Original articles

Sports related injuries in Scottish adolescents aged 11–15

J M Williams, P Wright, C E Currie, T F Beattie

Abstract

***Objectives*—To measure the age and sex distribution of self reported sports and leisure injuries in a 12 month retrospective recall period among a representative national sample of Scottish adolescents, and to examine the characteristics (gender, age, handedness, and level of sports participation) of sports related injuries in relation to injuries sustained during other activities.**

***Design/Setting*—Self completion questionnaire survey administered in schools during April-June 1994.**

***Subjects*—4710 pupils aged 11, 13, and 15 years drawn from a representative sample of 270 classes with returns from 224 classes (83% completion rate).**

***Results*—42.1% of the sample reported a medically attended injury. These were significantly more frequent among boys but there were no significant age differences in overall frequency of injury. Sport related injuries accounted for 32.2% of all medically attended injuries. As with all injuries, frequency was greater in boys than girls at all ages, and there are differences in the pattern of lesions in sports and non-sports injuries. Lower limb injuries were more frequent than upper limb injury in sports (57.6 *v* 23.9%), whereas there were no differences in non-sports injuries (31.5 *v* 31.3%). Age and handedness differences in sports injury rates were also identified. High sports participation was significantly associated with a higher risk of injury in general and sports related injury in particular.**

***Conclusion*—Age, gender, handedness, and level of sports participation have been shown to be implicated in differential risk of sports related injury. Reducing sports injury among adolescents should be a priority, but research into the injury profiles of different sports is needed before detailed injury prevention strategies can be developed.**

(*Br J Sports Med* 1998;**32**:291–296)

Keywords: adolescents; injury rate; gender; age; handedness

Department of Psychology, University of Edinburgh, Edinburgh, Scotland, UK
J M Williams
P Wright

Research Unit in Health and Behavioural Change, University of Edinburgh
C E Currie

Accident and Emergency Department, Royal Hospital for Sick Children, Edinburgh
T F Beattie

Correspondence to:
Dr J Williams, Department of Psychology, University of Edinburgh, 7 George Square, Edinburgh EH8 9JZ, Scotland, UK.

Accepted for publication
7 April 1998

Accidental injuries are the leading cause of mortality and morbidity among children younger than 14 years of age in Great Britain, and adolescents between the ages of 11 and 15 years appear to be particularly at risk.[1] Scottish accident rates are higher than those in England and Wales, and it is proposed that accidents should be a priority area for action to improve Scotland's health.[2]

It is also suggested, however, that to improve the health of adolescents we must increase sports participation and physical exercise among this age group, and the Scottish Office, for example, has set as one of its key initiatives the promotion of "...more widespread exercise by everyone, young and old" (Scottish Office, 1992, p 25). Sports activities and exercise generally improve cardiovascular health and general psychological wellbeing,[3] but sometimes result in injury. A common assumption is that the health benefits achieved through leisure and sports activities far outweigh the costs of injuries, which are often considered to be an "inevitable" part of exercise[4] because of the high level of mechanical energy involved.[5] A greater understanding of the level of risk to health incurred by sports related injuries among adolescents is required to inform policy relating to both injury prevention and exercise promotion, and further to help reduce the health costs associated with sports injuries.

While most fatal sports and leisure injuries in Scotland during 1988–1993 were among adults,[6] outpatient accident and emergency department attendances for leisure injuries were highest for 5–15 year olds (153.5 per 1000 annually, about 15%). An alternative approach has been to estimate the percentage of all medically attended injuries incurred during sports activities. Using this method it has been shown that, of Norwegian children aged 5 to 14 years who are injured, 27% sustained their injuries during sports activities.[4] In France 11% of all injuries in children aged 0–15 years were from sports injuries,[7] while in the United States sports related injuries account for 36% of all injuries sustained by children between the ages of 5 and 17 years.[5] In New Zealand there is some evidence of a developmental change in sports injury rates, with 33% of all injuries among 10–11 year olds occurring during sports and leisure activities,[8] whereas for 12–13 year olds 39% of injuries

result from sport,[9] and among 14–15 year olds 51% of injuries are sustained during sports participation.[10] Despite the methodological differences in the design of these studies, which in part must explain the varying incidence rates reported, they serve to show that sports injuries account for a significant proportion of all injury events among adolescents in numerous countries, and confirm that adolescents are at risk of injury through these activities.

