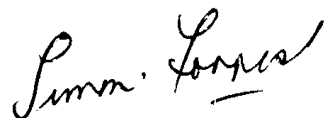

Forward

The Sports Medicine Australia (South Australian Branch) data collection on amateur sport's players has provided some valuable insights into the sporting risks encountered in a variety of sporting pursuits. More importantly, it has established some protocols that will be important in conducting future data collection at this level.

The cooperation of sporting associations, their development officers and competition participants proved invaluable in enabling this snapshot to be captured. It is hoped that with continuing education, sporting organisations will further realise the importance of maintaining injury surveillance data, both in terms of preventing and managing injury.

As the Chief Executive of the Department of Recreation and Sport, I endorse the cooperation between this Department, Sports Medicine Australia, Living Health and all of the South Australian sporting associations in providing safe environments for participants. The higher the number of people who play in well managed competitions, the higher the health benefit for the community.

Finally, I would like to commend all those individuals and organisations who participated in, and contributed to, the preparation of this valuable report.



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Sporting Associations

Badminton SA
SA Baseball League
Blind Sports SA
SA Cricket Association
SA Womens Cricket Association
SA National Football League
Hockey SA
Leagueball SA
Royal SA Bowling Association
SA Womens Bowling Association
Lacrosse SA
Netball SA
Orienteering Association of SA
SA Rugby League
SA Soccer Federation
SA Softball
SA Swimming
Touch SA
The Umpires of the above sporting groups.

Executive Summary

Information about the prevalence and incidence of sports injuries at a grass roots level is something that is lacking in Australia. Most studies into sports injuries focus on elite level competition or just on hospital admission data, leaving the majority of injuries unreported.

This study conducted by Sports Medicine Australia (SA Branch) and funded by Living Health, surveyed 16 different sports during February of 1996. The survey consisted of a self-reporting questionnaire (Appendix 1) that attempted to investigate the rate of injury in the preceding week and also the level of safe sport practices in place (specifically warm up procedures, fluid replacement and protective equipment).

This study provided important baseline data on participation and injury rates in South Australian amateur sports players. Lessons were learnt about the logistics of running a large scale study which relied heavily on volunteer involvement. Improvements could be made therefore to data collection procedures, in order to improve compliance rates in future data collection exercises.

Data was collected from 7323 players across the sixteen sports. Recommendations for further action are detailed in Section 6. A summary of the findings are presented below:

Injury Rates

The sports reporting the highest percentage of injured players within the week preceding the survey were baseball, cricket, football, hockey, lacrosse, rugby league, soccer and softball. Those with the lowest injury rates were badminton, blind sports, league ball and lawn bowls. Return rates in some sports were low and therefore figures quoted in this report may not be typical of the sport overall.

Types of Injury

Injuries were categorised into contact, non-contact or mixed mechanisms. Overall non-contact (ie. falling, twisting, tripping, over - exertion) was the main mechanism of injury. The exceptions to this were lacrosse and rugby where contact injuries (collision, being hit by something or someone) outnumbered non-contact injuries.

Body Part Injured

The most commonly injured body part was the lower limb in all sports except, cricket (the back) and swimming (the shoulder or arm).

Management of Injuries

Information was collected on the immediate treatment of the reported injuries. With the exception of baseball, softball and pre season football, all sports reported over 40% of their injuries were treated by untrained personnel.

It is recommended that each sport consider increasing the number of personnel trained in sports injury management.

Less than half the injuries were reported as being treated incorrectly (ie.no treatment, heat or massage). The worst sports for poor injury management were cricket, leagueball, lacrosse and swimming where approximately 30% of injuries were classified as being mismanaged.

Types of Injury

The majority of injuries were soft tissue injuries and were considered minor (ie. players continued playing). Severe injuries (ie. left the field for treatment and stayed off) were reported in football, netball, rugby league, hockey, soccer and touch.

Hours of participation associated with injury

In badminton, netball, swimming and umpiring, the injured players undertook more mean hours of participation than the non-injured players, which suggests that fatigue and perhaps overuse or overtraining may have contributed to the injury. In football however the injured players had significantly lower mean participation hours, which suggests that lack of fitness may have been a contributory factor.

Wearing Of Protective Equipment

The wearing of protective equipment was recorded in all sports. Apart from hockey, the use of mouthguards was generally low in those sports that contained a risk of injury to the mouth, such as football, lacrosse, rugby league and soccer. This may have been due to the nature of pre-season training in some of these sports.

Warm Up

Overall, approximately 25% of participants reported not warming up prior to activity, 28% reported non-specific warm up activities and 47% undertook specific warm up.

Fluid Replacement

Fluid consumed before, during and after sport was recorded in the survey.

Unsuitable fluid consumption was divided into poor consumption (ie. tea, coffee, soft drinks) and bad consumption (ie. no fluid or alcohol.)

Overall, fluid consumption was acceptable with some notable exceptions.

Lawn bowlers require the most education about fluid consumption before during and after participation, whilst cricket, basketball and touch players need to be educated about the most appropriate fluid intake after participation.

1. Introduction

1.1 Focus of Data Collection

There is little information on the number of individuals in Australia who participate in amateur sports, or on the injuries they sustain. Information is particularly lacking on those sports which do not have well funded associations that are in a position to monitor participation and injury levels. Most information on injury from sports participation is currently collected from hospital admissions and/or medical clinic presentations. While such data provides specific and detailed information on the nature and cost of injury, it misses the opportunity to collect information from players who are injured but do not seek medical attention, and players who are not injured and participate, or not, in safe sport behaviour. Thus, because of the lack of baseline data, it has been difficult to

monitor the effectiveness of campaigns that aim to increase participation in recreational activities and safe-sport practices.

In order to redress the lack of baseline information, Sports Medicine Australia (SA Branch) and Living Health funded a study which surveyed amateur sports players in sixteen sports (plus umpiring) in metropolitan Adelaide during the third week of February 1996 (23rd Feb to 29th Feb). The survey was retrospective over the preceding week, and was conducted on the assumption that over this short time frame, recall bias would be minimal. Sixteen sports agreed to participate in the project, and the number of available players during the survey week was calculated from club and administration records.

The sports that participated in the survey are listed in Table 1. This table also reports an estimation of the percentage capture of all available players during the period of data collection. The number of survey forms distributed by the project team to participating clubs was known, but the number of forms which were actually distributed to players was not known. A contributing factor to this lack of information was the number of clubs which had initially promised involvement, but which did not eventually participate. Data collection was optimised by the presence of the investigators and project assistants at as many venues as possible during the data collection period.

Moderate to high rates of compliance (greater than 50%) were obtained from only five sports: blind sports, football, lacrosse, orienteering and touch. Poor compliance rates from the remaining sports mean that the estimations of risk of injury derived from the data may well be inaccurate. The small sample of players participating in the project may not be an accurate reflection of the players who did not participate. An early lesson from this project was, therefore, that successful data collection on amateur sports players requires commitment from several levels within the sport: administrators, coaches, team managers and players.

Sport	estimated capture rate	Sport	estimated capture rate
Badminton	45.2%	Leagueball	NA
Blind Sports	100%	Netball	47.8%
Baseball	35.8%	Orienteering	90.9%
Cricket	7.6%	Rugby League	9.2%
Football	63.8%	Soccer	5.5%
Hockey	39.5%	Softball	25.7%
Lacrosse	54.1%	Swimming	29.3%
Lawn Bowls	43.6%	Touch	72.1%
		Umpiring	40.5%

Table 1. Sports which participated in data collection

2. Methods

The questionnaire was administered to sports players at sports venues, by sports administrators, players, coaches, volunteers and Sports Medicine Australia (SA Branch) and Living Health personnel. To facilitate its completion, the questionnaire was limited to a double sided A4 page which could be completed within five minutes, using the pencils provided. An example of the questionnaire is provided in Appendix 1. Each sport's questionnaire was modified to ensure, where appropriate, questions

and responses were sports specific. Players answered the questionnaire by circling the appropriate response(s). Injured players were invited to be followed up over the next month and to seek further information on the management of their injury. Of the total number of players participating in the survey, less than 10% were injured, and as there was a low response rate to the request for follow up, the longitudinal data were not analysed. Questionnaire items are summarised in Table 2.

Player Demographics	age gender post code
Participation	level of competition team position hour of practice and play
Injury descriptors	body part injured nature of injury
Factors associated with injury	previous injury in the season playing conditions how injury occurred
Injury prevention	warm up procedures protective equipment worn fluid replacement type of footwear
Injury management	who provided early treatment type of early management longer term management of injury longer term effects of injury

Table 2. Questionnaire items

3. Results

3.1 Demographics and Participation

Data were collected from 7323 players. Age and gender characteristics are listed in Table 3. Sports in which similar proportions of men and women participated were badminton, blind sports, hockey, lawn bowls, orienteering and swimming. Significantly more women than men participated in league ball, netball and soft ball, and significantly more men participated in the remaining

seven sports. Football and rugby league were played only by men. The youngest participant was a swimmer (aged five years) and the oldest participant played lawn bowls (aged 88 years). The sports in which the mean age was greater than 30 years (therefore the sport particularly attracted older players) comprised badminton, blind sports, lawn bowls, orienteering and umpiring.

