Epidemiology of basketball and netball injuries that resulted in hospital admission in Australia, 2000–2004

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ABSTRACT

Objective: To characterise injuries sustained in basketball and netball that result in hospital admission and to compare the profiles of injury between the two sports.

Design and setting: Population-based retrospective descriptive epidemiological study using data from the National Hospital Morbidity Database, July 2000 to June 2004.

Participants: Patients discharged from a public or private hospital with basketball or netball codes as the "activity when injured".

Results: There were 5090 basketball-related hospital admissions (mean patient age, 22.2 [SD, 10.7] years; 71.5% male) and 4596 netball-related admissions (mean patient age, 26.3 [SD, 10.9] years; 88.9% female). Fractures were the most common injury (46.8% [2384] of basketball-related and 29.5% [1358] of netball-related admissions), with the forearm and hand or wrist the most common fracture sites. The participant-based forearm fracture hospitalisation rate (5 + years age group) peaked in the 5–14-years age group. Anterior cruciate ligament rupture was the most common diagnosis, accounting for 760 (16.5%) netball-related admissions (mean [SD] age, 26.7 [8.4] years) and 354 (7.0%) basketball-related admissions (mean age, 25.5 [7.9] years). Achilles tendon injury accounted for 732 (15.9%) netball-related admissions (mean age, 35.2 [7.5] years) and 381 (7.5%) basketball-related admissions (mean age, 35.8 [7.8] years).

Conclusions: The high rates of anterior cruciate ligament rupture and Achilles tendon injury resulting in hospital admission and their long-term consequences impact extensively on the individual and the community. The common injuries sustained in basketball and netball were strongly age-related.

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Basketball and netball are played by more than 450 and 20 million people, respectively, worldwide, and by more than 1.8 million and 1.3 million in Australia.[1,2] Many studies of basketball injuries have been published, but few of netball injuries, and most epidemiological studies are of school,[3,4] college,[5,6] or professional players.[7] To our knowledge, no population-based studies have been published of hospital admissions for basketball- or netball-specific injuries, representing the more severe end of the spectrum.

We report a retrospective population-based descriptive epidemiological study of basketball- and netball-related hospital admissions in Australia between 2000 and 2004. An analysis of data for the year July 2002 to June 2003 has been published previously.[8,9]

METHODS

Data source

We obtained data on basketball- and netball-related hospital admissions from the National Hospital Morbidity Database. This database is compiled by the Australian Institute of Health and Welfare and records inpatient episodes at all public and almost all private hospitals in Australia (between 1 July 2000 and 30 June 2004, 1.8%–4.6% of private hospital episodes were omitted[10]). It excludes military, correctional facility and offshore territory hospitals. Cases are coded using the International Classification of Diseases, 10th revision, Australian modification (ICD-10-AM).[11,12] All injury cases are coded for the activity during which the injury occurred.

We included all episodes that ended between 1 July 2000 and 30 June 2004 and included a basketball or netball activity code in any field. We analysed the first recorded diagnosis. As the records represented hospitalisation episodes rather than cases, we excluded episodes that began with transfer from another acute hospital to reduce multiple counting of cases.

Data analysis

Participation-based rates of injury were calculated using denominators from Australian Bureau of Statistics data for the 5–14 years age group,[13] and from the annual *Participation in exercise, recreation and sport* reports for the 15–54 years age group. These reports exclude children under 15 years and present sex and age groups separately.[14-17] Rates for the 55-years-and-over age group are not shown separately because of the large standard error in participation data.[14-17]

Data were analysed with the computer programs SPSS, version 14.0 (SPSS Inc, Chicago, Ill, USA), Stata, version 9.2 (StataCorp, College Station, Tex, USA) and Excel 2003 (Microsoft, Redmond, Wash, USA). We used two-sample t tests with equal variances to compare mean ages, and χ^2 tests to compare rates and proportions of cases in specific groups. Significance was set at 5%.

