0.1%	0.0%	0.0%	0.0%	0.0%	0.1%
Other elbow/arm injuries	0.0%	0.0%	0.0%	0.7%	0.0%	0.6%	0.0%	0.2%
Wrist and hand fractures	0.3%	0.1%	0.1%	0.9%	0.9%	0.3%	1.0%	0.6%
Other wrist/hand injuries	0.1%	0.2%	0.3%	0.1%	0.0%	0.2%	0.1%	0.1%
Side and abdominal strains	0.8%	0.4%	0.4%	0.4%	0.7%	0.2%	0.7%	0.5%
Other trunk injuries	0.0%	0.4%	0.0%	0.1%	0.1%	0.0%	0.1%	0.1%
Lumbar stress fractures	1.0%	0.1%	0.8%	0.6%	1.1%	1.6%	2.4%	1.2%
Other lumbar injuries	0.5%	0.7%	1.3%	0.9%	0.3%	0.6%	0.7%	0.7%
Groin and hip injuries	0.4%	1.1%	0.1%	0.3%	0.7%	0.6%	0.9%	0.6%
Thigh and hamstring strains	0.9%	0.9%	0.7%	0.6%	0.7%	0.8%	0.7%	0.7%
Buttock and other thigh injuries	0.0%	0.0%	0.0%	0.2%	0.0%	0.0%	0.3%	0.1%
Knee cartilage injuries	0.5%	0.4%	0.6%	1.1%	1.2%	1.1%	0.4%	0.8%
Other knee injuries	0.2%	0.9%	0.4%	1.3%	0.1%	0.1%	0.2%	0.5%
Shin and foot stress fractures	0.8%	0.0%	0.1%	0.2%	0.2%	0.5%	0.0%	0.2%
Ankle and foot sprains	0.2%	0.4%	0.4%	0.5%	0.5%	0.3%	1.4%	0.6%
Other shin, foot and ankle injuries	0.4%	0.1%	1.1%	0.1%	0.7%	0.5%	1.3%	0.7%
Heat-related illness	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Other medical illness	0.4%	0.2%	0.6%	0.1%	0.2%	0.2%	0.5%	0.3%
Total injuries	6.9%	7.1%	7.4%	9.5%	9.7%	8.5%	11.4%	9.1%

Table 19 – Comparison of injury prevalence by body parts

As expected and previously documented, pace bowlers (16.2%) have a higher injury prevalence than spin bowlers (4.6%), batsmen (4.7%) and wicket-keepers (1.7%) (Table 18). There were no striking differences in injury prevalence between states over the six year period. Certain states had individual years in which injury prevalence was very high, usually due to a few players suffering long-term injuries that stopped them playing for the majority of the season.



Age	Batsman	Keeper	Pace bowler	Spin Bowler
<=22	3.1%	0.0%	21.6%	3.1%
23-26	3.9%	2.3%	13.3%	1.0%
27-30	3.4%	0.6%	13.8%	5.2%
31+	6.2%	3.5%	20.2%	6.0%

Table 20 - Comparison of injury prevalence by age and position

Table 20 shows that injury prevalence for all positions increases in players over 30 years of age. However, pace bowlers exhibit their highest injury prevalence in bowlers 22 years of age and under. This is due mainly to the increased incidence and prevalence of lumbar spine stress fracture in younger bowlers. Side strains are also more likely to occur in younger bowlers, whereas shoulder injuries, knee injuries, hamstring and calf strains are more common in older bowlers.



Risk factors for bowling injury

Table 21 shows an increase in risk per innings and risk per 1000 balls for bowling second in a one day match and bowling in the second innings in a Test match. The risk of bowling in the second innings of a One Day match (compared to the first) is not significant (odds ratio 1.41, 95% C.I. 0.81-2.47). The risk for the second innings of a first class match compared to the first is statistically significant (odds ratio 1.90, 95% C.I. 1.35-2.67). There does not seem to be any consistent relationship as to whether or not the bowler has batted prior to bowling or not-batted, suggesting that fatigue from batting is not a relevant risk factor.

