Acute injuries in soccer, ice hockey, volleyball, basketball, judo, and karate: analysis of national registry data

Urho M Kujala, Simo Taimela, Ilkka Antti-Poika, Sakari Orava, Risto Tuominen, Pertti Myllynen

Abstract

***Objective*—To determine the acute injury profile in each of six sports and compare the injury rates between the sports.**

***Design*—Analysis of national sports injury insurance registry data.**

***Setting*—Finland during 1987-91.**

***Subjects*—621 691 person years of exposure among participants in soccer, ice hockey, volleyball, basketball, judo, or karate.**

***Main outcome measures*—Acute sports injuries requiring medical treatment and reported to the insurance company on structured forms by the patients and their doctors.**

***Results*—54 186 sports injuries were recorded. Injury rates were low in athletes aged under 15, while 20-24 year olds had the highest rates. Differences in injury rates between the sports were minor in this adult age group. Overall injury rates were higher in sports entailing more frequent and powerful body contact. Each sport had a specific injury profile. Fractures and dental injuries were most common in ice hockey and karate and least frequent in volleyball. Knee injuries were the most common cause of permanent disability.**

***Conclusions*—Based on the defined injury profiles in the different sports it is recommended that sports specific preventive measures should be employed to decrease the number of violent contacts between athletes, including improved game rules supported by careful refereeing. To prevent dental injuries the wearing of mouth guards should be encouraged, especially in ice hockey, karate, and basketball.**

Unit for Sports and Exercise Medicine, Institute of Biomedicine, University of Helsinki, Töölö Sports Hall, Mannerheimintie 17, FIN-00250 Helsinki, Finland
Urho M Kujala, *chief physician*
Simo Taimela, *research assistant*
Ilkka Antti-Poika, *consultant orthopaedic surgeon*
Sakari Orava, *consultant orthopaedic surgeon*

Department of Public Health, University of Helsinki, FIN-00290, Helsinki
Risto Tuominen, *senior researcher*

Department of Orthopaedics and Traumatology, Helsinki University Central Hospital, FIN-00260 Helsinki
Pertti Myllynen, *senior lecturer in orthopaedics and traumatology*

Correspondence to:
Dr Kujala.

BMJ 1995;311:1465-8

Introduction

The growing popularity of sports and exercise is focusing attention on the injuries that may occur in addition to the health benefits.[1-6] Treating sports injuries may be expensive, so preventive strategies and measures are required on economic as well as medical grounds.[7-9] Several epidemiological surveys have outlined the frequency and types of injuries in various sports, but study comparisons are complicated by the different injury criteria used as well as by inconsistency in data collection and recording.[10] The risk of acute injury varies enormously. Most endurance sports are extremely safe, whereas formula 1 car racing killed 69 of a small group of drivers between 1950 and 1994. Injury rates in popular team games such as soccer, volleyball, basketball, and ice hockey lie between these extremes.[11] Martial arts such as judo and karate are also becoming popular, and the associated risks may be greater than in most team games.[11 12] Though endurance sports may cause the highest rates of stress injury, these rarely result in permanent disability.

Before embarking on a programme to prevent sports injuries we must first define the extent of the problem and identify the mechanisms and factors involved. Then we must introduce measures likely to reduce the risks and monitor their effects. Research shows that strategies to prevent sports injuries may be useful and that most interventions effective enough to measurably alter injury profiles in various sports entail changing rules or improving equipment.[5 13 14] In soccer, safety interventions and improved treatment of injuries and rehabilitation may prevent future injury.[15 16]

We analysed the types and severity of acute injuries in some common team games (soccer, ice hockey, volleyball, basketball) as well as in judo and karate and compared the apparent injury risks between these sports. This information is crucial for prioritising measures in sports injury prevention.

Subjects and methods

From 1987 to 1991 anyone in Finland intending to compete in soccer, ice hockey, volleyball, basketball, judo, or karate was obliged to obtain a licence from the appropriate sports association. During the study period all licences issued to soccer and ice hockey players as well as those issued to judo and karate competitors were linked to an insurance policy from a single company (Pohjola Insurance Company Ltd) covering acute onset sports injuries. Among basketball players the insurance was not compulsory. For volleyball players the insurance was compulsory from 1987 to 1990 but not during 1991. However, about two thirds of basketball and volleyball players had the insurance linked to their sports licence even when it was not compulsory. This study is therefore based on 621 691 person years of exposure among athletes with a sports licence linked to insurance (see table 1). Exact data on age and sex of the insured athletes at the beginning of each person year of exposure were available for 1990 and 1991 in all the sports except basketball. Thus the analysis of injury rates by age and sex was limited to five sports and two years (23 363 injuries during 250 291 person years of exposure; see table 2).