Sport	Total players	Females	Males	Mean age (SD) (Years)	Age range (Years)
Badminton	249	131	118	32.2 (14.4)	10 - 66
Baseball	358	8	350	21.1 (8.4)	12 - 54
Blind Sports	52	17	35	42.1 (22.4)	12 - 83
Cricket	228	22	206	23.9 (6.9)	13 - 56
Football	115	0	115	19.4 (4.6)	14 - 34
Hockey	348	201	147	21.6 (8.9)	9 - 61
League Ball	631	572	59	23.3 (9.8)	10 - 73
Lawn Bowls	1135	496	666	62.3 (11.7)	13 - 88
Lacrosse	111	39	72	33.3 (10.1)	9 - 57
Netball	2047	2024	23	19.1 (9.1)	7 - 59
Orienteering	40	13	27	39.1 (17.5)	7 - 71
Rugby League	46	0	46	19.8 (4.1)	14 - 29
Soccer	44	11	33	19.6 (4.2)	13 - 35
Softball	617	529	88	21.6 (10.8)	8 - 56
Swimming	352	193	159	14.8 (9.1)	5 - 75
Touch	545	196	349	28.6 (7.4)	12 - 61
Umpiring	405	113	292	33.3 (12.6)	11 - 67

Table 3. **Player demographics**

The relative contribution of each sport to the total number of participants in this data collection is reported in Figure 1. This information is compared with the sport-specific proportion of the total number of questionnaires distributed. The figure illustrates that the response to the survey from badminton, baseball, blind sports, football, hockey, lawn bowls, lacrosse, netball, orienteering, touch and umpiring

equalled, or exceeded the sport-specific proportion of the total number of questionnaires distributed. Responses to the survey from these particular sports mirror community involvement with them. The data indicates that in February 1996, the most commonly played sports in metropolitan Adelaide (those played by more than 10% of the sporting community) were cricket, netball, lawn bowls and soft ball.

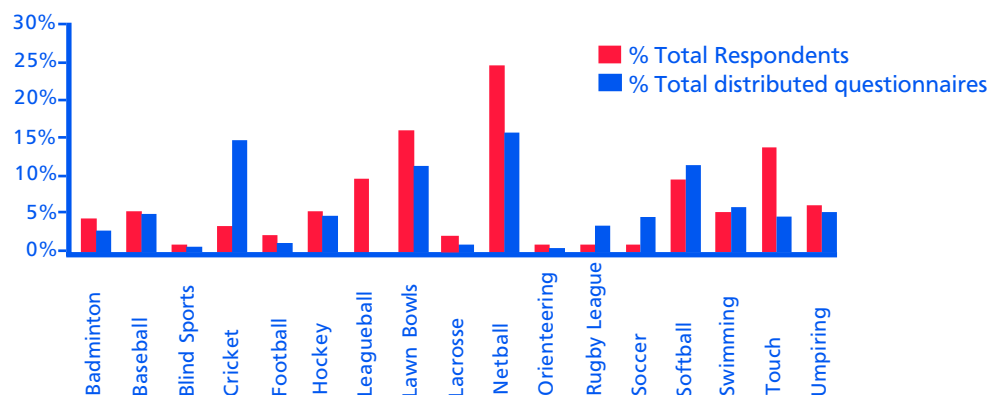


Figure 1. **The relative contribution per sport to the total number of participants, compared with the relative contribution of each sport to the total number of questionnaires distributed**

3.2 Overall Injury Statistics

3.2.1 Overall Prevalence

Overall, 544 players (7.4% total) reported sustaining an injury on the day of, or during the week preceding, questionnaire administration. Injury was defined as an event which prevents normal participation in play, training or other usual activities. Based on the percentage of injuries per players in each sport, the sports with the highest injury rates were baseball, cricket, football, hockey, lacrosse, rugby league, soccer, softball and touch.

The percentage of injured players of the total number of players participating in each sport, and the subsequent percentage of non-injured players is reported in Table 4. In this sample, the safest sports (those with injury rates of less than five per cent) were badminton, blind sports, league ball, lawn bowls and on a marginal level netball (4.9%).

Sport	% injured players per sport	% non-injured players per sport	Sport	% injured players per sport	% non-injured players per sport
Badminton	3.2%	96.8%	Netball	4.9%	95.1%
Baseball	11.4%	88.6%	Orienteering	7.5%	92.5%
Blind Sports	1.9%	98.1%	Rugby League	19.6%	80.4%
Cricket	10.9%	89.1%	Soccer	27.3%	72.7%
Football	27.8%	72.2%	Softball	18.3%	81.7%
Hockey	10.0%	90.0%	Swimming	8.8%	91.2%
League Ball	3.5%	96.5%	Touch	11.2%	88.8%
Lawn Bowls	1.0%	99.0%	Umpiring	5.7%	94.3%
Lacrosse	10.8%	89.2%			

Table 4. Sport-specific injury rates (% injured players per players in each sport)

3.2.2 Relative Injury Rates

The sport-specific injury rate reported in the previous section is somewhat deceptive because of large differences in the number of players participating in data collection, and the generally small number of injured players overall. Injury rates are placed in better perspective when overall rates of injury per sport (the percentage of injured players per sport of the overall total number of injured players (N=544)) are compared with the relative contribution of each sport to total player numbers (previously reported in Figure 1.). Disproportionately higher relative injury

rates to participation rates are apparent for baseball, football, rugby league, soccer, softball and touch, while disproportionately lower rates of injury to participation is found for blind sports and lawn bowls. The relationship between overall rates of injury per sport and contribution per sport to the total number of players is reported in Figure 2.

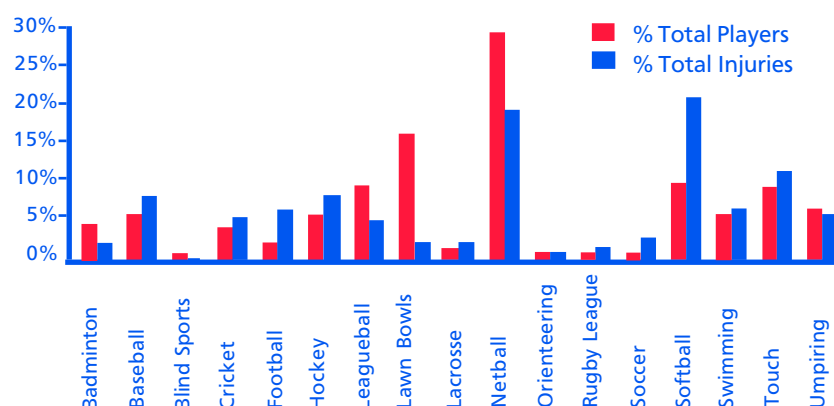


Figure 2. Comparing participation rates with sport-specific injury rates

3.2.3 Standardised Injury Rates

Injury rates were standardised by adjusting the per-sport rate of total injuries by the per-sport contribution to total participants. This provides the relative proportion of injured to non-injured players per sport. A rate of close to one (1) indicates the same relative contribution to injury rates and to total player numbers. Those sports for which the relative injury rate is considerably higher than one (1)(football, rugby league, soccer and softball)

suggests either a truly higher risk of injury, or else sampling bias where a disproportionately higher number of injured players participated in data collection. Conversely, a relative injury rate considerably lower than one indicates either a truly smaller risk of injury, or else sampling bias where a disproportionately lower number of injured players participated in data collection. The standardised injury rates are reported in Table 5.

Sport	Standardised rate of injury	Sport	Standardised rate of injury
Badminton	0.4	Leagueball	1.4
Blind Sports	0.3	Netball	0.6
Baseball	1.5	Orienteering	1.0
Cricket	1.4	Rugby League	2.7
Football	3.6	Soccer	3.7
Hockey	1.3	Softball	2.4
Lacrosse	0.5	Swimming	1.1
Lawn Bowls	0.1	Touch	1.5
		Umpiring	0.7

Table 5. Standardised injury rates

3.2.4 Odds Ratios of Injury

Odds ratios of sport-specific injury were determined from 2x2 tables in which the unknown values were derived from known totals. Odds ratios of sport-specific injury (+ 95% confidence limits) are reported in Table 6.

The sports with significantly high risk of injury (odds ratios where the lower 95% confidence limit is greater than one)

were baseball, cricket, football, hockey, rugby league, soccer, softball and touch. Sports that were significantly protective for injury (ie. safe sports) (where the upper 95% confidence limit is less than one) were badminton, blind sports, league ball, lawn bowls and netball. Significant odds ratios are denoted in the table by *.

Sport	Odds ratio (CL)	Sport	Odds ratio (CL)
Badminton	0.4 (0.2-0.8)*	Lacrosse	1.5 (0.8-2.8)
Baseball	1.6 (1.1-2.3)*	Netball	0.5 (0.4-0.7)*
Blind Sports	0.2 (0.01-0.6)*	Orienteering	0.9 (0.2-3.3)
Cricket	1.5 (0.9-2.4)*	Rugby League	2.9 (1.3-6.4)*
Football	4.9 (3.2-7.6)*	Soccer	4.6 (2.2-9.4)*
Hockey	1.4 (0.9-1.9)*	Softball	3.2 (2.5-4.0)*
Leagueball	0.4 (0.3-0.6)*	Swimming	1.2 (0.8-1.7)
Lawn Bowls	0.1 (0.01-0.2)*	Touch	1.6 (1.2-2.1)*
		Umpiring	0.7 (0.5-1.1)

Table 6. Sport-specific odds ratios of injury

3.2.5 Specific Injury Mechanisms

Gross injury statistics are potentially misleading, as injury in sport can be caused by three distinct mechanisms (contact, non-contact and mixed mechanisms (contact + non-contact)). The literature provided little guidance regarding the criteria that definitively distinguish true non-contact injury from injury that occurred by direct contact, as well as from injury that began with one mechanism but was completed by the other (mixed mechanisms). Non-contact injury was therefore defined a priori for the purpose of analysis as injury which happened via falling, landing badly, twisting, tripping and/or over-exertion. Contact injury was defined as occurring by collision, knocking

something, being hit by something and/ or running into something or someone.