RESULTS

Over the 4 years, there were 5090 basketball-related hospital admissions (mean patient age, 22.2 years [SD, 10.7 years]; 71.5% male) and 4596 netball-related hospital admissions (mean patient age, 26.3 years [SD, 10.9 years]; 88.9% female). Another 244 admissions began with transfer from another acute hospital and were excluded. Fewer than 15 admissions were of children aged under 5 years (10 for basketball-related injury and less than five for netball-related injury).

In comparison, 60.5% of basketballers in Australia (in the 5 + years age group) are male, and 90.7% of netballers are female, while 26.5% of basketballers and 34.6% of netballers are aged 25 years or older.[13-17]

The average annual hospitalisation rate (5 + years) was 1.7 per 1000 participants for basketball and 1.4 per 1000 for netball. There were statistically significant differences in patient mean age between basketball and netball participants for many diagnoses and regions of the body injured, but the absolute differences in age were mostly too small for clinical significance.

Fracture was the most common principal diagnosis for both sports, most markedly for basketball (Box 1), and forearm fractures were the most common type. The average annual rate of hospital admission for forearm fracture (5 + years) was highest in the

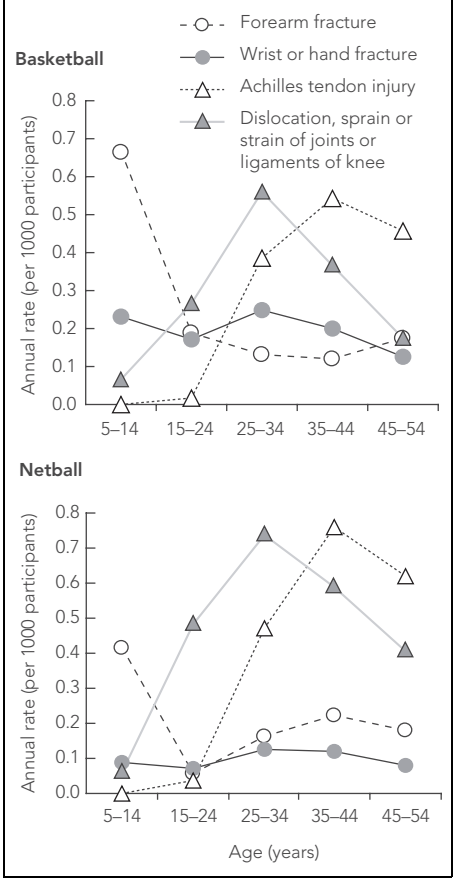
1 Category of principal diagnosis for basketball- and netball-related hospital admissions, by patient sex and mean age at admission, July 2000 – June 2004

	Basketball			Netball		
	Hospitalisations (%)		Mean age (SD)	Hospitalisations (%)		Mean age (SD)
Principal diagnosis	Males	Females	(years)	Males	Females	(years)
Fracture*	1799 (49.4%)	585 (40.3%)	19.3 (9.9)	129 (25.2%)	1229 (30.1%)	22.3 (12.0)
Dislocation	395 (10.9%)	146 (10.1%)	23.2 (9.5)	63 (12.3%)	403 (9.9%)	26.2 (10.2)
Sprain and strain*	386 (10.6%)	281 (19.4%)	25.1 (8.5)	114 (22.3%)	1163 (28.5%)	26.4 (8.6)
Muscle and tendon injury*	364 (10.0%)	106 (7.3%)	34.6 (9.0)	144 (28.1%)	651 (15.9%)	34.7 (8.1)
Other injury†	236 (6.5%)	114 (7.9%)	19.0 (9.4)	25 (4.9%)	231 (5.7%)	23.0 (9.1)
No injury	178 (4.9%)	111 (7.6%)	25.0 (12.6)	20 (3.9%)	236 (5.8%)	28.3 (10.8)
Intracranial injury*	117 (3.2%)	73 (5.0%)	16.6 (8.3)	5 (1.0%)	100 (2.4%)	20.7 (10.3)
Open wound*	99 (2.7%)	9 (0.6%)	21.0 (9.4)	7 (1.4%)	34 (0.8%)	26.9 (13.4)
Superficial injury*	65 (1.8%)	26 (1.8%)	22.4 (9.2)	5 (1.0%)	37 (0.9%)	21.4 (9.3)
Total	3639 (100%)	1451 (100%)	22.2 (10.7)	512 (100%)	4084 (100%)	26.3 (10.9)