The injury criteria remained similar throughout. The sports insurance covered all traumatic acute injuries during competitions and training. The injury criteria also included all injuries of sudden onset, such as those that usually have no clear external accidental cause—for example, muscular strains.

The insurance company paid the medical costs of treatment after the injured athlete completed the injury report and the treating physician the medical accident report. Data on each injury, based on the two reports, were entered into a computer database by means of a structured format. Before paying the

Table 1—*Person years of exposure, numbers of injuries, and injury rate in six sports in Finland (sports insurance data 1987-91)*

Sport	Person years of exposure	No of injuries	Injury rate (95% confidence interval)†
Soccer	296 646	26 330	89 (88 to 90)
Ice hockey	179 798	16 836	94 (92 to 95)
Volleyball	87 668	5 235	60 (58 to 61)
Basketball	39 541	3 472	88 (85 to 91)
Judo	9 936	1 163	117 (111 to 123)
Karate	8 102	1 150	142 (134 to 150)

†Injuries per 1000 person years of exposure.

Table 2—*Injuries per person years of exposure and injury rates (plus 95% confidence intervals) by age and sex in soccer, ice hockey, volleyball, judo, and karate among competitive athletes in Finland in 1990 and 1991*

Sport	No of injuries/years of exposure [injury rate† (95% confidence interval)]				
	Age <15	Age 15-19	Age 20-24	Age 25-34	Age >34
Soccer	1 591/63 591 [25 (24 to 26)]	2 474/26 698 [93 (89 to 96)]	2 837/11 162 [254 (246 to 262)]	4 344/22 553 [193 (187 to 198)]	766/11 946 [64 (60 to 69)]
Males	1 273/56 623 [23 (21 to 24)]	2 065/21 788 [95 (91 to 99)]	2 602/9 830 [265 (256 to 273)]	4 183/21 464 [195 (190 to 200)]	761/11 768 [65 (60 to 69)]
Females	318/6 968 [46 (41 to 51)]	409/4 910 [83 (76 to 91)]	235/1 332 [176 (156 to 197)]	161/1 089 [148 (127 to 169)]	5/178 [28 (9 to 64)]
Ice hockey	1 202/33 393 [36 (34 to 38)]	2 875/19 688 [146 (141 to 151)]	1 829/7 048 [260 (249 to 270)]	1 705/8 576 [199 (190 to 207)]	235/6 727 [35 (31 to 39)]
Males	1 186/32 958 [36 (34 to 38)]	2 823/19 027 [148 (143 to 153)]	1 796/6 759 [266 (255 to 276)]	1 685/8 262 [204 (195 to 213)]	231/6 576 [35 (31 to 40)]
Females	16/435 [37 (21 to 59)]	52/661 [79 (59 to 102)]	33/289 [114 (78 to 151)]	20/314 [64 (39 to 97)]	4/151 [27 (7 to 67)]
Volleyball	94/8 202 [12 (9 to 14)]	391/7 688 [51 (46 to 56)]	593/2 753 [215 (200 to 231)]	1 154/7 962 [145 (137 to 153)]	364/5 171 [70 (63 to 77)]
Males	25/3 838 [6 (4 to 10)]	185/3 571 [52 (45 to 60)]	345/1 461 [236 (214 to 258)]	815/5 255 [155 (145 to 165)]	254/3 816 [67 (59 to 75)]
Females	69/4 364 [16 (12 to 20)]	206/4 117 [50 (43 to 57)]	248/1 292 [192 (170 to 213)]	339/2 707 [125 (113 to 138)]	110/1 355 [81 (67 to 97)]
Judo	34/1 142 [30 (21 to 41)]	154/1 524 [101 (86 to 116)]	128/601 [213 (180 to 246)]	108/684 [158 (131 to 185)]	25/289 [88 (58 to 128)]
Males	21/969 [22 (14 to 33)]	111/1 228 [90 (75 to 108)]	95/436 [218 (179 to 257)]	81/496 [163 (131 to 196)]	22/260 [85 (54 to 125)]
Females	13/173 [75 (41 to 125)]	43/296 [145 (105 to 185)]	33/165 [200 (139 to 261)]	27/188 [144 (94 to 194)]	3/29 [103 (22 to 273)]
Karate	11/352 [31 (16 to 55)]	91/896 [102 (82 to 121)]	141/572 [247 (211 to 282)]	185/885 [209 (182 to 236)]	32/188 [170 (116 to 224)]
Males	9/304 [30 (14 to 56)]	63/664 [95 (74 to 120)]	123/417 [295 (251 to 339)]	148/710 [208 (179 to 238)]	27/158 [171 (112 to 230)]
Females	2/48 [42 (5 to 143)]	28/232 [121 (79 to 163)]	18/155 [116 (66 to 167)]	37/175 [211 (151 to 272)]	5/30 [167 (57 to 347)]