Innings type	Injured	Non-injured	Risk per innings	Overs bowled	Risk per 1000 balls
<i>One Day bowling first</i>	21	1786	1.2%	14579	0.240
One Day bowling second Day after batting	5	728	0.7%	5081	0.164
One Day bowling second Day after not-batting	14	538	2.5%	4298	0.543
One Day bowling second Night after batting	5	369	1.3%	2671	0.312
One Day bowling second Night after not-batting	6	331	1.8%	2705	0.370
<i>One Day bowling second total</i>	30	1966	1.5%	14755	0.339
<i>One Day total</i>	51	3752	1.3%	29334	0.290
First class first innings bowling first	28	1540	1.8%	29665	0.157
First class first innings bowling second after batting	22	1294	1.7%	23901	0.153
First class first innings bowling second after non-batting	10	491	2.0%	9874	0.169
<i>First class first inning total</i>	60	3325	1.8%	63440	0.158
First class second innings bowling after batting	49	1659	2.9%	23346	0.350
First class second innings bowling after non-batting	20	835	2.3%	12974	0.257
First class bowling after enforcing follow-on	4	224	1.8%	4378	0.152
<i>First class second innings total</i>	73	2718	2.6%	40698	0.299
<i>First class total (per innings)</i>	133	6043	2.2%	104138.2	0.213

Table 21 – Innings and risk of bowling injury

Of interest with respect to bowling injuries in innings after the follow-on has been enforced, although there were only 4 injuries occurring in this circumstance, none of them occurred during four-day games where the follow-on was enforced. All of them were suffered by the Australian team in Test matches. It may be that it is safer to enforce the follow-on in a four-day game as there is usually insufficient time for the batting team to go on to bat for a marathon second innings, which has occurred to the Australian team and has led to high acute workloads amongst the bowlers.



A further analysis of injury risk was taken in the following circumstances:

- (1) Bowling risk in the second innings of a game when a team-mate had been previously injured bowling in the first innings – although this would generally lead to higher workload, with current data this is not associated with a significant increase in injury risk.
- (2) Bowling in the second match of back-to-back matches (defined as less than a three day break between first class games or less than a one day break between one day games) – this was associated with an increase in bowling injury risk (risk ratio 2.00, 95% CI 1.26-3.17).
- (3) Bowling after enforcing the follow-on in a Test match - associated with an increase in injury (risk ratio 9.42, 95% CI 3.29-26.94).

Risk factors for non-bowling injuries

It was reported four seasons ago that there were two injury mechanisms that were potentially immediately preventable. There were a number of injuries that occurred between 1995-96 and 1999-00 from sliding into the boundary fence, and it was felt that these could be prevented by instituting a boundary rope at all grounds.¹ In baseball and softball, the use of slide-away bases has been shown to lower the rate of serious ankle injury.¹⁸ The boundary rope policy was instituted at all grounds in the early stages of season 2000-01. There were no significant injuries from fence or rope collision in the past four seasons, indicating that this policy has been successful to date.

A number of injuries have occurred from football cross-training drills and these could potentially be prevented by substituting other less dangerous drills as cross-training activities. There has been a divergence of opinion regarding the feasibility of eliminating football drills from the cross-training regime of elite cricket players. Some fitness personnel feel that it was very difficult to avoid monotony in cricket training and that the benefit of occasionally including touch football or soccer games in the training regime outweighs the negative of injury risk. It is worth noting that the Indian cricket team uses volleyball as their practice activity as an alternate sport, as this has a lower injury risk than touch football. Since this issue has been highlighted and debated, there has been a reduction in the number of injuries occurring during football drills, presumably due to more care being taken.

The incidence and prevalence of contact injuries during batting fortunately remains very small at the elite level, with less than 5% of batsmen are missing through injury at any given time. This suggests that protective equipment being worn by batsmen during matches and training is adequate.



Discussion

Discussion of international definition methods

It is worth commenting on the aspects of the definitions that were the most difficult for the international panel to reach agreement.

