

Injuries in Australian cricket at first class level 1995/1996 to 2000/2001

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Objective: To describe and analyse injuries and illness occurring in Australian cricket at first class level.

Methods: Injuries occurring to the state and national teams were surveyed prospectively between the seasons 1998/1999 and 2000/2001, and the three preceding seasons were surveyed retrospectively. The definition of an injury was detailed and generally required the player to miss playing time in a major match.

Results: Average injury match incidence in the seasons studied prospectively varied from a low of 19.0 injuries per 10 000 player hours in first class domestic matches to a high of 38.5 injuries per 10 000 player hours in one day internationals. The average seasonal incidence was 19.2 injuries per squad (25 players) per season (20 matches). Injury prevalence (the percentage of players missing through injury at any given time) was 14% for pace bowlers, 4% for spin bowlers, 4% for batsmen, and 2% for wicket keepers. The most common injuries were hamstring strains, side strains, groin injuries, wrist and hand injuries, and lumbar soft tissue injuries. Bowlers who had bowled more than 20 match overs in the week leading up to a match had an increased risk of sustaining a bowling injury (risk ratio 1.91, 95% confidence interval (CI) 1.28 to 2.85). A further risk for bowling injury is bowling second in a match—that is, batting first (risk ratio 1.62, 95% CI 1.04 to 2.50). A risk factor for injury in fielding is colliding with the boundary fence.

Conclusions: Further study is required to determine ways to minimise the risk of injury in fast bowlers. Cricket grounds should mark a boundary line on the playing field to prevent players colliding with fences in the field.

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For one of the world's most popular team sports, there have been relatively few publications in the medical literature on cricket injuries.¹ Many of the previously published epidemiological data on cricket injuries, particularly at the elite level, have come from South Africa.^{2–7}

In Australia at the amateur level, cricket injuries are common, probably reflecting the popularity of the sport rather than the relative danger. Cricket accounts for 7.3% and 3.7% of adult and child sporting presentations to emergency departments in Australia, making it respectively the fifth and eighth most common sport presenting.⁸

Lumbar stress fractures of the pars interarticularis are known to have a particularly poor prognosis in fast bowlers in cricket, and these injuries have previously been researched in detail.^{9–13} Other specific body areas affected by cricket injuries that have been reviewed are the shoulder¹⁴ and the hand.¹⁵

The aims of this study are to present a profile of injuries in Australian cricket at the elite level between the seasons 1995/1996 and 2000/2001, and to present a preliminary analysis of some of the risk factors for injury.

METHODS

The Australian cricket team plays matches in each summer season (October–March) and occasionally in winter seasons on tours to England. Tours to countries other than England occur as part of the summer season, usually at either the start (August–October) or finish (February–April) of the Australian season. First class cricket is not played in Australia in winter.

The matches under consideration over the study period were all Test matches and one day international matches involving the Australian team, and all Pura Milk Cup (Sheffield Shield) and ING-Mercantile Mutual Cup (one day) matches involving the six Australian state teams.

The length of matches (exposure time) was considered to be six hours for every day of actual play in first class matches and six hours 40 minutes for all one day matches (unless abandoned without a ball being bowled). Therefore a five day Test match was considered to have been played over 30 hours, whereas a Test match lasting only three days was considered to have been played over 18 hours. This formula takes into account some of the variation in length of matches, but not all time lost through shortened play. It also does not take into account the fact that players who are on the batting team, but not currently batting, are not exposed to an injury risk during that time. Calculating exact exposure time for individual players in cricket would be overwhelmingly complex.

The prospective component of this study started in the 1998/1999 season, at the same time that the Australian Cricket Board (ACB) and state teams instituted a standard system for contracting first class players on an annual basis. The cohort under surveillance from seasons 1998/1999 onwards was:

- any player under contract to one of the teams;
- any uncontracted player who was selected to play in one of the teams (including 12th man), from the time of his first game until the end of that season;
- any uncontracted player chosen for an overseas touring squad.

For seasons 1995/1996 to 1997/1998, the cohort for each season was retrospectively defined as:

- any player who was selected to play a match for that team over the entire season;
- any player who had played for that team during the previous season, but was missing the entire current season because of a long term injury or illness.