The proportion of contact, non-contact and mixed injury mechanisms per injured individuals per sport are reported in Figure 3. To explain the illustration, 66.7% of the injured badminton players suffered non-contact injuries and the remaining 33.3% suffered mixed mechanism injuries. No badminton player reported suffering a contact injury.

Further analysis of injury statistics in this report addresses only contact and non-contact injuries, as multiple data entries on the mechanism of injury precluded definitive isolation and description of particular types of multiple mechanisms.

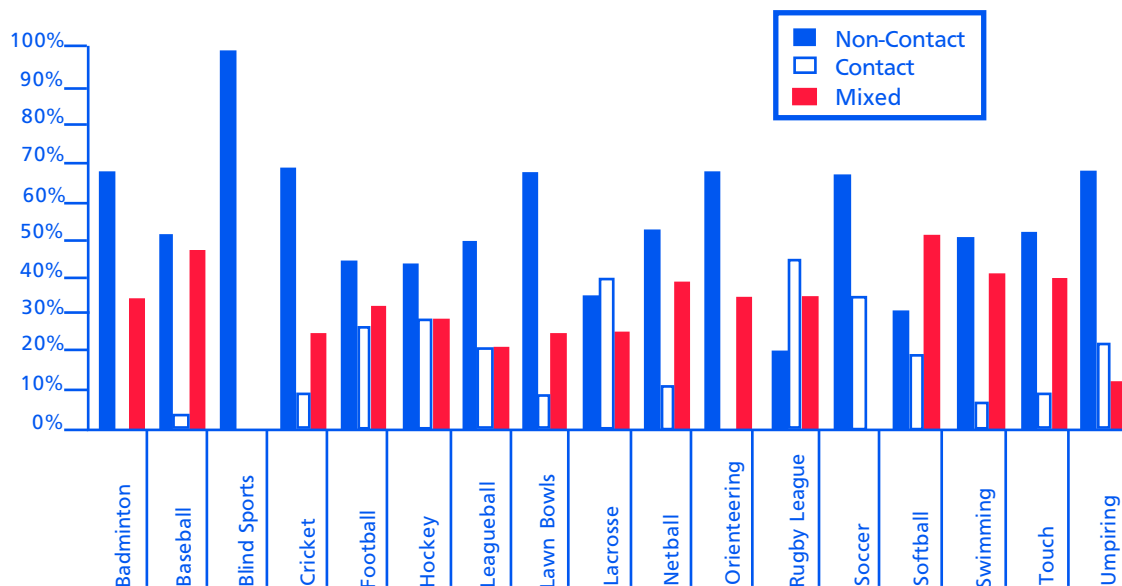


Figure 3. Mechanisms of injury in each sport

3.2.6. Body Parts Injured

Detailed data were collected on the body part involved with injury. However, for the purpose of analysis, body parts were combined into nine gross areas:

- 1 = head, face and neck
- 2 = chest and abdomen
- 3 = upper and lower back
- 4 = groin and pelvis
- 5 = shoulder and upper arm
- 6 = elbow and forearm
- 7 = hand, wrist and fingers
- 8 = thigh and hip
- 9 = knee and lower limb

The most commonly injured body part in all but one sports was the lower limb. The exception was cricket where the lower back was reported as the most commonly injured body area. The frequency with which body parts were injured is reported per sport and mechanism of injury (contact = C and non contact = NC) in Table 7. (following page).

3.2.7 Trained Management of Injury

The person who managed the current injury was defined as trained or untrained, for the purpose of identifying those sports with high injury rates and low rates of trained assistance. Trained and untrained personnel were defined by the following protocol:

Trained	Untrained
first aider sports trainer coach physiotherapist sports doctor GP podiatrist chiropractor	athlete family friends

Misclassification of trained and untrained personnel by this definition was possible, particularly for coaches, athletes, family and friends, as it was possible that coaches may not have sports first aid training, and that athletes, family and friends may be trained in sports first aid.



Sport	Nature Injury	Head	Chest	Back	Groin	Shoulder /arm	Elbow	Hand	Hip/ thigh	Low limb	Total
Badminton	C										0
	NC					29%		14%		57%	7
Baseball	C										1
	NC		4.5%	4.5%	4.5%	13.6%	4.5%	4.5%	4.5%	54.9%	22
Blind Sport	C										0
	NC								100%		1
Cricket	C							6.2%		6.2%	2
	NC		6.2%	31.6%	6.2%			6.2%	18.7%	18.7%	14
Football	C			5%		10%		10%		5%	8
	NC			10%					25%	35%	14
Hockey	C	8%						12%	8%	12%	10
	NC	4%		4%		4%	8%		4%	36%	15
Leagueball	C	7%				7%	7%	14%			5
	NC			7%				7%			9
Lawn Bowls	C						10%				1
	NC			10%	10%	20%		10%		40%	9
Lacrosse	C	11%			22%			22%			5
	NC				11%					34%	4
Netball	C	1.5%						12.5%		3.1%	11
	NC	1.5%		3.1%	1.5%			18.7%	4.7%	53.4%	53
Orienteering	C										0
	NC									100%	2
Rugby League	C	16.6%				16.7%			16.7%	16.7%	4
	NC					16.6%				16.7%	2
Soccer	C								8.3%	25%	4
	NC							8.3%	16.6%	41.8%	8
Softball	C	7.3%	1.8%		1.8%	3.6%		12.7%		9%	20
	NC			5.4%		5.4%	5.4%	12.7%	10.9%	24%	35
Swimming	C			5.8%							1
	NC			11.6%	5.8%	47%		5.8%		23.5%	16
Touch	C							8.6%		5.7%	5
	NC	5.7%			2.8%				31.4%	45.7%	30
Umpiring	C		5%		5%	5%	5%	10%			6
	NC			10%		5%				55%	14

Table 7. Frequency of injured body parts per sport injuries

The proportion of currently injured players who were provided with early assistance by untrained personnel is listed per sport in Table 8. Those sports where less than 50% current injuries were managed by trained personnel were badminton, baseball, hockey, leagueball, lawn bowl, lacrosse, orienteering, touch and umpiring.

Players who had sustained a previous injury in the season and also reported an injury in the week preceding data collection were also identified, for

the purpose of investigating whether there was more trained management of the current injury, on the basis of the previous injury. The management of these players is also listed in Table 8.

There was little difference between the two groups of players in the proportion who were managed by untrained personnel.

Sport	% current injuries managed by untrained personnel	% previously injured players managed by untrained personnel	Sport	% current injuries managed by untrained personnel	% previously injured players managed by untrained personnel
Badminton	80.0%	85.7%	Lacrosse	80.0%	60.0%
Baseball	51.5%	48.3%	Netball	46.0%	36.9%
Blind Sports	0%	no prev. inj.	Orienteering	100.0%	no prev. inj.
Cricket	45.6%	40.1%	Rugby League	44.5%	33.3%
Football	24.1%	14.3%	Soccer	41.7%	28.6%
Hockey	59.3%	62.6%	Softball	35.2%	33.4%
Leagueball	65.0%	50.0%	Swimming	48.1%	31.3%
Lawn Bowls	70.0%	80.0%	Touch	80.7%	76.2%
			Umpiring	68.1%	62.5%

Table 8. Proportion of injured players who did not have trained early assistance

3.2.8 Appropriate Management of Current Injury

The initial way in which injuries were managed was examined in an attempt to identify those sports which required further education. Poor early management was defined as no treatment, or any early management regime that contained heat or massage. The percentage of players whose current injury was managed poorly are listed per sport in Table 9. Gratifyingly, less than half all injured players were managed inappropriately. The highest rates of poor management were found in league ball, lacrosse and swimming. Players who reported sustaining a previous injury in the season, and reported a current injury were also investigated for the type of early management that was provided to the current injury.

This investigation, like the previously reported one, was undertaken on the assumption that if the current injury was managed inappropriately, then the previous injury may also have been

managed in the same way, a consequence of which may have been to increase the risk of this current incident. The percentage of previously injured players whose current injury was managed poorly (by no treatment, or by any management that contained heat or massage) are listed per sport in Table 9.

There were similar proportions of players in both groups whose current injuries were poorly managed, indicating that sustaining a previous injury had little influence on knowledge of appropriate injury management.

Sport	% current injuries poorly managed	% with previous injury whose current injury is poorly managed	Sport	% current injuries poorly managed	% with previous injury whose current injury is poorly managed
Badminton	20.0%	14.3%	Lacrosse	37.5%	50.0%
Baseball	10.8%	15.0%	Netball	13.2%	10.4%
Blind Sports	0%	no inj.	Orienteering	0%	no inj.
Cricket	29.3%	32.4%	Rugby league	0%	0%
Football	10.2%	0%	Soccer	16.6%	14.3%
Hockey	20.0%	43.9%	Softball	16.1%	31.4%
Leagueball	25.0%	0%	Swimming	40.0%	49.8%
Lawn Bowls	44.4%	75.0%	Touch	12.1%	9.6%
			Umpiring	28.6%	50.0%

Table 9. Poor management of injury

3.2.9 Severity of Injury

Severity of injury was rated in four ways in the questionnaire (continued to play, left field and returned, left field and stayed off, offsite to medical treatment). For analysis purposes, those classed as "more severe" injuries were considered to be those which did not return to the field (the last two options). The frequency of minor and more severe injuries per sport was compared across contact and non-contact injuries, and it appeared that a higher proportion of non-contact than

contact injuries did not return to the field, non-contact injuries were generally more severe. Small numbers of injuries in many of the sports however, precluded definitive testing of this observation. Injury severity per sport and per nature of injury (contact (C), non-contact (NC)) is reported in Table 10. There is a considerable amount of missing data in this table as approximately 20% of injured players did not complete this question.