* $P < 0.001$ for comparison of the proportion of basketball-related hospital admissions v netball-related hospital admissions attributed to the specific diagnosis.
† Includes superficial and open wounds of the eye. ◆

5–14-years age group, at 0.7 per 1000 participants for basketball and 0.4 per 1000 participants for netball (Box 2).

2 Crude average annual rate of hospital admissions, by patient age at admission



The most common region of the body injured was the knee or leg (Box 3), with anterior cruciate ligament (ACL) rupture the most common diagnosis (Box 4) (the ICD-10-AM code does not differentiate complete and partial rupture[11,12]). Most admissions for ACL rupture were elective (97.2% for basketball and 98.0% for netball), and more than 70% were to private hospitals. The average annual participant-based rate of hospital admission for ACL rupture (15+ years age group) was 1.3 times higher for females than males for basketball ($P < 0.05$) and 1.5 times higher for netball ($P < 0.01$). The rate (5+ years age group) was highest in the 25–34-years age group, at 0.3 per 1000 participants for basketball and 0.4 per 1000 for netball.

Achilles tendon injury was the second most common diagnosis (the ICD-10-AM combines Achilles tendon rupture and injury[11,12]). Hospital admissions were elective for 47.0% of basketballers with Achilles tendon injury and for 43.3% of netballers; more than 60% were to public hospitals. The annual average participant-based rate of hospital admission for Achilles tendon injury (15+ years) was 2.2 times higher for males than females for basketball, and 1.7 times higher for netball (both $P < 0.001$).

DISCUSSION

To our knowledge, this is the first study to focus on hospital admissions for basketball and netball injuries, and it reports a different profile of injury from that found in non-hospital-based studies. We found fractures were the most common injury leading to hospital admission, and that the knee or leg was the most commonly injured region of the body. In contrast, ligament sprain or tear was reported as the most common injury in non-professional Western Australian basketball (68.3%) and netball (61.2%) teams,[18] and the ankle was reported as the most commonly injured region of the body in many studies.[3,4,7,18] A study of female high school basketballers found ankle injury was more common, but knee injury was more severe.[3]

We found a higher proportion of knee and leg injuries in female patients than in males. ACL rupture was more prominent in netballers than in basketballers ($P < 0.001$). The participant-based rate of hospital admission for ACL rupture was significantly higher in females than in males for both sports, with ACL rupture accounting for 11% of hospital admissions in female basketballers and 17% in female netballers.

Many other studies have found that knee injury and ACL injury are more common in females. Exposure-based knee injury risk was 2.3 times higher in girls than in boys in a study of Texas high-school basketballers,[4] and relative risk of ACL injury was 5.4 times higher in female than male intercollegiate basketballers at the United States Naval Academy.[5] Indeed, ACL injury accounted for 8% of game injury in women's collegiate basketball in the US.[6]

Little has been published on ACL injury and age. The mean age of female basketballers with ACL injury at a university sports medicine clinic was 17 years (95% CI, 14–20 years).[19] We found the mean age of

3 Principal body region injured in basketball- and netball-related hospital admissions, by patient sex and mean age at admission, July 2000 – June 2004