A survey injury was defined as any injury or illness to which any of the following applied:

- (1) it affected the availability for selection of a player in a major match;
- (2) it required surgery at any stage of the year;
- (3) during a major match:
 - (a) it caused a batsman to retire hurt or bat with a runner;
 - (b) it caused a fielder to be absent from the field for more than one hour;
 - (c) it caused a bowler to finish bowling because of injury before the end of a normal over;
 - (d) it prevented 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) it prevented a regular wicket keeper from fielding in this position.

The reason for using the broader statement "affecting the availability for selection" rather than simply "missing a match because of injury" is the nature of the various roles in cricket. Occasionally, a bowler or all-rounder is unable to bowl but makes himself available for selection (or plays at a lower level) as a batsman only. In these situations the player may have still played in a match on a given date, but was suffering from an injury that had ruled him out of contention for playing at a higher level.

The definition of an injury recurrence was one that had previously caused a player to miss game(s), then, after it had recovered enough to allow the player's selection in a team, it recurred requiring further game(s) to be missed. This was considered a second injury with respect to incidence. Any other injury—for example, a chronic condition—that had multiple exacerbations but did not cause games to be missed in the sequence described above was defined as a single injury for statistical purposes.

Injury incidence analyses the number of new injuries occurring over a given time period, and was measured in two ways.

Injury match incidence considered only the number of injuries occurring during major matches, using 12 players (per team) and length of matches (in hours) in the denominator. The unit of measurement was injuries per 10 000 player hours.

Injury seasonal incidence considered the number of defined injuries occurring per squad per season. This took into account gradual onset injuries and training injuries as well as match injuries. A squad was defined as 25 players, and a season as 20 matches (of either first class or one day variety) for the purposes of this calculation. The incidence was adjusted for smaller or larger squads and longer or shorter seasons so that rates between different squads and years could be compared. The unit of measurement was injuries per squad per season.

Injury prevalence considered 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 was 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 "missed player games" as described above.

For the purposes of comparing bowlers with batsmen, a bowler was defined each season as a player who averaged more than five overs in major matches during that season or the season before. The inclusion of the "season before" in the definition of a bowler was to include players who had bowled in the previous season but were bowling less the following season because of injury. As a result of this definition, most "part time" bowlers were defined as "bowlers".

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

Bowlers were rated as "fast", "fast-medium", "medium", or "slow/spin" according to the player profiles in Allan's Cricket Annals.¹⁶⁻²⁰

Injury diagnosis was coded in a cricket specific modification of the OSICS system,^{21,22} with similar diagnoses grouped together in injury categories. Incidence and prevalence rates were reported for injuries overall and also for specific injury categories.

A database program written in Microsoft Access was developed for entry of injuries as part of this survey and distributed to all states. The primary recorder of injuries was the main team doctor at two states and the main team physiotherapist for four states and for the Australian team. 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.

A variety of methods was used to retrospectively record injuries from the 1995/1996, 1996/1997, and 1997/1998 seasons.

(1) Team medical officials were asked to provide any historical records that they had available.

(2) Records of matches played were obtained from the Australian Cricket Board (ACB).

(3) Injuries reported by the media in those seasons were generally recorded in Allan Miller's seasonal cricket annuals.¹⁷⁻¹⁹ These reports were used to prompt team medical officials for recall.

(4) Data from a previous attempt at starting injury surveillance during the 1995/1996 season were used.

(5) Insurance records on file at the ACB were checked for payments made to players for missing matches through injury.

(6) When the researched historical information was drafted, a printout of each player's injury history was checked by team medical officials, who in all but one state had remained constant since the 1995/1996 season.

Injuries that occurred during bowling were analysed further with respect to risk factors. Multivariate analysis of bowling injury risk was undertaken with a forward stepwise logistic regression procedure using the SPSS program (SPSS Inc, Chicago, Illinois, USA).

RESULTS

Tables 1 and 2 detail injury incidence. Table 1 includes a separate column to show only those seasons surveyed with a prospective methodology. Table 2 lists the frequency of specific injury types and their onsets. Bowling injuries are far more common than batting or fielding injuries. The trunk/lumbar spine and groin/thigh regions are the most commonly injured body areas in bowlers in particular.