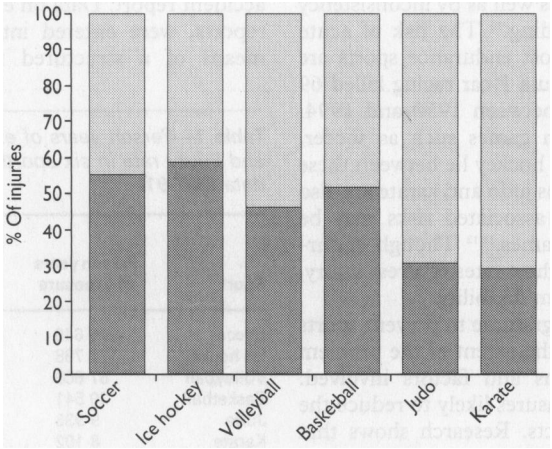
†Injuries per 1000 person years of exposure.

medical costs the insurance company checked the two reports for agreement. In cases of disagreement or incomplete information the insurance company sought clarification. This increased the validity of the data. The structured format of each injury report included age at the time of injury, type of sports event, circumstance of injury (training or competition), type of injury and mechanism, and injured body part. Data on payments made as death benefits or permanent disability benefits after sports injuries were also recorded. The insurance company and the sports associations consented to our using the data (without personal identification codes).

Statistical analyses—For each sport we calculated injury rates per 1000 person years of exposure (plus 95% confidence intervals) by age and sex as well as by types of injuries, anatomical locations of the injuries, and circumstances of the injuries.

Results

A total of 54 186 acute sports injuries (48 256 in males, 5930 in females) were recorded during the five years of the study. Karate and judo had the highest injury rates, followed by ice hockey, soccer, and basketball. Volleyball had the lowest injury rate (table 1). In the team games 46-59% of the injuries occurred during competitions, whereas in judo and karate around 70% occurred in training (figure). From the data for 1990 and 1991 the injury rates were clearly highest among 20-24 year old athletes (table 2). Sex differences in injury rates were less obvious, though among 20-24 year olds men had a higher injury rate than women in each sport.



Proportions of injuries occurring in competitions (dark areas) and training sessions (light areas) in different sports

Most injuries were to the lower limbs in soccer (66·8%), volleyball (57·4%), and basketball (56·0%), whereas upper limb injuries were most common in judo (37·6%). Sites other than limbs, including the teeth, were injured most often in karate and ice hockey (table 3). Sprains, strains, and bruises were the most common types of injury (table 4). Non-dental fractures accounted for 4·0-10·8% of injuries overall, occurring most often in karate, judo, and ice hockey and least often in volleyball (table 4). Dislocations were proportionally more frequent in judo and karate (table 4).

No death benefit for an accidental sports injury was awarded during the study. There was one neck fracture in an ice hockey player leading to tetraplegia. Benefit in respect of various degrees of permanent disability (that is, at least 5% disability) was awarded in 102 cases. Fifty nine of these occurred in soccer (0·22% of all soccer injuries), 24 in ice hockey (0·14%), 11 in volleyball (0·21%), four in basketball (0·11%), two in judo (0·17%), and two in karate (0·17%); 92 occurred in males and 68 during competitions. The most common injury was a sprain or strain (66 cases), while 16 injuries were fractures. The knee was the most common location for injuries resulting in permanent disability (64 cases).

Discussion

We have defined the acute injury profiles in six sports on the basis of 54 186 injuries examined by physicians and reported to a national sports insurance company. However, not all treated injuries are reported to the insurance company and many minor injuries that are self treated also go unreported. Thus our data underestimate the true injury rates in each sport.

The overall sex difference in injury risk was small but the age difference was clear. Athletes aged 20-24 years had the highest risk, probably because training and competition are most intense at this age. We did not have records on exact hours of exposure and so could not calculate the exact injury risk per hour of training or competition. Our findings agree with earlier reports that injuries in young team players are less frequent than in adults.[17-19] In judo the reason for the unexpectedly high injury rate among young girls was probably that as a minority group in many clubs

they often have to train with boys and men. In adult team games entailing various types of bodily contact between athletes men probably train more but tend to have a rougher style than women. This also may partly explain the sex difference in injury risk.