Principal body region injured	Basketball			Netball		
	Hospitalisations (%)		Mean age (SD) (years)	Hospitalisations (%)		Mean age (SD) (years)
	Males	Females		Males	Females	
Knee or leg*	833 (22.9%)	415 (28.6%)	24.0 (9.3)	171 (33.4%)	1529 (37.4%)	26.8 (9.1)
Elbow or forearm*	709 (19.5%)	253 (17.4%)	16.4 (9.1)	47 (9.2%)	688 (16.8%)	20.1 (12.4)
Wrist or hand*	598 (16.4%)	215 (14.8%)	21.9 (10.5)	45 (8.8%)	367 (9.0%)	24.6 (11.0)
Head*	485 (13.3%)	192 (13.2%)	19.5 (9.0)	21 (4.1%)	244 (6.0%)	21.6 (9.7)
Ankle or foot*†	464 (12.8%)	135 (9.3%)	30.8 (10.2)	166 (32.4%)	788 (19.3%)	32.7 (9.2)
Shoulder or arm*	180 (4.9%)	32 (2.2%)	20.5 (9.3)	21 (4.1%)	81 (2.0%)	22.7 (9.4)
Trunk‡	87 (2.4%)	37 (2.5%)	23.6 (11.7)	13 (2.5%)	66 (1.6%)	25.3 (10.3)
Hip or thigh*	59 (1.6%)	14 (1.0%)	21.4 (11.4)	—	21 (0.5%)	25.5 (17.0)
Neck	26 (0.7%)	35 (2.4%)	18.0 (7.4)	—	37 (0.9%)	23.4 (10.8)
Other	198 (5.4%)	123 (8.5%)	24.5 (12.4)	22 (4.3%)	263 (6.4%)	27.8 (10.6)
Total	3639 (100%)	1451 (100%)	22.2 (10.7)	512 (100%)	4084 (100%)	26.3 (10.9)

— = count less than 5. * $P < 0.001$ for comparison of the proportion of basketball-related hospital admissions v netball-related hospital admissions attributed to injury at the specific body site. † Includes Achilles tendon injury. ‡ $P < 0.05$ for above comparison. ◆

players admitted to hospital for ACL rupture was 25.5 years (SD, 7.9 years) for basketballers, and 26.7 years (SD, 8.4 years) for netballers.

Sports-related Achilles tendon rupture peaks in the fourth decade.[20] We found the mean age at hospital admission for Achilles tendon injury was 35 years. Degenerative change is usually present in complete rupture,[20] and most ruptures occur 2–6 cm above the calcaneus, where the blood supply is lowest, and flow decreases with age.[21] This does not explain why the hospitalisation rate per participant peaks in the fourth decade.

Our study has limitations. As it reports only injury resulting in hospital admission, it includes a minority of basketball and netball injuries; indeed, the Latrobe Valley study found the rate of sports-related hospital admissions was one per 10 casualty presentations and one per 12 general practice consul-

4 Principal diagnosis for basketball- and netball-related hospital admissions, by patient sex and mean age at admission, July 2000 – June 2004