Injury seasonal incidence was 17.5 injuries per squad per season over the six seasons, and 19.2 injuries per squad per season for the three seasons surveyed prospectively. There was a very similar seasonal injury rate for both the Australian and state squads, with the Australian team seasonal incidence being 17.5 (18.2 for the prospective seasons) and the average state incidence being 17.6 (19.2 for the prospective seasons).

Injury prevalence rates (table 3) follow a similar pattern to injury incidence, with the major exception of lumbar stress fractures, an uncommon injury but which accounts for a large proportion of missed playing time in bowlers because of its severity. The average injury prevalence (in units of percentage of players missing through injury) was 7% for the domestic matches. One day internationals had an average injury prevalence of 10%. Injury prevalence was higher in pace bowlers (14%) than spin bowlers (4%), batsmen (4%), and wicket keepers (2%).

The injury prevalence rates for the seasons surveyed prospectively and retrospectively were similar, with an average

Table 1 Injury match incidence in the seasons 1995/1996 to 2000/2001 (injuries/10 000 player hours)

	1995/96	1996/97	1997/98	1998/99	1999/00	2000/01	All years	Last 3 years
Domestic one day	18.9	11.4	19.5	32.5	23.9	30.8	23.8	29.3
Domestic four day	17.3	11.7	18.1	22.5	17.6	17.0	17.3	19.0
Domestic (state) matches								
Total	17.6	11.7	18.4	24.2	18.6	20.1	18.4	21.0
One day international								
Home	13.6	34.1	49.6	68.1	54.5	41.9	44.7	54.5
Away	38.9	43.0	38.9	32.5	24.1	22.7	33.3	27.3
Total	24.1	40.4	43.6	45.4	35.3	32.7	38.1	38.5
Test match (five day international match)								
Home	22.4	22.7	10.8	30.3	52.4	15.2	25.8	34.4
Away		10.8	46.6	9.2	22.4	17.8	17.3	16.1
Total	22.4	14.7	22.2	17.2	37.2	16.8	21.4	23.7
International matches								
Total	23.1	23.1	30.8	28.7	36.5	22.2	27.6	29.2
All matches								
Total	18.4	14.4	20.8	25.4	22.8	20.6	20.4	22.9

Table 2 Injury incidence (frequency and percentage) by category and onset (1995/1996 to 2000/2001)

Body area	Injury category	Injuries in international and interstate matches				Other injuries	Total injuries
		Batting	Bowling	Fielding	Keeping		
Head & neck	Fractured facial bones	1 (2)		1 (2)		3	5 (1)
	Lacerations and other head injuries	4 (7)		2 (3)		2	8 (2)
	Neck injuries	2 (4)		1 (2)		2	5 (1)
Upper limb	Shoulder tendon injuries		8 (6)	5 (8)		16	29 (6)
	Shoulder dislocations and subluxations			1 (2)		3	4 (1)
	Elbow injuries			1 (2)		2	3 (1)
	Forearm fractures	2 (4)		1 (2)		2	5 (1)
	Arm lacerations & haematomas	3 (5)				1	4 (1)
	Wrist and hand injuries	8 (14)	3 (2)	17 (28)	1	27	56 (11)
	Upper limb stress fractures		1 (1)			1	2 (0)
	Other upper limb injuries					1	1 (0)
Trunk & back	Side and abdominal strains		26 (21)	3 (5)		16	45 (9)
	Rib fractures (traumatic and stress)		2 (2)			1	3 (1)
	Lumbar stress fractures		4 (3)			10	14 (3)
	Lumbar injuries (other than stress fractures)	1 (2)	10 (8)	2 (3)	1	27	41 (8)
Lower limb	Groin injuries	5 (9)	10 (8)	2 (3)		21	38 (7)
	Hamstring strain injuries	12 (21)	15 (12)	9 (15)		20	56 (11)
	Quadriceps strain injuries	2 (4)	11 (9)			5	18 (3)
	Knee ligament injuries		1 (1)	3 (5)		8	12 (2)
	Knee cartilage injuries	2 (4)	7 (6)		1	21	31 (6)
	Knee tendon injuries	1 (2)	2 (2)		1	11	15 (3)
	Calf muscle strain injuries	2 (4)	3 (2)	2 (3)		7	14 (3)
	Leg stress fractures		4 (3)			4	8 (2)
	Lower limb fractures (not stress fractures)	1 (2)		1 (2)		3	5 (1)
	Lower limb haematomas & lacerations	7 (13)	1 (1)	4 (7)		4	16 (3)
	Shin soft tissue overuse injuries		1 (1)				1 (0)
	Ankle and foot sprains		5 (4)	4 (7)		13	22 (4)
	Heel and achilles injuries		7 (6)	1 (2)		9	17 (3)
	Foot stress fractures		2 (2)			2	4 (1)
	Other lower limb injuries		1 (1)			1	2 (0)
Medical	Medical illness	3 (5)	2 (2)			38	43 (8)
All		56 (100)	126 (100)	60 (100)	4	281	527 (100)