Sport		Minor Injury		More Severe Injury		Totals
	Injury nature	Continued playing	Left field, returned	Left field, stayed off	Offsite for treatment	Actual injury numbers
Badminton	NC	85.7%	0%	14.3%	0%	7
	C	0%	0%	0%	0%	0
Baseball	NC	70.0%	5%	20.0%	5%	20
	C	100.0%	0%	0%	0%	1
Blind Sport	NC	100.0%	0%	0%	0%	1
	C	0%	0%	0%	0%	0
Cricket	NC	64.7%	11.8%	23.5%	0%	17
	C	100.0%	0%	0%	0%	2
Football	NC	30.8%	7.7%	23.1%	38.5%	13
	C	57.1%	0%	0%	42.9%	7
Hockey	NC	66.7%	0%	33.3%	0%	15
	C	70.0%	30.0%	0%	0%	10
Leagueball	NC	77.8%	11.1%	11.1%	0%	9
	C	80.0%	20.0%	0%	0%	5
Lawn Bowls	NC	50.0%	33.0%	16.7%	0%	6
	C	0%	0%	0%	0%	0
Lacrosse	NC	100.0%	0%	0%	0%	4
	C	60.0%	40.0%	0%	0%	5
Netball	NC	53.3%	15.6%	24.4%	6.7%	45
	C	88.9%	0%	11.1%	0%	9
Orienteering	NC	100.0%	0%	0%	0%	2
	C	0%	0%	0%	0%	0
Rugby League	NC	100.0%	0%	0%	0%	1
	C	25.0%	25.0%	25.0%	25.0%	4
Soccer	NC	62.5%	0%	15.0%	12.5%	8
	C	50.0%	50.0%	0%	0%	4
Softball	NC	68.7%	9.4%	18.7%	8.1%	32
	C	63.2%	10.5%	10.5%	15.8%	19
Swimming	NC	75.0%	6.2%	12.5%	6.2%	16
	C	100.0%	0%	0%	0%	2
Touch	NC	34.4%	12.5%	40.6%	12.5%	32
	C	25.0%	50.0%	25.0%	0%	4
Umpiring	NC	53.8%	0%	15.4%	30.8%	13
	C	80.0%	20.0%	0%	0%	5

Table 10. Severity of Injury

3.2.10 Putative Causal Factors

Factors which may have been associated with injury were examined. The small number of injuries in some of the sports precluded clear definition of injury mechanisms.

3.2.11.1 Age

The percentage of each injury type is reported per 10 year age group. The odds of any injury occurring in any one age group (compared to the baseline risk of one, for the youngest age group) is reported at the top of each table.

As there were many instances of too few numbers to have confidence in the injury associated with age groups, only significant findings have been tabled.

For example in lacrosse there appears to be 4 times the risk of injury in the 26-35y.o. compared with 15y.o.

Lacrosse

	< 15yrs	16-25yrs	26-35yrs	36-45yrs	46-55yrs	56-65yrs	66+yrs
Odds Ratio	1.0	3.7*	4.1*	0	0	0	0
non contact	50.0%	50.0%	0%	0%	0%	0%	0%
contact	80.0%	0%	20.0%	0%	0%	0%	0%
mixed	66.7%	33.3%	0%	0%	0%	0%	0%

Netball

	< 15yrs	16-25yrs	26-35yrs	36-45yrs	46-55yrs	56-65yrs	66+yrs
Odds Ratio	1.0	1.4*	8.7*	9.8*	0	0	0
non contact	76.9%	21.1%	0%	1.9%	0%	0%	0%
contact	72.9%	27.3%	0%	0%	0%	0%	0%
mixed	59.5%	32.4%	8.1%	0%	0%	0%	0%

Swimming

	< 15yrs	16-25yrs	26-35yrs	36-45yrs	46-55yrs	56-65yrs	66+yrs
Odds Ratio	1.0	0.2*	0.3*	0.5	0.06*	0	0
non contact	50.0%	31.3%	0%	12.5%	6.2%	0%	0%
contact	100%	0%	0%	0%	0%	0%	0%
mixed	53.8%	38.5%	7.7%	0%	0%	0%	0%

Touch

	< 15yrs	16-25yrs	26-35yrs	36-45yrs	46-55yrs	56-65yrs
Odds Ratio	1.0	4.6*	3.2*	3.3*	2.1	0
non contact	6.2%	31.2%	46.9%	15.6%	0%	0%
contact	20%	20%	40%	20%	0%	0%
mixed	12.5%	16.7%	50	16.7%	4.2%	0%

3.2.11.2 Age and Hours of Practice and Play

Combined hours of practice and play, and age were examined in order to identify an association between age and the time spent on a sport. The findings provided little evidence of any trend, for instance, that younger players spent more time on their sport than older players.

3.2.11.3 Hours of Practice and Play Associated with Injury

The hours in which injured and non-injured players participated in their

sport in the week preceding the questionnaire was investigated, in order to determine whether factors such as fatigue, overuse or under preparation may have contributed to the injury. The sports in which a significant difference between means (where the t-test had a p value of less than 0.05) was observed are highlighted in Table 11. In badminton, hockey, netball, softball, swimming and umpiring, the injured players undertook higher mean hours of participation than the non-injured players. In football however the injured players had significantly lower mean participation hours.

Sport	Non - injured group		Injured group		t - test SD (<i>p value</i>) hours
	Mean hours	SD hours	Mean hours	SD hours	
Badminton	4.2	6.3	8.3	5.3	-2.5 (0.03)
Baseball	5.2	2.7	5.1	2.3	0.08 (0.9)
Blind Sports	4.6	3.6	3.1	0	0.4 (0.6)
Cricket	10.1	4.1	10.1	4.9	-0.1 (0.9)
Football	10.1	7.7	6.9	5.1	2.1 (0.03)
Hockey	3.3	3.6	4.8	4.0	-2.3(0.02)
Leagueball	1.8	3.2	1.9	1.1	-0.2 (0.8)
Lawn Bowls	7.9	6.3	8.2	6.5	-0.2 (0.9)
Lacrosse	2.5	3.3	2.0	2.2	0.4 (0.6)
Netball	2.1	2.0	22.5	2.3	-2.1 (0.03)
Orienteering	3.8	3.4	5.2	1.7	-0.6 (0.5)
Rugby League	9.0	6.1	10.9	5.1	-0.9 (0.4)
Soccer	9.2	4.8	8.9	5.9	0.2 (0.8)
Softball	3.1	1.9	3.8	2.7	-2.8(0.005)
Swimming	6.4	5.4	9.8	6.3	-3.3 (0.009)
Touch	1.8	2.8	1.9	2.5	-0.3 (0.7)
Umpiring	4.2	3.4	6.5	11.2	-2.7 (0.007)

Table 11. Mean hours of participation for injured vs non injured groups

3.2.11.4 Playing conditions and position in team

There was little variation during the week of the survey in the playing conditions under which players participated. The position in the team was also not able to be analysed for its influence on injury, as the injury rate in

most sports was too low and missing data from the injured players precluded clear comparisons.

4. Overall Safe-Sport Practice

4.1 Wearing Protective Equipment

This section reports on the frequency with which specific protective equipment was worn on body areas. These body areas are listed below in Table 12.

Protective equipment is encouraged to minimise and prevent contact injuries

between players, between players and playing surfaces, and between players and equipment. Sunscreen and hats are encouraged for outdoor sports to reduce the risk of skin cancer.

Head	Hat /Helmet	Mouthguard	Visor			
Body	Box	Shoulder pads	Chest protector			
Arm	Gloves	Finger strapping	Wris strapping	Arm pads		
Leg	Knee brace	Ankle brace	Ankle strapping	Leg/shin	Thigh pads	Knee/ankle strapping
Sunscreen						

Table 12. Protective equipment reportedly worn

The percentage of players who wore no protective equipment on particular body areas is reported in Table 13. The percentage of players who wore no mouthguard is also reported because of the specific nature of this equipment. However, information contained in this table needs to be evaluated in the light of the demands and playing environments of the sports. For instance, the general non-use of protective equipment on the head by badminton players possibly reflects an indoor playing environment and the low risk of injury to the head by equipment or other players.

The high use of hats/helmets by baseballers and softballers possibly reflects awareness of the need for protection from sun, players and equipment in an outdoor environment. Apart from hockey, the use of mouthguards was generally low in those sports that contained a risk of injury to the mouth, such as football, lacrosse, netball, rugby league, soccer and touch. However, this finding needs to be tempered with the pre-season nature of training for football and rugby league, where training involved mainly running and strength work.

Sport	Head	Mouth-guard	Body	Arm	Leg	Sunscreen
Badminton	97.4%	100%	100%	88.9%	84.7%	99.1%
Baseball	9.5%	100%	21.1%	35.6%	85.5%	62.3%
Blind Sports	5.3%	100%	100%	100%	66.7%	5.6%
Cricket	4%	100%	25.7%	5.3%	4.4%	16.1%
Football	75.0%	85.2%	100%	89.7%	55.0%	70.3%
Hockey	27.7%	35.8%	94.2%	91.9%	7.8%	76.1%
Leagueball	94.3%	98.4%	100%	92.5%	58.1%	95.4%
Lawn Bowls	8.7%	100%	100%	92.9%	91.9%	30.1%
Lacrosse	60.4%	90.6%	66.7%	75.0%	78.1%	94.5%
Netball	95.5%	98.5%	100%	92.9%	74.1%	78.6%
Orienteering	65.0%	100%	100%	100%	90.0%	60.5%
Rugby League	48.1%	70.4%	79.2%	81.5%	50.0%	80.0%
Soccer	84.1%	100%	100%	95.5%	15.9%	63.6%
Softball	1.5%	95.5%	80.8%	7.1%	33.8%	31.8%
Swimming	2.1%	100%	100%	100%	75.0%	71.4%
Touch	72.1%	100%	100%	96.6%	78.9%	83.9%
Umpiring	38.7%	100%	72.6%	91.6%	55.6%	57.2%

Table 13. The percentage of players per sport who wore no protective equipment

4.2 Contact Injury and Protective Equipment

The relationship between protective equipment that was worn and contact injuries that were suffered was definitive because of the small numbers of contact injuries reported. However, for each sport, injured participants in the study generally reported more equipment being worn, than not worn, on the injured body part. Moreover, the survey did not collect information on whether the equipment was securely fastened, or fitted appropriately, and therefore more specific findings on the injury mechanism cannot be reported. Clearly perceived risk encourages people to wear protective equipment, although not universally. Future research might examine not so much the frequency, but the severity of contact injuries with or without effective, appropriately worn protective equipment within specific sports.