The definition of a 'significant' injury is limited and obviously does not include all occurrences of 'injuries'. However, a broader definition than the one provided (e.g. any condition presenting to medical staff) is likely to be subject to a major bias and is therefore unsuitable for use when comparing different teams and/or countries¹⁹. The major bias is that the injury rate according to this definition will vary substantially according to the accessibility of medical staff. A team which has medical staff present at every training session (for example, a team physiotherapist) will almost certainly report a higher rate of injuries (according to this definition) than a team in which players must travel to consult medical staff. Therefore the limited definition proposed (of an 'injury' or 'significant' injury) should be the one used for highlighted reporting of injury rates (e.g. in the abstract) and comparison with other studies.

In terms of the limits provided within the definition of a 'significant' injury, the decision to include those injuries which prevent bowling, batting and wicketkeeping but not those which limit fielding (other than wicketkeeping) was again made with the aim of consistency amongst different teams. Because batsman, bowlers and wicketkeepers cannot be legally replaced in these roles by the 12th man, it was felt that there would be a good level of consistency amongst various teams for the replacement of players in these roles. However, as the 12th man can legally field (in a non-wicketkeeping position) for any player, and some teams take advantage of these substitutions more than others (and at times when it is not absolutely necessary), it was decided not to include being unable to field as being part of the injury definition.

The group had difficulty in deciding how accurate calculations should be when determining the exposure for match injuries and this was the one area of the consensus statement where opinions originally differed strongly amongst the authors and reviewers. The most accurate method possible would involve counting every ball bowled and faced, and every minute of play. However, it was felt that not all teams (even at the international and first class levels) would have the resources available to easily do this. We decided that specific batting and bowling injury incidence in matches should be calculated based on exact exposure in terms of number of deliveries, and that where possible, teams should be encouraged to keep records of this amount of exposure. It was agreed that the 'headline' match injury incidence rate should be in a time-based unit (of injuries per 10,000 player hours) but that due to the nature of cricket, calculating the exact number of players on the ground for each team and their exact amount of time of exposed to injury was fraught with difficulty. Our final decision to have a standard 'estimate' of exposure of player hours for each type of standard match (as listed in Table 2) was a concession to simplicity, with the aim



of encouraging as many studies as possible to use the same definition (particularly those that are not given great financial support). A suggested method for calculating exposure more accurately would be to add minutes batted per team (multiplied by 2 for each batsman on the field) to minutes bowled per team (multiplied by 11 for the bowler and each fielder) to assess total player minutes of exposure. It is possible that the 'time-estimate' definition supplied will be revised in the future to a method that calculates specific exposure more accurately if it can be demonstrated both that it would make a significant difference to the final results of studies and that the vast majority of surveillance systems around the world would have the resources to calculate the exposure more accurately.

Choosing the number of players exposed to injury at any given time as 6.5 per team is controversial, but this was done to achieve consistency with other sports. Generally most team sports have a set number of players on the field and a bench of reserves. The number of players exposed in other sports is generally considered to be the number present on the field rather than the total number of players (including the interchange bench). For a sport such as cricket, it is problematic that the two teams do not have an equal number of players on the field at any given time (11 fielding and 2 batting). An argument can be made that potentially some teams may spend more time batting than others and that exact exposure times for each activity should be calculated because of this. For a single game, or even a single Test series, this imbalance of exposure may mean that the 'calculated' exposure of players would be different to the 'real' exposure. However, it is assumed that over a long period of time, teams will spend close to 50% of their playing time in the field and 50% of their playing time batting. For superior teams, whose batsmen tend to bat for longer (on average) than weaker teams, their batting exposure will be reduced by those occasions in which the captain declares, or by those occasions where the team wins a match by more than an innings and therefore does not need to bat a second time. A further objection may be that very occasionally, when an injured batsman is batting with a runner, that there are actually 14 players on the field. This is not worth taking into account because of its rarity, and also, because technically the two players are sharing the duties of one player (one playing the ball, the other the running between the wickets) and therefore the injury exposure is not really doubled.