Values in parentheses are percentages.

injury prevalence for all players of 7.8% for the entire study and 8.1% for the seasons surveyed prospectively.

Table 4 shows that the major risk factors for injury are bowler speed, high number of match overs in the previous week, number of days of play, and bowling second (batting first) in a match. Bowlers who had bowled a high number of match overs in the week before a match (more than 20) also had a significantly greater risk of injury. The increased risk in first class matches (according to number of days played) com-

pared with one day matches in the initial analysis is essentially due to increased exposure.

There were two unusual injury mechanisms which appear to be preventable without further risk factor or intervention studies being required. Seven injuries occurred between 1995/1996 and 1999/2000 from players colliding with the fence when sliding to field the ball, and it was felt that these could be prevented by using a boundary rope. In baseball and softball, the use of slide away bases has been shown to lower the

Table 3 Injury prevalence (missed games and percentage of players unavailable) by position (1995/1996 to 2000/2001)

Body area	Injury category	Batsman		Wicket keeper		Pace bowler		Spinner	
Head & neck	Fractured facial bones	3	0.0%					6	0.2%
	Lacerations and other head injuries					1	0.0%		
	Neck injuries					6	0.1%		
Upper limb	Shoulder tendon injuries	25	0.3%			73	0.9%	35	1.1%
	Shoulder dislocations and subluxations					3	0.0%		
	Elbow injuries					28	0.3%		
	Forearm fractures	8	0.1%			5	0.1%	2	0.1%
	Arm lacerations & haematomas	1	0.0%						
	Wrist and hand injuries	34	0.4%			46	0.5%	26	0.8%
	Upper limb stress fractures					8	0.1%		
Side and abdominal strains	3	0.0%			124	1.5%	6	0.2%	
Trunk & back	Rib fractures (traumatic and stress)					13	0.2%		
	Lumbar stress fractures	9	0.1%			126	1.5%		
	Lumbar injuries (other than stress fractures)	39	0.5%	2	0.1%	121	1.4%	1	0.0%
	Groin injuries	30	0.4%			87	1.0%		
Lower limb	Hamstring strain injuries	18	0.2%	9	0.6%	85	1.0%	5	0.2%
	Quadriceps strain injuries	5	0.1%			50	0.6%		
	Knee ligament injuries	29	0.4%	3	0.2%	16	0.2%	29	0.9%
	Knee cartilage injuries	36	0.5%	8	0.5%	70	0.8%	1	0.0%
	Knee tendon injuries	6	0.1%	1	0.1%	29	0.3%		
	Calf muscle strain injuries	4	0.1%			14	0.2%	6	0.2%
	Leg stress fractures					53	0.6%		
	Lower limb fractures (not stress fractures)					40	0.5%	4	0.1%
	Lower limb haematomas & lacerations	2	0.0%			5	0.1%		
	Shin soft tissue overuse injuries					1	0.0%		
	Ankle and foot sprains	14	0.2%			34	0.4%	5	0.2%
	Heel and achilles injuries	20	0.3%			42	0.5%		
	Foot stress fractures					34	0.4%		
	Other lower limb injuries					4	0.0%		
Medical	Medical illness	16	0.2%	2	0.1%	42	0.5%	5	0.2%
Total		302	4.0%	25	1.6%	1160	13.7%	131	4.0%

incidence of serious ankle injury.²³ We noted this mechanism before the start of the 2000/2001 season, and, as a result, the ACB instituted a policy to use a boundary rope (well inside the fence) to mark the playing field limits at all grounds. There were no significant injuries from fence or rope collision in

2000/2001, indicating that this policy has been successful at preventing injuries in the preliminary stages.