4.3 Warm Up Activities

Public health campaigns, emphasise the need to appropriately warm up before participating in any sporting activity. There is conflicting advice on whether specific warmup activities, or general limbering up activities, are more efficacious in obtaining performance-ready tissues. There were clear sport-specific differences in the percentage of players who undertook some warm up activity. In the questionnaire, participants could choose from several options, and for analysis purposes, these were aggregated to no warm up activities at all, specific activities (stretches, etc.) and non-specific activities (easy actions). Overall, 24.7% participants did not warm up, 47.1% undertook specific warmups and 28.2% did non-specific warm up activities. The number of injuries in each category is reported per sport in Table 14.

Sport	No warm up Injury number	Specific Warm up Injury number	Non-Specific Warm up Injury number
Badminton	0	4	3
Baseball	0	6	10
Blind Sports	0	0	1
Cricket	0	9	6
Football	0	9	5
Hockey	1	8	4
Leagueball	3	3	3
Lawn Bowls	3	0	2
Lacrosse	2	1	1
Netball	2	28	17
Orienteering	0	0	0
Rugby League	0	2	0
Soccer	0	4	3
Softball	1	15	11
Swimming	0	9	2
Touch	1	9	2
Umpiring	2	7	5

Table 14. Number of injuries to players who participated in warm up activities

It is commonly believed that undertaking warm up activities reduces the risk of occurrence of non-contact injuries. However, the apparently higher prevalence of injury occurring following warm up suggests that warm up activities may not be undertaken appropriately for the nature of the sport.

It may be that stretching exercises are not culpable in themselves but the key factor is warming up with the same kind of activities which the player is expected to undertake during the game.

4.4 Fluid Replacement

Safe-sport advice includes consuming appropriate fluids before, during and after sport. Whilst lack of fluid replacement may not be an injury risk in itself, dehydration and consequent fatigue may contribute. The data were initially broadly analysed to describe any fluid consumption prior to, during and after participating in sports.

The data are reported in Figure 4. Few sports reported less than 75% compliance with fluid before participating, and only one sport (orienteering) reported less than 50% compliance during participation. All sports reported 80% or more compliance with fluid participation after participation.

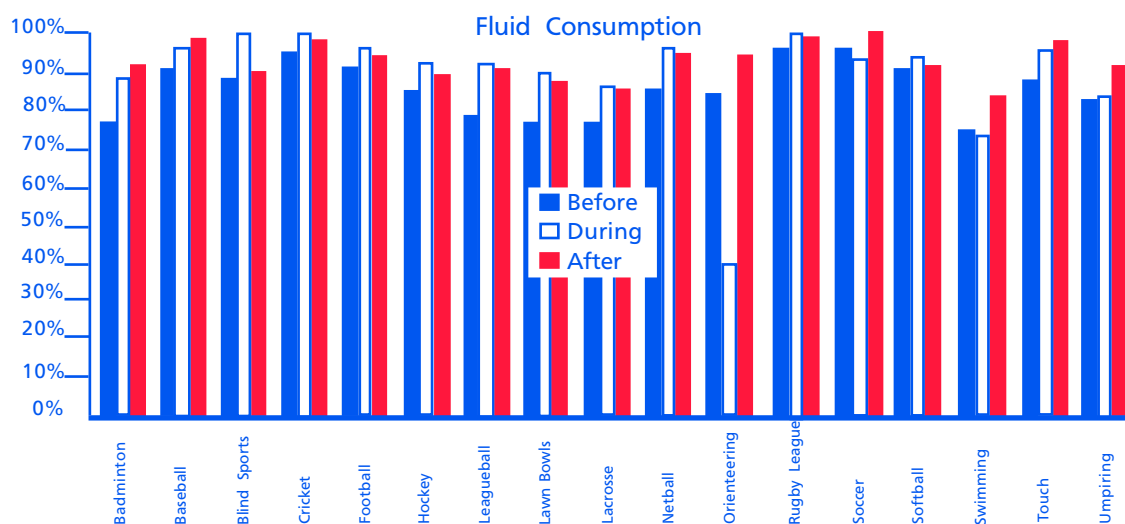


Figure 4. Any fluid consumption prior to, during and after participation.

4.4.1 Dehydrating Fluids

Fluid consumption was more closely investigated by identifying fluids that were poor (tea, coffee, soft drink) and fluid consumption than was contra-indicated ie. bad (alcohol, or drinking nothing at all). The percentage of participants who reported consuming poor or bad fluid consumption before, during and after sport are listed in Table 15.

The desired response in this table would be 0% (all participants consuming

"good" fluids that did not dehydrate them). Those sports which reported a rate of poor or bad fluid consumption higher than 25% are highlighted. The data suggests that lawn bowlers require the most education about fluid consumption at any stage of the game, orienteers need to be educated to consume fluids during their sport, and cricketers, baseballers and touch players need to be educated about fluid consumption after participation.

Sport	Before		During		After	
	poor	bad	poor	bad	poor	bad
Badminton	12.5%	0%	0%	0%	12.5%	0%
Baseball	4.8%	1.8%	0%	0%	20%	25%
Blind Sports	0%	0%	0%	0%	0%	0%
Cricket	5.3%	0%	0%	5.3%	15.8%	47.4%
Football	0%	0%	0%	0%	0%	4.5%
Hockey	4.2%	4.2%	0%	8%	20%	0%
Leagueball	0%	26.7%	0%	6.3%	14.3%	21.4%
Lawn Bowls	44.4%	11.1%	44.4%	11.1%	66.6%	33.3%
Lacrosse	0%	33.3%	0%	0%	0%	11.1%
Netball	3.2%	12.7%	0%	7.9%	1.6%	14.8%
Orienteering	0%	0%	0%	100%	0%	0%
Rugby League	0%	0%	0%	0%	0%	0%
Soccer	0%	8.3%	0%	8.3%	16.7%	8.3%
Softball	0%	5.5%	0%	5.5%	11.1%	9.3%
Swimming	0%	5.7%	5.6%	22.2%	5.0%	11.8%
Touch	0%	5.7%	0%	8.3%	33.4%	3%
Umpring	5%	5%	0%	25%	10%	5%

Table 15. Poor and bad fluid consumption

5. Sport-Specific Results

5.1 Badminton

Based on the data collected in this project, badminton was not a highly played summer sport. It was played by similar numbers of men and women, and attracted a wide age range of players, the mean age being 32 years. Few injuries were reported, and compared with all other sports, the odds ratio of injury for badminton was protective. All injuries were non-contact, or mixed mechanisms, and they were roughly divided into upper limb (both upper and lower arm) injuries (approximately 40%) and lower limb injuries (approximately 60%). Badminton is essentially a non-contact sport which requires racquet skills coupled with running, turning, fast direction changes and sudden stopping movements in a defined space. Therefore the nature and location of injuries was not unexpected.

The majority of injuries were minor and of a soft-tissue nature, and injured badminton players were not provided with a great deal of trained court-side assistance. Safe sport practices were not widely implemented, as few wore protective equipment on either upper or lower limb, and approximately one-third did not warm up at all. However, a relatively high proportion of players consumed fluid appropriately (before, during and after the game). As badminton is generally played on an indoor surface, there was little need for sun protection, as recognised by the small proportion of players who wore hats and sunscreen.

All but one of the injuries (contact and mixed mechanisms) were sustained by players under 25 years. The injured players reported a significantly higher number of hours of practice and play than the non-injured players.

Contributing factors may include overuse, fatigue or grade of competition. These factors are in need of further investigation. The low rate, and generally minor nature of, injury suggests that

badminton is a safe sport for all ages. It could be promoted as a safe summer sport for people who are not currently participating in one. It appears that youth and a high number of contact hours with the sport may be risk factors for injury.

5.2 Baseball

Baseball is an outdoor sport with training sometimes undertaken indoors. The game requires players to produce fast acceleration and deceleration from upper and lower limbs, as well as the whole body. Despite safety measures, the sport may involve contact between players, and between players and equipment or players and the surface. In this data, baseball was essentially a young male sport, although the oldest player was over 50 years.

Approximately one in nine players sustained an injury in the week preceding the administration of the questionnaire and the odds ratio of injury for this sport was significantly high compared with all other sports (OR = 1.6). Twenty five percent injuries were classified as more severe, and all of these were considered by players to be non-contact. Despite the potentially contact nature of the sport, protective equipment was not universally worn by players, with 79% only wearing a hat/ helmet, 78.6% only wearing a box and 63.2% only wearing gloves. No player reported wearing a mouthguard, and less than 40% of players wore sunscreen. These are areas where safe-sport strategies could be improved.

The majority of injuries in this data set were non-contact, and approximately half occurred to the knee or lower leg. There was a relatively even frequency of non-contact injuries to the chest, back, upper limb and thigh/hip areas.