Athletes usually spend far more time training than competing. About half of the injuries to team game athletes occurred in competitions. Hence competitions plainly entail a higher risk of injury per hour than training.

When the analysis of injury rates was restricted to 20-24 year old athletes only small differences were found between sports. The overall injury risk was lowest in volleyball and highest in ice hockey, judo, and karate. Our findings agree with other reports that violent bodily contact between athletes increases the risk of injury[20 21] but that use of protective equipment may reduce the difference in injury outcomes between sports. Comparison of injury rates with those in other studies is complicated by methodological differences. The ranking of injury risks in different sports may also vary with local circumstances in the study area, such as the age distribution and level of the teams playing. De Loës and Goldie reported that soccer players had a clearly higher injury risk than ice hockey players in one municipality in south west Sweden.[11] But our finding that the overall injury rate was higher in ice hockey players than footballers in Finland agrees with national data from Sweden.[22] In our study the differences in overall injury rates between the sports were partly explained by the differing age distributions of the athletes.

All the sports studied had higher acute injury rates than reported among endurance athletes.[23] During the study period participants in motor sports had similar compulsory national sports licence insurance. In 1990 and 1991 among male participants in various competitive motor sports the injury rate per 1000 person years of exposure was 182 (95% confidence interval 171 to 194) and was highest in the youngest age groups—278 (223 to 333) among participants aged under 15 and 245 (220 to 269) among 15-19 year olds. From 1987 to 1991 fractures other than dental accounted for 29% of all injuries to motor sports participants. These data confirm that the relative safety of junior sports is not extended to all types of motor sports.

The types and anatomical distribution of injuries, as well as the rarity of severe injuries, corresponded with earlier findings.[24] As expected, the most common injuries were sprains, strains, and bruises. As found in earlier studies, knee injury was the most common cause of permanent disability,[9] defined simply as an impairment of optimal function. Fractures seldom resulted in permanent disability, though

Table 3—*Anatomical locations of injuries by sports and injury rates (plus 95% confidence intervals) (sports insurance data 1987-91)*