Eleven injuries occurred during football activities undertaken as part of cross training drills (usually supervised by team staff); some were serious knee injuries.

Table 4 Logistic regression analysis of risk of bowling injury

Match type	Variable	B	SE	Risk ratio	95% CI	
All	High match overs previous week (>20)	0.65	0.20	1.91	1.28 to 2.85	
	Bowling speed	Spin			1.0	
		Medium	1.15	0.51	3.16	1.17 to 8.55
		Fast medium	2.16	0.40	8.69	4.00 to 18.90
		Fast	2.50	0.42	12.19	5.36 to 27.70
	Days played	1			1.0	
		2	-0.03	1.03	0.97	0.13 to 7.20
		3	0.97	3.03	2.63	1.45 to 4.77
		4	0.80	0.21	2.23	1.49 to 3.34
		5	0.97	0.38	2.64	1.25 to 5.58
First class	High match overs previous week	0.60	0.245	1.81	1.12 to 2.93	
	Bowling speed	Spin			1.0	
		Medium	1.13	0.61	3.1	0.94 to 10.23
		Fast medium	2.11	0.47	8.2	3.27 to 20.63
		Fast	2.58	0.49	13.2	5.02 to 34.73
Bowling second	0.48	0.22	1.62	1.04 to 2.50		
One day	High match overs previous week	0.84	0.36	2.30	1.13 to 4.70	
	Bowling speed	Spin			1.0	
		Medium	1.18	0.92	3.27	0.54 to 19.70
		Fast medium	2.26	0.73	9.60	2.28 to 40.47
		Fast	2.28	0.72	9.77	2.06 to 46.26

DISCUSSION

The reported injury incidence and prevalence are low compared with other professional sports, reflecting that cricket is a relatively safe game and is played over a long duration. For example, the injury prevalence in cricket at 8% overall is lower than previously reported for elite football competitions in Australia (15% Australian football, 16% first grade rugby league, 13% state rugby union).²⁴

Injury prevalence did not vary much between the seasons surveyed prospectively and retrospectively, suggesting that the retrospective methodology used accurately ascertained games missed through injury. Injury incidence (particularly seasonal incidence) was slightly lower in the years surveyed retrospectively, which suggests an inability to retrospectively uncover all details of minor injuries in those years.

The injury definition, like many others in the sports medicine literature, is somewhat cumbersome. A recent argument has been made to simplify the definition of an injury in team sports, for example to define an injury simply as "a condition that causes a player to miss a match".²⁵ Our definition incorporates this component, but also adds extra possible criteria for an injury, which were considered necessary because of the length of a cricket match and the multiple roles that players may have during a game. A further definition that may be contested is the use of the value of 12 players in the denominator for injury exposure, as each team contains 12 players. However, only 11 fieldsmen and 2 batsman (13 players out of 24) are exposed to injury at any given time. It is hoped that, at future cricket conferences and scientific meetings, a standard international injury definition and methods for calculating incidence can be agreed upon and published.

The 4% overall injury prevalence in batsmen and spin bowlers is an acceptable figure, and, in general, all that is required is further monitoring of this rate to see that it does not increase over time. Wicket keepers (2%) had the lowest overall injury prevalence. This may be explained by the lack of sprinting and long throwing in the field, the total lack of any bowling whatsoever, and the reluctance of wicket keepers to miss games when carrying minor injuries for fear of "losing" their position in the side.

The 14% injury prevalence in pace bowlers requires further study of risk factors, in the hope that some injuries may be prevented in the future. The most important potentially reversible risk factor is bowler workload. The sporting activity most similar to bowling is pitching in baseball, for which workload is monitored much more closely than bowling.