Most players undertook some form of warmup activity, which suggests a good awareness of safe sport strategies. However, coupled with the relatively high

frequency of non-contact injuries, this suggests that the warmup activities undertaken may not be appropriate for the sport, and/or they may not be properly conducted.

Players drank appropriate fluids before, during and after the game, suggesting good awareness of fluid consumption. Despite the lack of trained personnel field-side to manage injuries, there was a low rate of poor injury management, suggesting that generally baseballers are aware of appropriate injury management strategies.

5.3 Blind Sports

Blind sports were played by a small proportion of the sport players, possibly reflecting the prevalence of sight impairment in the community. Approximately twice as many men as women participated in blind sports, and the age range of players was extensive (69 years). The injury rate was very low, representing one person with a non-contact injury to the thigh, and consequently the odds ratio of injury was protective. The complete compliance of blind sport players with data collection underpins the importance of the findings. Blind sport players were moderately aware of safe sport strategies, with approximately 70% undertaking warmups of some nature and over 80% of players drinking appropriately. However, approximately one-third players only wore hats, or leg/shin guards. There are consequently opportunities for improving safe-sport strategies for blind sport players, particularly in the use of protective equipment and in warming up.

5.4 Cricket

In this data set, cricket was mostly played by young men, with the oldest player aged 56 years. Cricket players were significantly under-represented, as illustrated by the low rate of compliance with the survey. The findings from this survey therefore need to be verified by further research. Cricket is an outdoor

sport involving bursts of fast movement, and for bowlers, considerable upper limb and back activity. There was a one in 10 chance of injury and the odds ratio of injury (compared with all other sports) bordered on significance (OR=1.5). Non-contact injuries were most commonly reported by cricketers, and this was the only sport where the rate of injury was not highest to the lower limb (the highest body area injured in cricket was the back). A smaller number of contact injuries occurred to the hand and the lower limb. Approximately 80% of the non-contact injuries were considered to be minor by respondents, although there was a concerning high proportion of injuries which were managed by untrained personnel and/ or by poor management court-side.

Protective equipment was worn by most players on hands and legs, but approximately one-quarter of players did not wear a box. Warmup activities were practised by most players, but as for the other sports, the relationship between non-contact injuries and warmup activities indicates that warmup strategies may not be appropriate to the sport, or may not be undertaken as recommended. This is particularly concerning considering the number of injuries to the back. Education regarding fluid intake particularly after participation in the game needs to be improved, as alcohol was drunk after the game by approximately 50% of players. Moreover, more field-side assistance is required for injured players, as approximately half the injured players were not provided with trained on-ground assistance for injuries, and approximately 30% of players' injuries were managed poorly (with heat, massage, or no management at all).

5.5 Pre-Season Football

Football was in pre-season training phase during this study, and therefore data collection was undertaken by only a small number of players, compared with the large number that would be

participating in the winter months. It was played exclusively by young men in this data set (all younger than 35 years), and compliance with data collection was moderately high. The reported injury rate in the week preceding the survey was high (approx. 28%) with an odds ratio of approximately five (5) that a football player would sustain an injury, compared with all other sports players. The majority of injuries involved the lower limb and back. The high prevalence of injury was reflected in the low (non-significant) odds ratios that a previously injured player would report an injury in the week preceding the survey (OR=1.7). Average participation hours were significantly less in the injured player group, suggesting that lack of preparation and match readiness may have contributed to the injury.

Over 80% of players wore no mouthguard, and few players wore protective equipment on the body or arms. Approximately 45% of players wore some form of protective equipment on the leg. Although 99% of footballers undertook some form of warmup, injury seemed closely linked with specific warm ups, suggesting that the warmups undertaken may not have been appropriate for the nature of the activity. Footballers appeared to be better provided with trained assistance field-side than other sports, as less than 30% of injuries were managed by untrained personnel, and only 10% of injuries were managed inappropriately. Footballers also appeared to be well educated about appropriate fluid consumption, with less than 5% of them consuming inappropriate fluid after the game.

5.6 Hockey

Data capture on hockey represented approximately 40% of available summer hockey players. It was played by similar numbers of men and women, and represented a wide range of player ages (age range = 52 years). Hockey is an outdoor activity consisting of running and

gross upper limb and trunk control. Ten percent of players reported an injury in the preceding week, and the odds of injury from hockey were significantly higher than from all other sports (OR=1.4). One third of the injured participants sustained severe injuries, in that they could not continue playing. There was also a significantly higher odds that players who had previously been injured would report an injury in the week preceding the questionnaire, suggesting that the nature of injury and game may contribute to ongoing injury problems.

As hockey is generally played outdoors, it appears that more sun-safe education is required. Approximately 30% of players wore no visor/helmet, and 77% of players wore no sunscreen (Some of this may be due to night games). Of more concern, was the fact that only 60% of players wore mouthguards, especially as 10% of contact injuries were to the head. Over 80% of players used lower limb protection, which was consistent with the high frequency of leg injuries. However, there was a lack of upper limb, and in particular hand protection, and this should be redressed in the light of the high percentage of injuries to the forearm and hand.

Warm up of some type was well implemented as only 15% of players did not warm up. There was a high proportion of untrained pitch-side assistance to injured players, which in view of the nature and severity of injuries reported, may need to be addressed. Fluid replacement practice was generally good, but one-fifth of players did not drink appropriate fluids after the completion of the match. Given the running nature of the game, this may need to be specifically addressed.

5.7 Leagueball

Leagueball was mainly played by females, attracting players ranged from 10 to 73. The compliance rate with data collection was unable to be calculated.

This sport could be promoted as a safe sport suitable for all ages, as in this data set the injury rate was very low (3%), and the sport was protective of injury (odds ratio of 0.2 of injury, compared with all other sports). Because of the extremely low rate of injury, the odds ratio of a player who had been previously injured being injured again in the week of survey were very high, suggesting that once an injury had occurred, it may continue to "niggle".

Non-contact injuries were the most common, evidence of the no contact, running nature of the game. Fifty percent of the injuries involved the lower limb, while the remainder were reported on the chest, abdomen and arms. There was a high proportion of injured players who were not provided with trained assistance, reflected in the poor management of 25% of injured players. The majority of injuries were minor, and players were able to continue participating with the injury. Although approximately 40% of leagueball players used some form of lower limb protection, the majority used no protective equipment on head, body and arms. This survey therefore identified a number of areas for improving participation in safe-sport practice in this sport.

5.8 Lawn Bowls

Lawn Bowls was played by the second highest number of participants. It was an exceptionally safe sport, with less than 2% of players reporting injury, and the odds ratio of injury was protective. Data were captured from some 40% of available players during the survey period. Similar numbers of men and women participated, and this sport attracted the oldest age group. Given the outdoor nature of the sport, it was pleasing to see that over 90% of players wore hats, but efforts could be made to increase the number of players wearing sunscreen, as only 30% of players were wearing it. Few players wore protective equipment on legs and arms.

Those that did may have been doing so as management of existing problems rather than for injury prevention. While few bowlers warmed up before participating, the low rate of injury perhaps suggests that education regarding warmup may not be cost-effective. There is however, a clear need for education on fluid consumption, as a high proportion of players did not adequately hydrate before, during or after the game.

5.9 Lacrosse

Over 50% of summer lacrosse players in Adelaide responded to the survey. Lacrosse was played by twice as many males as females, and the mean age of players was 33 years, with players aged from 9 to 57 years. Eleven percent of lacrosse players sustained injuries in the week preceding the survey. The risk of injury was not significant in this sample however, and risk of injury needs to be assessed in a larger sample over a longer time period. Half the lacrosse injuries were contact injuries, to face/head, back, groin and hand, but the majority of non-contact injuries were to the lower limb. There was a high odds ratio (approx 23) that previously injured players would sustain an injury in the week preceding the survey, suggesting that the fast running, turning and throwing aspects of the sport promoted ongoing sub-acute injury. There was a high proportion of injured players who were not provided with trained early assistance for their injuries, and there was a significant number of injured players whose injury management was poor. It appeared that having sustained a previous injury did not ensure better management of the current injury. However, despite the high rate of current injury, all injuries in lacrosse were minor, with no player having to cease play following injury.

There was a significant age-related risk of injury, with players 16-35 years more likely to sustain an injury than other players. It was of concern that so few players wore protective equipment in a

game that requires a ball to be propelled around the head and upper body. Although minor injuries only were reported to these areas in this survey, there is a strong possibility of serious injury to these areas, given the nature of the game.

Thirty per cent of players did not participate in warmup activities and the lacrosse players in this survey required more education regarding consumption of appropriate fluid before and after the game. Approximately 20% consumed inappropriate fluids during the game and 35% consumed inappropriate fluids after the game.

5.10 Netball

Netball was the most commonly played sport in Adelaide during the week of the survey. It was played mainly by young females (the majority being under 25 years, while the oldest player was 59 years). There was a large response to the survey from netballers, representing approximately 50% of available players on that week. Netball players reported a low injury prevalence (less than 5%) and there was a protective odds ratio of injury for netballers compared with all other sports. The majority of netball injuries were soft tissue and non-contact, affecting mainly the lower limb and the hand/ fingers. Injuries were mostly minor, irrespective of where they occurred. On the basis of the data collected in this study, netball could be recommended, particularly to women, as a relatively safe sport.