Injury location	%† (No) [injury rate‡ (95% confidence interval)]					
	Soccer	Ice hockey	Volleyball	Basketball	Judo	Karate
Lower limb	66·8 (17 577) [59 (58 to 60)]	35·8 (6 031) [34 (33 to 34)]	57·4 (3 005) [34 (33 to 36)]	56·0 (1 945) [49 (47 to 51)]	38·6 (449) [45 (41 to 49)]	37·3 (429) [53 (48 to 58)]
Thigh	10·6 (2 803) [9 (9 to 10)]	6·1 (1 031) [6 (5 to 6)]	2·3 (118) [1 (1 to 2)]	2·5 (87) [2 (2 to 3)]	1·9 (22) [2 (1 to 3)]	4·3 (49) [6 (4 to 8)]
Knee	21·5 (5 657) [19 (19 to 20)]	17·2 (2 888) [16 (16 to 17)]	19·0 (993) [11 (11 to 12)]	15·8 (547) [14 (13 to 15)]	20·2 (235) [24 (21 to 27)]	11·0 (127) [16 (13 to 18)]
Leg§	5·9 (1 557) [5 (5 to 6)]	1·9 (325) [2 (2 to 2)]	1·8 (94) [1 (1 to 1)]	2·0 (68) [2 (1 to 2)]	2·0 (23) [2 (1 to 3)]	3·3 (38) [5 (3 to 6)]
Ankle	20·5 (5 397) [18 (18 to 19)]	7·9 (1 325) [7 (7 to 8)]	31·1 (1 626) [19 (18 to 19)]	31·4 (1 090) [28 (26 to 29)]	8·3 (97) [10 (8 to 12)]	7·7 (88) [11 (9 to 13)]
Foot	7·7 (2 015) [7 (7 to 7)]	2·4 (404) [2 (2 to 2)]	2·9 (153) [2 (1 to 2)]	4·0 (138) [3 (3 to 4)]	6·0 (70) [7 (5 to 9)]	10·7 (123) [15 (13 to 18)]
Lower limb, other¶	0·6 (148) [0 (0 to 1)]	0·3 (58) [0 (0 to 0)]	0·4 (21) [0 (0 to 0)]	0·4 (15) [0 (0 to 1)]	0·2 (2) [0 (0 to 0)]	0·3 (4) [0 (0 to 1)]
Upper limb	12·1 (3 189) [11 (10 to 11)]	31·5 (5 306) [30 (29 to 30)]	22·4 (1 174) [13 (13 to 14)]	19·3 (670) [17 (16 to 18)]	37·6 (437) [44 (40 to 48)]	26·3 (303) [37 (33 to 42)]
Upper arm and shoulder	3·0 (800) [3 (3 to 3)]	10·2 (1 724) [10 (9 to 10)]	9·3 (489) [6 (5 to 6)]	2·6 (92) [2 (2 to 3)]	20·0 (233) [24 (21 to 26)]	6·1 (70) [9 (7 to 11)]
Forearm and elbow	1·3 (334) [1 (1 to 1)]	4·6 (771) [4 (4 to 5)]	1·6 (84) [1 (1 to 1)]	1·3 (46) [1 (1 to 2)]	7·7 (90) [9 (7 to 11)]	3·8 (44) [5 (4 to 7)]
Palm and wrist	3·6 (948) [3 (3 to 3)]	8·2 (1 382) [8 (7 to 8)]	2·1 (111) [1 (1 to 2)]	3·8 (131) [3 (3 to 4)]	3·4 (40) [4 (3 to 5)]	6·0 (69) [9 (7 to 11)]
Fingers	3·7 (978) [3 (3 to 4)]	6·4 (1 074) [6 (6 to 6)]	9·1 (477) [5 (5 to 6)]	11·1 (386) [10 (9 to 11)]	4·5 (52) [5 (4 to 7)]	9·3 (107) [13 (11 to 16)]
Upper limb, other¶	0·5 (129) [0 (0 to 1)]	2·1 (355) [2 (2 to 2)]	0·2 (13) [0 (0 to 0)]	0·4 (15) [0 (0 to 1)]	1·9 (22) [2 (1 to 3)]	1·1 (13) [2 (1 to 2)]
Other sites	21·1 (5 564) [19 (18 to 19)]	32·7 (5 499) [31 (30 to 31)]	20·2 (1 056) [12 (11 to 13)]	24·7 (857) [22 (20 to 23)]	23·8 (277) [28 (25 to 31)]	36·3 (418) [52 (47 to 56)]
Teeth	2·8 (737) [2 (2 to 3)]	7·1 (1 196) [7 (6 to 7)]	2·0 (106) [1 (1 to 1)]	5·2 (182) [5 (4 to 5)]	2·7 (31) [3 (2 to 4)]	6·4 (74) [9 (7 to 11)]
Eye	0·9 (245) [0 (0 to 1)]	1·2 (202) [1 (1 to 2)]	1·9 (101) [1 (1 to 1)]	3·0 (103) [3 (2 to 3)]	0·9 (11) [1 (0 to 2)]	2·1 (24) [3 (2 to 4)]
Head and neck, other sites	4·9 (1 282) [4 (4 to 5)]	8·6 (1 448) [8 (8 to 8)]	5·6 (291) [3 (3 to 4)]	7·4 (256) [6 (6 to 7)]	6·3 (73) [7 (6 to 9)]	10·9 (125) [15 (13 to 18)]
Thorax and abdomen	2·6 (693) [2 (2 to 3)]	3·8 (632) [4 (3 to 4)]	0·9 (47) [1 (0 to 1)]	1·5 (52) [1 (1 to 2)]	4·2 (49) [5 (4 to 6)]	4·7 (54) [7 (5 to 8)]
Back	5·8 (1 531) [5 (5 to 5)]	7·2 (1 220) [7 (6 to 7)]	8·7 (458) [5 (5 to 6)]	5·4 (187) [5 (4 to 5)]	7·9 (92) [9 (7 to 11)]	9·7 (111) [14 (11 to 16)]
Pelvis and hip	2·5 (665) [2 (2 to 2)]	2·7 (447) [2 (2 to 3)]	0·5 (28) [0 (0 to 0)]	0·9 (3) [1 (0 to 1)]	0·7 (8) [1 (0 to 1)]	1·5 (17) [2 (1 to 3)]
Multiple sites or unknown	1·6 (411) [1 (1 to 2)]	2·1 (354) [2 (2 to 2)]	0·5 (25) [0 (0 to 0)]	1·4 (47) [1 (1 to 2)]	1·1 (13) [1 (1 to 2)]	1·1 (13) [2 (1 to 2)]

†Percentage of injuries in sports studied.
‡Injuries per 1000 person years of exposure.
§Leg refers to anatomical area between knee and ankle.
¶Other or multiple sites: this category of upper limb includes clavicle injuries.