Principal diagnosis	Basketball			Netball		
	Hospitalisations (%)		Mean age (SD) (years)	Hospitalisations (%)		Mean age (SD) (years)
	Males	Females		Males	Females	
Fracture of forearm*	677 (18.6%)	247 (17.0%)	16.3 (9.1)	42 (8.2%)	657 (16.1%)	19.7 (12.3)
Dislocation, sprain or strain of joints or ligaments of knee*	451 (12.4%)	318 (21.9%)	25.0 (8.6)	126 (24.6%)	1299 (31.8%)	26.7 (8.8)
Rupture of anterior cruciate ligament*	194 (5.3%)	160 (11.0%)	25.5 (7.9)	59 (11.5%)	701 (17.2%)	26.7 (8.4)
Tear of meniscus, current†	101 (2.8%)	59 (4.1%)	26.1 (10.2)	19 (3.7%)	185 (4.5%)	28.4 (9.9)
Injury to multiple structures of the knee*	40 (1.1%)	30 (2.1%)	25.8 (8.4)	18 (3.5%)	178 (4.4%)	27.1 (8.2)
Fracture at wrist or hand level*	446 (12.3%)	159 (11.0%)	21.0 (10.0)	26 (5.1%)	289 (7.1%)	24.0 (10.9)
Fracture of leg or ankle*	322 (8.8%)	84 (5.8%)	21.9 (10.0)	39 (7.6%)	165 (4.0%)	27.0 (10.9)
Injury of muscles or tendons at leg level*	320 (8.8%)	86 (5.9%)	35.5 (7.9)	140 (27.3%)	611 (15.0%)	35.1 (7.6)
Injury of Achilles tendon*	297 (8.2%)	84 (5.8%)	35.8 (7.8)	136 (26.6%)	596 (14.6%)	35.2 (7.5)
Fracture of skull or facial bones*	196 (5.4%)	66 (4.5%)	22.3 (9.0)	7 (1.4%)	45 (1.1%)	23.4 (7.8)
Fracture of nasal bones*	144 (4.0%)	54 (3.7%)	21.7 (8.4)	6 (1.2%)	36 (0.9%)	23.8 (8.0)
Intracranial injury*	117 (3.2%)	73 (5.0%)	16.6 (8.3)	5 (1.0%)	100 (2.4%)	20.7 (10.3)
Dislocation, sprain or strain of joints or ligaments at ankle or foot level†	80 (2.2%)	32 (2.2%)	22.7 (7.2)	16 (3.1%)	117 (2.9%)	23.3 (8.5)
Other principal diagnosis*	1030 (28.3%)	386 (26.6%)	22.0 (10.8)	111 (21.7%)	801 (19.6%)	25.6 (11.0)
Total	3639 (100%)	1451 (100%)	22.2 (10.7)	512 (100%)	4084 (100%)	26.3 (10.9)

* $P < 0.001$ for comparison of the proportion of basketball-related hospitalisations v netball-related hospitalisations attributed to the specific diagnosis: † $P < 0.05$ for above comparison. ◆

tations.[22] Denominator data were limited, with exposure time not available with age data; or age and sex available separately. Hence, the statistical testing relied heavily on comparing proportions. The National Hospital Morbidity Database excludes some hospitalisations. One injury may result in multiple hospitalisations and, without linkage of data, this number is unknown.

ACL rupture and Achilles tendon injury accounted for many hospital admissions. These injuries cause individual burden (pain, inconvenience and time off work) and significant cost to society, through direct (eg, hospital) and indirect costs (eg, loss of income). Estimated Australian direct hospital costs between 1 July 2002 and 31 June 2003 for basketball and netball were $2.7 million and $2.4 million, respectively.[8] ACL rupture and Achilles tendon injury also have long-term complications. Most people with ACL rupture have radiographic features of knee osteoarthritis at 10–15 year follow-up.[23] Achilles tendon ruptures may re-rupture: 12.1% if managed conservatively, and 2.2% if surgically treated.[24]

We found that forearm fractures occurred in childhood, ACL rupture in the third decade, and Achilles tendon injury in the fourth decade. The reasons for the strong relationship between age and injury type are likely to be multifactorial. Different styles of play at different ages might predispose to different injuries; older players are more likely to have previous injuries that affect play. Different age groups may use different court surfaces or equipment, which may influence injury types and rates. Injury in an older person might be more likely to result in hospital admission than the same injury in a younger player. However, the relatively constant rate of hospital admissions for hand and wrist fractures per participant suggests that hospitalisation is affected more by the nature of injury than by age. It is likely that propensity to different injuries varies with age.

Basketball and netball are played extensively, so even small reductions in the rate per participant of ACL rupture and Achilles tendon injury would significantly affect the burden of injury and its consequences. Meta-analysis has shown neuromuscular training decreases ACL injury in females.[25] Further research and implementation of policies to reduce these injuries is required.

Public policy increasingly focuses on obesity and chronic diseases. Playing sport in childhood and continuing in adulthood is promoted for health and obesity prevention. Playing sport has costs in terms of injury and its long-term consequences. Policymakers must aim to minimise the costs of sport by preventing injury.

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COMPETING INTERESTS

None identified.

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