Netball players who were injured previously in the season had a high likelihood of reporting an injury in the current week (OR=4.9). This finding reflected the low risk of injury from netball, and indicated that once injuries occur, they may re-occur during the season. Correct early management of netball injuries was mostly reported, although assistance was not generally provided by trained personnel. A significant number of injuries occurred

to players who were not wearing protective equipment, and few players used protective equipment, particularly mouthguards, hats and protective equipment on arms, legs and the hands. Compared with players less than 15 years, the risk of injury was significantly higher for netball players aged 16 to 35 years. Older players are bigger than younger players and as the court size does not change, older players physically take up more space, and are therefore more liable to contact injury. Older players also tend to play in higher grades, which involves more aggression, speed and time commitment.

Players who were injured played significantly more hours than non-injured players. Despite netball being a mainly outdoor sport, more than 60% of players did not use sunscreen. While the majority of netball players warmed up (non-specific and specific warm up exercises), injury appeared, once again, to be related to warmup. Further research is indicated into this phenomenon.

Most netballers were aware of appropriate fluid intake, as they consumed fluids appropriately before, during and after the game. Education efforts for netballers should therefore be oriented towards wearing appropriate protective equipment, and research needs to be undertaken into developing, implementing and evaluating netball - specific warmups.

5.11 Orienteering

Data was collected from most orienteers participating in the sport in South Australia during February 1996. The mean age of orienteers was high compared with other sports (approximately 40 years) and coupled with the relatively low injury rate, orienteering appears to be a safe sport appropriate to men and women of all ages. There was an even risk of injury from orienteering when compared with other sports, and all injuries sustained by orienteers were to soft tissues of the

lower limb, via non-contact mechanisms. All injuries to orienteers were minor, but were managed by untrained personnel. The management in all instances was good however, in that it never included heat or massage. No orienteers wore protective equipment on body or legs, although only some orienteers wore hats and sunscreen. More education could be directed to educating players about wearing hats and sunscreen, given the outdoor nature of this sport. Moreover, 35% of orienteers did no warmup before participating in their sport, and no orienteer consumed fluid during the event. The low injury rate suggests that perhaps orienteers warmup simply by participating in their sport, and the running style of the sport possibly precludes drinking during participation. Despite the low injury rate reported in this survey, these factors require further investigation to ensure that over time, orienteers are not running a higher risk than other sports participants of injury or illness from the nature of their sport.

5.12 Pre-Season Rugby League and Soccer

The rate of capture from rugby league and soccer players was poor (10%, and 5% respectively) and therefore the findings reported in this survey may be inaccurate. Both sports were played mainly by young men, with the oldest players being aged 29 and 35 respectively, and in particular, rugby league was in pre-season training. The respondents represented higher grades of rugby league and soccer, as these were the only players involved in summer playing or training. The injury rates for both sports were very high, and standardisation of the data indicated that either the risk of playing these sports was very high, or that the data over-represented injured players. Based on the data, the odds of injury from these sports, compared with all other sports were 3 and 4.6 respectively. Both sports reported injuries mainly of a soft tissue nature, to the leg and lower limb,

and there were some reported injuries in rugby to the head and shoulder. High proportions of injuries in both sports were managed by untrained personnel, although the percentage of poorly managed injuries was low. High proportions of players in both sports wore protective equipment on their legs, but few players wore a mouthguard or sunscreen, despite the risk of direct injury to the head, and the outdoor nature of the sports. Larger data sets representing a higher proportion of players are required from both these sports to more clearly define the rate of injury and to monitor safe-sport behaviour.

5.13 Softball

Softball places similar demands on players as baseball, as the sport requires sudden bursts of speed, fast acceleration and deceleration of the shoulder and trunk, and the possibility of contact between players, between players and equipment and between players and the surface. The data set represents approximately one-quarter of available softball players. The majority of players were young women, with the oldest player aged 56 years. Injury rates were high, with 18% of players reporting an injury in the week preceding the survey. Age was not a risk factor for injury, and neither was the time spent playing in the previous week.

While the risk of injury may truly be high for this sport (as represented by an odds ratio of 3), attempts to standardise the data suggested that the sample may also over-represent injured players. Therefore further study is required, both cross-sectionally and longitudinally, to more accurately estimate the risk of injury from softball. Multiple mechanism injuries were most commonly reported by softballers, followed by non-contact injuries. Contact injuries were reported to head, body, arms and legs, while non-contact injuries were reported to arms and legs. The most common of any site of injury was the lower limb.

Approximately 85% of injuries were soft tissue, but approximately 30% of both contact and non-contact injuries were classified as more severe, in that the player left the field and did not return to complete the game. Softballers who had sustained an injury previously in the season had a high risk of reporting a current injury. This may be a further indication of the selection bias, but may also indicate that the nature of the injury invites ongoing, niggling injuries. One-third of soft ball injuries were managed field-side by untrained personnel, but less than 20% of the injuries were managed poorly. Of interest was the higher proportion of previously injured players with current injuries, that were poorly managed, suggesting that previous injury did not improve knowledge or application of appropriate injury management.

There was good compliance from softballers on the use of head, arm and leg equipment, and sunscreen, although only 5% of players used mouthguards. The majority of contact injuries were sustained by players wearing equipment. The majority of players undertook some form of warmup, as did all injured players. Over 80% of players consumed appropriate fluids. Education strategies for softballers should focus on increasing the use of mouthguards and on implementing appropriate warmup activities for softball injury.

5.14 Swimming

Data collected from swimmers represented approximately 30% of participating swimming club members. The mean age of swimmers was low and the majority of swimmers were aged less than 40 years. A small number of older swimmers were represented in the data, with the oldest being 75 years. The reported rate of injury was close to 9%, but the standardised rate of injured swimmers to total swimmers in the data set was approximately 1, matching the

even odds of injury when compared with other sports. The risk of injury for swimmers over the age of 15 years was significantly protective, and therefore swimming could therefore be promoted as a safe sport particularly for older men and women. The most common mechanism of injury for swimmers was non-contact, followed by mixed mechanism injuries. The lower limb was the most commonly injured body part, followed by shoulders, elbows and hands/ fingers. Of interest was the number of injuries which occurred to young swimmers outside the pool, suggesting that fatigue may play a major role in injury causation. Previously injured swimmers carried a significantly high risk of reporting an injury in the week preceding the survey, providing evidence of possible selection bias in the data, where injured swimmers were more likely to complete the survey form than non-injured swimmers. Approximately half the swimmers who were injured were not provided with trained assistance, or with good injury management, suggesting the need for improved trained first-aid assistance at swimming venues.

Swimmers appeared to be at higher risk of injuries classified as more severe than participants in other sports. While 85% of injuries were soft tissue, approximately 20% of them were classified as more severe, necessitating the player not resuming swimming. Injured swimmers swam for a significantly longer time in the preceding week than did non-injured swimmers, and coupled with the higher risk of injury for swimmers under 15 years, this data suggested that young swimmers training heavily were significantly at risk of sustaining a soft tissue injury from overuse and fatigue.

Close to 30% of swimmers did not drink appropriate fluids while swimming, and approximately 20% did not consume appropriate fluids after swimming sessions.

Swimmers run the risk of dehydrating as much as other sports players, and therefore education strategies for swimmers need to include information on appropriate hydration. The majority of swimmers reported using bathing caps and/or goggles, but there was a high proportion (over 70%) that did not use sunscreen. Most swimmers participated in specific warmup activities.

5.15 Touch

Data collected on touch represented over 70% of available players, these being two men to every one woman playing the sport. The average age of touch players was 28 years, representing a significantly older data set than for some other sports. The age range of touch players was wide, representing players aged between 12 and 61 years. One in nine players reported sustaining an injury in the preceding week and the odds of sustaining an injury were significantly high, when compared with all other sports (OR=1.6). Given the high compliance rate with data collection, this probably represents a true reflection of the risk of injury from touch. The majority of injuries were non-contact and mixed mechanism in nature, evidence of the running, turning and dodging skills required by the game. The majority of injuries were to the lower limb and to the thigh/hip. Compared with other sports, the odds of a previously injured player reporting a current injury were much lower (although the risk was still significant). Either the nature of the game does not support ongoing injury, or the risk associated with recurrent injury found in other sports (with similar proportion of current injury) is inaccurate, due to the selection bias in the data. Compared with other sports, the proportion of soft tissue injuries was considerably lower (60%), and like all but one sport, there were no reports of fracture. The remaining injuries consisted of cutaneous damage (abrasions, cuts and contusions).

Given that diving is an integral part of the game, this finding may have implications for the design of team uniforms. More than half the contact and non-contact injuries were classified as more severe, resulting in cessation of play.

Less than 20% of injured touch players were provided with trained assistance field-side, although the nature of the care provided was generally appropriate. Older age was a risk factor for injury, with all players over the age of 15 years significantly more at risk of injury. The number of hours of participation was not a risk for injury. Few touch players wore any protective equipment, and few wore sunscreen, despite the outdoor nature of the game. As noted with other sports, over 70% of players undertook some form of warmup, and all players reporting non-contact injuries engaged in it. Appropriate fluids were consumed by most players before and during the game, but over one-third of players drank inappropriately after the game. Education strategies should concentrate on informing players about sun protection and fluid consumption. Trained personnel should be provided field-side given the high proportion of severe injuries, and research should be undertaken into appropriate warm up activities.

5.16 Umpiring

It was difficult to make definitive statements about umpires because they represented a range of sports and therefore a wide range of physical activities. Umpiring duties are dependent on the nature of the sport, although it could be assumed that most umpiring requires constant movement to keep the play in sight. For most this would involve running and turning, and possibly bursts of speed. Less than half the available umpires completed the survey. Approximately one woman to two men were represented in the data, and the average age of umpires was considerably older than other sports (33 years).

Umpires ranged in age from 11 to 67 years. The risk of injury reported by umpires was low (approximately 6%), and compared with all other sports, there was a relatively even risk of injury.