Table 4—*Injury types by sports and injury rates (plus 95% confidence intervals) (sports insurance data 1987-91)*

Injury type	%† (No) [injury rate‡ (95% confidence interval)]					
	Soccer	Ice hockey	Volleyball	Basketball	Judo	Karate
Sprains and strains§	56·1 (14 769) [50 (49 to 51)]	36·9 (6 213) [35 (34 to 35)]	74·6 (3 905) [45 (43 to 46)]	61·3 (2 128) [54 (52 to 56)]	59·8 (696) [70 (65 to 75)]	44·7 (514) [63 (58 to 69)]
Knee	16·4 (4 321) [15 (14 to 15)]	11·2 (1 886) [11 (10 to 11)]	15·4 (807) [9 (9 to 10)]	12·4 (432) [11 (10 to 12)]	15·3 (178) [18 (15 to 21)]	9·0 (104) [13 (10 to 15)]
Ankle	16·7 (4 401) [15 (14 to 15)]	4·8 (812) [5 (4 to 5)]	29·2 (1 527) [17 (17 to 18)]	29·5 (1 023) [26 (24 to 27)]	6·5 (76) [8 (6 to 9)]	6·3 (72) [9 (7 to 11)]
Bruises and wounds	31·1 (8 184) [28 (27 to 28)]	42·0 (7 069) [39 (38 to 40)]	16·3 (853) [10 (9 to 10)]	22·2 (773) [20 (18 to 21)]	23·1 (269) [27 (24 to 30)]	35·1 (404) [50 (45 to 55)]
Fractures	9·6 (2 515) [8 (8 to 9)]	17·1 (2 885) [16 (16 to 17)]	5·9 (311) [4 (3 to 4)]	12·6 (436) [11 (10 to 12)]	11·3 (131) [13 (11 to 15)]	16·9 (194) [24 (21 to 27)]
Fractures other than dental	7·0 (1 844) [6 (6 to 7)]	10·6 (1 785) [10 (9 to 10)]	4·0 (212) [2 (2 to 3)]	7·6 (265) [7 (6 to 8)]	8·8 (102) [10 (8 to 12)]	10·8 (124) [15 (13 to 18)]
Foot and ankle¶	25·0 (461) [2 (1 to 2)]	11·3 (201) [1 (1 to 1)]	29·2 (62) [1 (1 to 1)]	18·5 (49) [1 (1 to 2)]	34·3 (35) [4 (2 to 5)]	21·0 (26) [3 (2 to 4)]
Lower limb, proximal from ankle¶	16·1 (297) [1 (1 to 1)]	6·8 (122) [1 (1 to 1)]	7·5 (16) [0 (0 to 0)]	3·8 (10) [0 (0 to 0)]	3·9 (4) [0 (0 to 1)]	4·0 (5) [1 (0 to 1)]
Fingers, palm, and wrist¶	35·5 (654) [2 (2 to 2)]	48·1 (858) [5 (4 to 5)]	53·8 (114) [1 (1 to 2)]	57·0 (151) [4 (3 to 4)]	18·6 (19) [2 (1 to 3)]	36·3 (45) [6 (4 to 7)]
Upper limb proximal from wrist¶	8·4 (154) [1 (0 to 1)]	21·6 (386) [2 (2 to 2)]	0·9 (2) [0 (0 to 0)]	4·2 (11) [0 (0 to 0)]	31·4 (32) [3 (2 to 3)]	5·6 (7) [1 (0 to 2)]
Other, non-dental¶	15·1 (278) [1 (1 to 1)]	12·2 (218) [1 (1 to 1)]	8·5 (18) [0 (0 to 0)]	16·6 (44) [1 (1 to 1)]	11·8 (12) [1 (1 to 2)]	33·1 (41) [5 (4 to 7)]
Dental fractures	2·5 (671) [2 (2 to 2)]	6·5 (1 100) [6 (6 to 6)]	1·9 (99) [1 (1 to 1)]	4·9 (17) [4 (4 to 5)]	2·5 (29) [3 (2 to 4)]	6·1 (70) [9 (6 to 11)]
Dislocations	0·8 (215) [1 (1 to 1)]	1·1 (191) [1 (1 to 1)]	1·4 (73) [1 (1 to 1)]	1·7 (59) [1 (1 to 2)]	3·9 (45) [5 (3 to 6)]	1·1 (13) [2 (1 to 2)]
Knee‖	0·3 (76) [0 (0 to 0)]	0·2 (39) [0 (0 to 0)]	0·3 (17) [0 (0 to 0)]	0·5 (16) [0 (0 to 1)]	1·0 (12) [1 (1 to 2)]	0·1 (1) [0 (0 to 0)]
Shoulder and elbow	0·2 (52) [0 (0 to 0)]	0·7 (113) [1 (1 to 1)]	0·2 (11) [0 (0 to 0)]	0·3 (10) [0 (0 to 0)]	1·9 (22) [2 (1 to 3)]	0·3 (3) [0 (0 to 1)]
Fingers	0·1 (31) [0 (0 to 0)]	0·1 (13) [0 (0 to 0)]	0·5 (25) [0 (0 to 0)]	0·3 (12) [0 (0 to 0)]	0·3 (4) [0 (0 to 1)]	0·3 (3) [0 (0 to 1)]
Others or unknown	2·5 (647) [2 (2 to 2)]	2·8 (478) [3 (2 to 3)]	1·8 (93) [1 (1 to 1)]	2·2 (76) [2 (1 to 2)]	1·9 (22) [2 (1 to 3)]	2·2 (25) [3 (2 to 4)]