When there was any dispute amongst authors regarding a proposed definition, we have generally decided to err on the side of definitions that will be adhered to by as many researchers as possible. If the onerous task were added forcing all researchers to attempt to calculate exact fielding and batting times, it would be a major disincentive against compliance. Even if there is a long-term small systematic error introduced by assuming a 50/50 split between batting and fielding, if the error is made consistently by all researchers then it will have far less of a problematic effect than if certain nations refused to follow the injury definitions because the task was too difficult.

The definition provided for injury prevalence differs somewhat from the concepts of injury prevalence in traditional (non-sporting) epidemiology. It is most similar to the concept of 'point prevalence' rather than 'period prevalence'. However, life in general is not divided into matches and training sessions. From both performance and insurance viewpoints, the concept of a 'missed match' is a fundamental one in



sport¹⁹. It is appropriate that injury prevalence focuses on the number of matches that players are unavailable for, which is the best simple measure of the overall impact that injury has had on a team.

The fundamental concept of a ‘missed player match’ is also the rationale behind including medical conditions apparently sustained outside cricket as ‘injuries’ in this survey. Firstly, any medical condition which impacts on a player’s ability to play is significant to both the player and team. Therefore, ‘injury prevention’ methods for a team can justifiably include immunization against infectious diseases (which may or may not be contracted playing sport). In addition, it removes the necessity for a judgment to be made on whether an injury or illness was related to the sport or not, which can sometimes be difficult. In our experience, the vast majority of causes of missed playing time amongst cricketers are indeed conditions caused by playing cricket.

The concept of a ‘major’ match was settled on to signify those matches for which all players would generally be trying to achieve selection. Although they have first class status, matches between a touring international side and a local domestic side are often not viewed as important competitively for the international side, hence many players may be ‘rested’ with a minor injury that may normally have allowed them to play. Because of the difficulty in this scenario of deciding whether a player missed through injury or not, these matches were excluded from the definition of a major match. The other matches listed as major matches by contrast are almost always fully competitive.

Even with the common definitions suggested, there will necessarily be structural factors that will affect injury rates depending on the number and type of matches played in each country. As the number of matches played increases, there is very likely to be a corresponding increase in injury prevalence (percentage of players injured at any given time). However, it is unclear whether there would be any consistent effect on injury incidence. If there is an ‘overuse’ threshold which is crossed, then perhaps an increased number of matches would result in higher injury incidence. However there may be a reverse effect of a corresponding decrease in injury incidence (injuries per 10000 player hours) with more match hours being played, if the greater number of matches leads to a decreased intensity of play and/or a decrease in training workload.

It was decided to focus the definitions presented on cricket matches between males at first class level, as there are enough similarities between countries to allow this to be done with minimal complexity. In the future, ideally a similar (or expanded) consensus statement can be made to cover definitions specifically for cricket at amateur and junior levels, and for women’s cricket. Hopefully these new definitions will share many of those contained in this statement, but will vary to take into account the different structures of the various cricket seasons and length of matches.



Comparison of new international definition with previous Australian study

	Australia	International
Definition of an injury	Causing a player to miss a match, be limited during a match or requiring surgery.	No longer considers fielding injuries only or those only requiring surgery.
Definition of a recurrence	An injury which caused missed games then return to play followed by further missed games.	Same
Definition of a squad member	Any player under contract, or any uncontracted player selected in the team (from the date of his selection)	Same
Definition of a survey match	First class or first team one day match (matches of domestic team against international touring teams excluded)	Same
Definition of a bowler	Player who averages more than 5 overs bowled per innings	Same
Injury match incidence	Injuries in matches divided by 12 players per team and 6 hours per days actually played	Divided by 6.5 players per team
Injury seasonal incidence	Injuries per squad of 25 players per season of 20 matches	Same
Injury prevalence	Percentage of players unavailable through injury for each match	Percentage of players unavailable through injury for each day

Table 22 – Comparison of international injury survey definition with previous Australian definitions

Table 22 shows that there have been three major changes to the injury definitions since previous Cricket Australia reports, brought about because of the new international consensus statement.