Non-contact injuries were by far the most common, reported mainly to the lower limb. Contact injuries were reported in small numbers to all parts of the body. Umpires who had previously reported an injury in the season had a significantly high risk of reporting a current injury, although compared with other sports, this risk was on the low side.

The management of umpiring injuries was generally poor, provided by untrained personnel. This is a concern when it is noted that 40% of non-contact injuries

were severe enough for the umpire to cease participation in the game. Umpires aged from 16-45 years were at more risk of injury than younger or older umpires, and umpires who participated more often had a higher risk of injury, indicating a possible relationship between overuse and fatigue, and injury. One quarter of umpires did not consume appropriate fluids during the match, and there again appeared to be a relationship between actually warming up and injury. Umpires participated more than players in warming up and wearing appropriate protective equipment on heads and legs. Approximately 50% wore sunscreen. More trained first-aid assistance should be provided for umpires, and education for umpires should encompass fluid intake.

6. Conclusion

This study provided important baseline data on participation and injury rates in South Australian amateur sports players. On the basis of the current data, sport-specific recommendations can be made on:

- appropriate use of protective equipment
- implementation of safe sport strategies such as fluid intake and court/field-side assistance for injury management
- strategies to reduce injury rates, such as monitoring hours of participation, and warm up procedures
- expected injury prevalence gathered in a short-time-frame cross-sectional study
- estimated injury incidence over a season.

Lessons were learnt about the logistics of running a large scale study which relied heavily on volunteer involvement. Improvements could be made therefore to data collection procedures, to improve compliance rates in future data collection exercises.

Prevalence studies such as this need to be repeated at the same time of the

year every two to three years, in order to monitor participation and injury rates and the effectiveness of injury prevention strategies. Moreover, longitudinal studies are required to further investigate those sports which appear to have a higher than acceptable risk of injury over a season. Research should be commissioned so that effective and safe sport-specific stretches can be further investigated prior to implementation. Comprehensive sport-specific education packages should be prepared to advise on:

- sport-specific upper and lower limb stretches, warm up and cool-down activities, taking account of the nature of venues and the type of surface being played on
- warning signs for over-use and fatigue, and for under- preparation
- protective equipment for at-risk body parts
- appropriate court-side and self-administered sports first aid procedures that can be implemented by untrained people.

7. Recommendations for further action

7.1 Education

7.1.1 Protective equipment

Wearing protective equipment is generally aimed at preventing damage from contact injuries. Some protective equipment is also worn with the aim of minimising damage from non-contact injuries, such as strapping ankles for ankle strains. The latter aim has varying support from evidence-based literature, and therefore this section addresses protective equipment for contact injuries only.

Based on the findings of this project, education on wearing protective equipment for contact injuries need not be provided to players in all seventeen areas (sports, plus umpiring). Each sport contains specific risk of injury pertaining to the physical demands of the sport and the opportunities for contact injuries. It would be appropriate at this stage to involve administrators, coaches and players of each sport in defining the specific nature of the activities involved in the sport, and in matching these with the location, nature and prevalence of contact injuries reported in this study. Appropriate use of protective equipment could then be reviewed in light of sport-specific opportunities for contact injuries, the cost of such injuries, the number and severity of injuries reported in this study and the costs entailed in mounting wide-scale education campaigns. As an example, it may not be cost effective to educate lawn bowlers on the use of mouthguards, but it may be most effective to educate lacrosse players on their use.

7.1.2 Sunscreen and hats

No outdoor sport which was played mainly during the daylight hours reported total compliance with players wearing appropriate sun protection. In view of the known risks of skin cancer, education into appropriate sun protection for all sport players would be appropriate and potentially cost effective. In order to

develop appropriate campaigns however, players and coaches should be approached to determine sport-specific barriers to using appropriate sun protection. Available types of hats and sunscreens need to be coupled with the demands of the sport to ensure that players' needs are catered for.

Manufacturers could be approached to develop hats and sunscreens for specific sports, if they could be guaranteed a market.

7.1.3 Warm up activities and other risks

Based on the findings of this project, education on warm up activities, age-related risks and risks associated with under- or over-use need to be provided to players in all sixteen sports, plus umpiring. Further longitudinal study should aim to identify other risks such as team position and playing surface. As for the use of protective equipment, these risks need to be evaluated in light of the physical demands of the sport. Again, administrators, coaches and players of each sport need to be involved in matching injury information with the nature of each sport, and the risks associated with the sport. Specific education strategies can then be targeted to at-risk groups of players.

This project particularly identified the need to fund research into the relationship between warm up activities and injuries. While most players reported participating in warm up activities of some sort, there appeared to be a high risk of injury associated with such behaviour. Reporting of warm up activities by players may have been inflated, in that injured players may have wanted to be seen to be undertaking appropriate behaviour. However, it may also indicate that warm up activities are

being practised incorrectly (stressing structures that then become injured during participation) or that incorrect information on warm up activities is being given to players in particular sports.

7.1.4 Fluid Intake

In no sport did all players consume appropriate fluids before, during and after activity. The cost of education on appropriate fluid intake would be effective, if only one player in each sport was prevented from sustaining serious dehydration problems. Identifying ways in which players could rehydrate while participating is required for those sports which reported high rates of non-participation in fluid intake during sport. This may involve rule changes to encourage compulsory fluid stops, or the development of drinking equipment which could be used while the player is on the move.

Drinking alcohol after the game is a strong Australian tradition, which is widely reported through various media. The benefits of drinking non-dehydrating fluids after the game therefore need to be promoted in association with other alcohol education campaigns, such as those which address drink driving.

7.2 Promotion of Safe Sports to Non-Sport Participants

7.2.1 Promoting low risk sports

Campaigns aiming to promote healthy lifestyles to individuals not currently participating in any sport, could highlight low risk of injury sports such as badminton, leagueball, lawn bowls, netball and orienteering. In this data set, badminton, lawn bowls and orienteering were played by men and women in relatively equal proportions, thus supporting their appropriateness for all non-active individuals. Moreover, netball and leagueball were played primarily by women in this data set, therefore lending

themselves to gender-specific health promotion activities.

7.2.2 Sports trainer or trained sports first-aid assistance

A number of sports did not have trained sports first-aid support for court/field-side injuries. An assumption from this could be that the management of injuries by untrained personnel may be inappropriate, and may therefore lead to a longer rehabilitation time than necessary. However, while poor injury management was noted in about one-third of the sports in this survey, in other sports, players, friends and family who provided early assistance to injuries appeared to be aware of correct injury management. Compared with the cost of placing a sports trainer at each venue for each game, it may be more efficient to train all players, and interested friends and family, about correct injury management. This would ensure that more individuals have an accurate basic knowledge of sports injury management, and therefore can recognise the need to seek further assistance from medical personnel.

This is particularly important when one considers the number of injuries which players reported as being minor (that is, they returned to playing immediately after injury). Some of these injuries may in fact have been severe, and the players' desire to return to play was not tempered by authoritative sports first-aid opinion. These players may not have returned to play, had the injury had been assessed by someone with formal sport first-aid training. More wide-spread knowledge of injury, warning signs of severe or incipient injury and immediate injury management may help to balance players' desire to continue playing, and thus prevent longer-term problems.

7.3 Areas for Further Research

This study highlighted a number of areas for further research. It also confirmed the importance of collecting

participation and injury information from players themselves, as the players were able to provide information that would not be available from other sources, such as medical records.

1. This study provided baseline information on the use of play-safe sport strategies, such as wearing protective equipment, warming up prior to participation and consuming appropriate fluids. Particular sports with general at-risk behaviour can now benefit from specific campaigns to modify behaviour, and changes in behaviour can be monitored by short-term data collection (such as repetitions of this study) every 12-18 months. However, not all sports need repetitions of such data collection. Low risk sports which do not attract health promotion campaigns do not need repeated data collection unless there are reasons to suspect behavioural changes. Special consideration may be given to the differing injury patterns in higher versus junior or social grades in various sports.
2. For high risk sports, data collection over an entire season would provide prevalence as well as incidence rates of injury, together with clearer information on injury causation. Season-long data collection would need to be undertaken with full association and club support and would need to ensure higher rates of compliance. Standard data items would need to be determined with the assistance of the association, coaches and players, as common data definitions are essential when data are collected over a period of time by multiple personnel.
3. The cost of injuries could be investigated, with data being sought from all players with, for

instance, sprained ankles. While the logistics of such an exercise would be difficult, it would provide information on the range of costs of medical treatment, the costs of time lost from work/normal duties, medications and opportunity cost associated with the injury.

4. The apparent association between specific warmup activities and injury is of concern. It suggests that either currently recommended warm up mechanisms, such as specific stretches, are causal agents of injury, or that the players are not warming up as recommended.

Two studies are therefore suggested:

- assessment by an independent trained sports-scientist of stretching routines currently being undertaken by sports players, for comparison with currently recommended stretching routines, in order to identify error in technique and/or understanding
 - a laboratory study undertaken to test the performance of muscle under different conditions (no warmup, specific warmup, general warm up, fatigue).
5. Sport-specific areas for study were highlighted, and these need to be developed from the sport-specific reports in this document. For instance, the high number of swimming injuries outside the pool, which occurred to younger players who were involved in heavy training, suggest that fatigue may be affecting judgement on body awareness, position in space and proprioception. The nature and mechanisms of injury for young

competitive swimmers therefore require closer investigation, possibly on a case-by-case basis. Moreover, the higher rate of netball injuries to older players suggests that grade of competition, court space, body awareness and rules may be related

to injury. Team-by-team data collection is recommended on factors such as player volume and reach, the physical requirements and court space required per player position and the biomechanical requirement of specific positions.

Appendix 1.