†Percentage of injuries in sport studied.
‡Injuries per 1000 person years of exposure.
§Includes ligament, tendon, and muscle ruptures.
¶Percentages of non-dental fractures.
‖Includes patellofemoral joint.

Key messages

- Sport and exercise benefit health but may also result in injury
- Many sports injuries result from true accidents but others are preventable
- Injury rates are low in child athletes and highest in young adults
- Every sport has a specific injury profile
- Preventive measures should be specific to the sport concerned and include those aimed at decreasing the number of violent contacts between athletes

the number of fractures (highest in ice hockey, judo, and karate) highlight the risk for high energy injuries.

High puck velocities, aggressive stick use, and body checking (collisions) account for most ice hockey injuries.[25] Catastrophic ice hockey injuries seem to be less frequent in Finland than North America,[26] possibly because of the larger rinks and less aggressive style in Europe. To avoid these injuries as far as possible, aggressive checking—particularly from behind the player and near the rink boards—should be minimised by game rules and strict refereeing.[25] Aggressive stick use may partly account for the high number of hand and wrist fractures in our study. Though facial injuries are common, they have declined with the more routine use of helmets and facemasks.[25] In ice hockey and many other sports mouth guards would substantially reduce dental injuries and should be designed according to the characteristics of each sport.

The injury profiles of the sports differed widely. To avoid injuries preventive measures should be specific to each sport. In general there should be greater focus on diminishing rough and violent contact between athletes.

Funding: Finnish Ministry of Education.
Conflict of interest: None.

1 Powell KE, Thompson PD, Caspersen CJ, Kendrick JS. Physical activity and the incidence of coronary heart disease. *Annu Rev Public Health* 1987;8: 253-87.
2 Helmrich SP, Ragland DR, Leung RW, Paffenbarger RS. Physical activity and reduced occurrence of non-insulin-dependent diabetes mellitus. *N Engl J Med* 1991;325:147-52.
3 Sarna S, Sahi T, Koskenvuo M, Kaprio J. Increased life expectancy of world class male athletes. *Med Sci Sports Exerc* 1993;25:237-44.
4 Fentem PH. Benefits of exercise in health and disease. *BMJ* 1994;308:1291-5.
5 Torg JS, Vegso JJ, Sennelt B, Das M. The national football head and neck injury registry. *JAMA* 1985;254:3439-43.
6 Kujala UM, Kaprio J, Sarna S. Osteoarthritis of the weightbearing joints of the lower limbs in former elite male athletes. *BMJ* 1994;308:231-4.
7 De Loës M. Medical treatment and costs of sports-related injuries in total population. *Int J Sports Med* 1990;11:66-72.
8 Sandelin J, Santavirta S, Lättilä R, Vuolle P, Sarna S. Sport injuries in a large urban population: occurrence and epidemiologic aspects. *Int J Sports Med* 1987;8:61-6.
9 Inklaar H. Soccer injuries. I: incidence and severity. *Sports Med* 1994;18: 55-73.
10 Walter SD, Sutton JR, McIntosh JM, Connolly C. The aetiology of sport injuries. A review of methodologies. *Sports Med* 1985;2:47-58.
11 De Loës M, Goldie I. Incidence rate of injuries during sport activity and physical exercise in a rural Swedish municipality: incidence rates in 17 sports. *Int J Sports Med* 1988;9:461-7.
12 McLatchie GR, Davies JE, Caulley JH. Injuries in karate—a case for medical control. *J Trauma* 1980;20:956-8.
13 Johnson RJ, Ettlinger CF. Alpine ski injuries: changes through the years. *Clin Sports Med* 1982;1:181-97.
14 Sim FH, Simonet WT, Melton LJ, Lehn TA. Ice hockey injuries. *Am J Sports Med* 1987;15:86-96.
15 Ekstrand J, Gillquist J. The avoidability of soccer injuries. *Int J Sports Med* 1983;4:124-8.
16 Ekstrand J, Gillquist J, Liljedahl SO. Prevention of soccer injuries. Supervision by doctor and physiotherapist. *Am J Sports Med* 1983;11:116-20.
17 Hayes D. An injury profile for hockey. *Canadian Journal of Applied Sports Science* 1978;3:61-4.
18 Nilsson S, Rooas A. Soccer injuries in adolescents. *Am J Sports Med* 1978;6:358-61.
19 Baxter-Jones A, Maffulli N, Helms P. Low injury rates in elite athletes. *Arch Dis Child* 1993;68:130-2.
20 Backx FJG, Beijer HJM, Bol E, Erich WBM. Injuries in high-risk persons and high-risk sports. *Am J Sports Med* 1991;19:124-30.
21 Watson AWS. Incidence and nature of sports injuries in Ireland. Analysis of four types of sport. *Am J Sports Med* 1993;21:137-43.
22 Folksam. *Sports injuries 1976-1983.* Uddevalla, Sweden: Bohusläningens Boktryckeri AB, 1985. (144 pages.)
23 Kujala UM, Nylund T, Taimela S. Acute injuries in orienteers. *Int J Sports Med* 1995;16:122-5.
24 Kujala UM, Heinonen OJ, Lehto M, Järvinen M, Bergfeld JA. Equipment, drugs and problems of the competition and team physician. *Sports Med* 1988;6:197-209.
25 Daly PJ, Sim FH, Simonet WT. Ice hockey injuries. A review. *Sports Med* 1990;10:122-31.
26 Tator CH, Edmonds VE, Lapczak L, Tator IB. Spinal injuries in ice hockey players, 1966-1987. *Can J Surg* 1991;34:63-9.