More study is required to determine why bowlers are more likely to be injured when their team is bowling second in a match. Before the start of the first innings, bowlers will warm up in the nets, whereas in subsequent innings they may start bowling immediately after batting. If further analysis showed that there was an increase in injury shortly after the start of the second innings, then a case could be made to allow bowlers a short warm up period between innings.

Injuries to bowlers that particularly need further study are side strains, hamstring and groin injuries, shoulder tendon injuries, and stress fractures. Side strains appear to be unique to bowlers. They occur on the non-bowling side of the body and most are strains of abdominal muscle insertions on to the lower ribs. Sometimes the diagnosis is believed to be a rib stress fracture rather than a muscle strain.

Knee ligament injuries are uncommon in cricket and in fact in this study were most likely to occur in cricketers playing football as part of cross training drills. An injury surveillance study of cricket in South Africa reported that three players suffered injury by a similar mechanism.²⁶ If cricketers were not allowed to include football in their training, these injuries may be prevented, but this suggestion has not been welcomed as it is a fairly ingrained tradition, particularly on long international tours.

Take home message

Fast bowlers have the highest risk of injury in cricket. Bowlers are more likely to be injured when undertaking high workloads and when bowling second (after batting). Cricket grounds should use a boundary rope or line inside the fence to mark the playing field.

Ankle and shin injuries caused by sliding into the fence while trying to prevent a boundary when fielding can be prevented by using a rope or marked line rather than a solid fence to signify the edge of the field.

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COMMENTARY

The authors of this injury survey should be congratulated on producing such a comprehensive retrospective and prospective analysis of injury in cricket. Cricket is generally looked upon as a safe sport, but clearly, from this study, it can be seen that this is not the case for fast bowlers, who are more at risk of injury than state rugby union players even.¹ As the authors state, further investigation into the causative factors is required; such studies are currently being undertaken in Australia, South Africa, and England.

Injury surveillance is a crucial part of making sport safer. Van Mechelen *et al*² recommended a four stage approach to injury prevention:

- (1) identify the incidence of common and serious injuries;
- (2) identify risk factors (both intrinsic and extrinsic) for the most common and serious injuries;
- (3) institute preventive programmes based on modification of reversible risk factors;
- (4) monitor success of intervention with ongoing surveillance.

This study highlights this approach with the identification of boundary fences as a risk factor and the simple measure of replacing them with a rope reducing the injury risk to zero.

The authors cite the playing of football (soccer) in cross training as a particular concern in the cause of preventable injuries; this concern is duplicated in England where seven injuries resulted in 64 days missed cricket in the 2001 season (personal communication, Joint Physiotherapists in County Cricket and England & Wales Cricket Board Joint Study). Clearly alternative safe and enjoyable forms of cross training need to be found that are acceptable to both players and coaching staff.

Continuous surveillance is necessary in all countries playing first class cricket, and information collected should be shared. This study hopefully will be the catalyst for this to occur.

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SPORTING MISCELLANY.....

The windsurfing mentality

Numerous different types of injury are described as a consequence of windsurfing. The most recent survey of injury patterns in professional World Cup windsurfers found the second most common form of injury to be a head injury.¹ The cause was usually one handed loops or "table-tops", both spectacular forms of jump. Despite these findings, only 10% of windsurfers surveyed used a helmet. Less serious injuries such as abrasions are more common in amateur windsurfers. A similar mentality is seen however. While windsurfing in the warm, salty waters of the Red Sea recently I was intrigued by quite how much discomfort I and fellow windsurfers were prepared to put up with from the effects of the activity on our hands (fig 1). About 10% wore gloves.

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- 1 Gosheger G, Jagersberg K, Linnenbecker S, *et al*. Injury patterns and prevention in World Cup windsurfing. *Sportverletz Sportschaden* 2001;25:50-4.



Figure 1 Hands unaccustomed to windsurfing in warm, salty water: superficial abrasions from prolonged boom contact.



Figure 1 can be viewed in colour on
www.bjsportmed.com