A reportable injury previously was any injury or illness was one which did *any* of the following (**boldface for those components no longer considered**):

1. Affects the availability for selection of a team or squad member in a major match
2. **Requires surgery at any stage of the year**



3. Causes a team member to be limited in performance during a major match, including:
 - a. to retire hurt from batting or bat with a runner
 - b. to be absent from the field for greater than one hour**
 - c. to finish bowling due to injury before the end of a normal over
 - d. preventing a bowler from being available to bowl for at least a session (in a first class match) or as many overs as required by the captain (in a one day match)
 - e. preventing a regular wicketkeeper from playing in this position

Therefore the newer definition leads to a lower injury incidence as those injuries that just caused a fielding absence or required surgery but did not affect match availability are no longer considered. However, the fact that only 6.5 players per team are now considered to be at risk (rather than 12 players per team) leads to an increase in injury incidence.

Increased match workload as a risk factor

Dennis has found a relationship between the overall bowler workload (matches and training) and risk of bowling injury. ¹⁶ It appears from this work (although it is not clearly established) that number of bowling sessions per week (whether they are training or match) is the factor which most correlates with injury risk.

In seasons prior to the workload study being implemented, it is not known what the extent of overall (match plus training) workload was, although it is very clear that match workload has increased over the years, particularly with respect to One Day Internationals (see Table 9).

Although formal recommendations have not been set in stone regarding the maximum or optimal number of bowling sessions or overs per week, once these figures are established, any increase in match workload will make it harder for players and coaches to fall within the prescribed range. English county cricket surveillance reveals an even higher match workload (match wise) for first class bowlers in England than Australia. ⁸ However, injury prevalence is also higher in England than Australia, and our figure could be expected to rise if our match workload was also to rise.

Other ways which may limit excess workload in the future may include:

- (1) Scheduling changes – elimination of back-to-back games, institution of a forced off-season (i.e. maximum number of matches scheduled per year for national teams).
- (2) Rule changes – allow 12th man to bowl for an injured player, which would reduce excess workload in the event of a team being a bowler short. However, this rule would be very difficult to enforce with respect to exploitation by a team wishing to use the rule as a form of interchange.
- (3) Recommendation of tactical changes – avoiding enforcing the follow-on if upcoming matches are scheduled, deliberate rotation of bowlers etc.



Biomechanics as a risk factor

Elliott has continued work showing that mixed bowling action is associated with a higher rate of lumbar spine injury.⁷ This recently published work reveals that junior players who have their action corrected show less progression of disc degeneration on MRI scan than in a previous observation study.

Because of the importance of bowling action as an injury risk, it is important to eventually establish a database of the most recently measured action type (perhaps assessed by shoulder counter-rotation) and to include this in future risk factor studies.

Conclusions

1. The greatest risk factors for bowling injuries that are apparent from current analysis of surveillance are bowling speed and workload. Other study has proven that the 'mixed' action is almost certainly a risk factor for lumbar spine injury in fast bowlers. Monitoring of bowling workloads in first class cricket has commenced and should be continued as a high priority. The focus on injury prevention in the medium term should be on bowling injuries in fast bowlers, including ongoing injury surveillance, an ongoing workload study and regular screening of all first class fast bowlers in Australia. This ideally should include all pace bowlers having their exact workload monitored and an annual formal biomechanical assessment and lumbar spine MRI. Future scheduling should bear in mind the potential for workload increase on players, with respect to issues such as back-to-back games and total number of matches scheduled.
2. There was a significant increase in injury prevalence in 2003-04 for the Australian team in particular, perhaps associated with the increase in number of matches scheduled during this season (although a small number of long-term injuries may have had most of the effect seen).
3. The action implemented four seasons ago at all major grounds in Australia to use a boundary rope rather than the fence has been a major success. Prior to this, there had been two major ankle injuries (and five other minor injuries) over five seasons caused by collisions with the fence whilst fielding. Although this was a small number, it was foreseen that this could be reduced almost to zero by institution of ropes at all playing grounds in Australia. This has actually happened, with no significant injuries in four seasons since the playing condition change.
4. The international definition of injuries has been agreed upon, which will eventually lead to great advances in amount of data obtained and understanding of risk factors.



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