(Accepted 5 October 1995)

Does the onset of tuberculosis in AIDS predict shorter survival? Results of a cohort study in 17 European countries over 13 years

Thomas V Perneger, Philippe Sudre, Jens D Lundgren, Bernard Hirschel, for the AIDS in Europe Study Group

Institute of Social and Preventive Medicine, University of Geneva, CMU Case Postale, 1211 Geneva 4, Switzerland
Thomas V Perneger, *medical epidemiologist*

Division of Infectious Diseases, Geneva University Hospital, Geneva
Philippe Sudre, *medical epidemiologist*
Bernard Hirschel, *professor*

University of Copenhagen, Hvidovre Hospital, Hvidovre, Denmark
Jens D Lundgren, *attending physician*

AIDS in Europe Study Group
Members of the study group are listed in reference 7

Correspondence to:
Dr Perneger.

BMJ 1995;311:1468-71

Abstract

***Objective*—To assess the impact of tuberculosis on mortality in patients with AIDS.**

***Design*—Community based cohort study.**

***Setting*—52 centres in 17 countries (AIDS in Europe study).**

***Subjects*—5249 patients who were alive and free of tuberculosis one month after the diagnosis of AIDS, enrolled between 1979 and 1989, and followed up until 1992.**

***Main outcome measures*—Onset of clinically active tuberculosis or death, or both.**

***Results*—During a mean follow up period of 15 months 201 (4%) patients developed tuberculosis and 3889 (74%) died. Patients who developed tuberculosis survived significantly longer (median 22 months) than those who did not (median 16 months). This apparent survival advantage was due to patients who survived longer having more opportunity to develop tuberculosis (or any other disease). In models that took into account the time at which tuberculosis was diagnosed, the onset of tuberculosis was associated with a significant increase in mortality (adjusted relative hazard of death 1·34; 95% confidence interval 1·12 to 1·60).**

***Conclusions*—The onset of tuberculosis in patients with AIDS predicts a substantial increase in mortality. Whether this increased mortality is directly attributable to the tuberculosis remains uncertain. If the association is causal preventive chemotherapy and aggressive treatment of tuberculosis could improve survival in AIDS.**

Introduction

The HIV epidemic has had a major impact on the incidence of tuberculosis and on mortality and the case fatality rate of that disease.[1-3] It is unclear, however, whether tuberculosis affects the course of HIV disease. In particular, we do not know whether tuberculosis shortens survival in patients with HIV infection. A recent review concluded that there was no noticeable decrease in survival attributable to tuberculosis in patients with HIV infection.[1] That conclusion rested