In order to develop appropriate policy and prevention strategies in Scotland, there is a need for a comprehensive measure of the scale of sports related injury among adolescents. Three major problems with the currently available data on sports related injuries in Britain have been identified.[11] Firstly, data from different sources are difficult to collate to produce an overall measure of injury incidence rates; secondly, data are often inaccessible to health, sports, and accident prevention professionals; and thirdly, the lack of detailed information about the sports and leisure injuries limits the development of prevention strategies. Finally, there is a need for agreement on definitions of both injury and severity measures to facilitate comparisons across studies.[12]

An alternative method of obtaining comprehensive injury data among adolescents is through self report survey.[13] The patterning and severity of injuries found using the self report method is consistent with results from other research, confirming the utility of self reports of injuries at these ages.[13] This paper reports the results of a national Scottish survey of adolescents aged 11 to 15 years from all regions. We describe in detail the frequency, type and location of lesions, and severity of sports and leisure injuries among a representative sample of Scottish adolescents. We also examine associations with gender, age, and handedness, which have all previously been shown to influence injury rates.[14] Finally, we explore the relation between level of sports participation and injury, and discuss how the risk of injury sustained during sport and leisure activities might be reduced.

Method

SAMPLE SELECTION

The survey sample was stratified by region and based on the Scottish population of schoolchildren at the ages of 11, 13, and 15 years—that is, Primary 7, Secondary 2, and Secondary 4. A cluster sample of school classes was selected from lists of all Primary 7, Secondary 2, and Secondary 4 classes in the 12 regional educational departments and independent schools in Scotland. The classes selected were unstreamed and of mixed ability to obtain a representative sample (composite classes were not included). This procedure was consistent with that used successfully in the Scottish WHO Cross-National Health Behaviour in School Children survey.[15] The survey was conducted between April and June 1994.

Table 1 Sample characteristics in terms of age and sex

	Total No	*No of classes*	*Age (years)*	*No of boys*	*No of girls*
Primary 7	1666	81	11.72 (0.31)	836	830
Secondary 2	1504	71	13.67 (0.32)	740	764
Secondary 4	1540	72	15.63 (0.33)	754	786
Total	4710	224	13.63 (1.64)	2330	2380

Where applicable, values are mean (SD).

DATA COLLECTION

Children completed the questionnaires independently and anonymously during a single school period (about 40 minutes). The supervising teacher was instructed to disallow any conferring between the children and to respond only to children's queries about procedure. Envelopes were provided in which the children could seal their completed questionnaires and be assured of confidentiality.

SURVEY QUESTIONNAIRE AND ANALYSES

The survey questionnaire was developed from a standardised instrument[15] and comprised sections relating the child's demographic characteristics, injuries sustained during the 12 months before questionnaire administration, and selected risk behaviours including sports participation.

Injuries

Respondents were initially presented with a list of various forms of injury and asked whether they had experienced any of these in the previous 12 months (for a more detailed account see Currie *et al*[13]). A filter question then asked "Have you had to go to a doctor, a nurse or hospital because of any of these injuries?" This was used to estimate the overall incidence of medically attended injuries. Those who reported having received medical attention for an injury were then asked to give a written description of the most severe injury sustained in the previous 12 months, and these were subsequently coded using the Abbreviated Injury Scale (AIS).[16] Where up to three injuries resulting from a single injury event were described each was coded independently and the Maximum Abbreviated Injury Score (MAIS) calculated. For the analyses presented here the codes of the first documented injury (most children listed only one injury) were grouped into location and type of lesion categories, in addition to the MAIS. As proxy measures of injury severity, adolescents were asked whether they had spent a night in hospital or missed days of school because of their injury.

Sports versus non-sports injury classification

Respondents also ticked one of a series of categorical responses to indicate where the injury had occurred and what activity they were engaged in at the time of injury. On the basis of these we were able to classify injuries into three mutually exclusive categories: those resulting from formal sports (in schools, sports centres, or public parks); those resulting from informal sports or leisure activities (including playing football in the street); and non-sports related injuries—that is, those reported to be incurred when the child was not training or playing sports at the time.

Table 2 Distribution of sports injuries by gender and age (frequency (%))

	Formal sports	*Informal sports*	*Non-sports*	*Significance (p value)*
Gender				
Boys	272 (29.1)	86 (9.2)	576 (61.7)	<0.0001
Girls	138 (19.8)	30 (4.3)	528 (75.9)	
Age				
11 years	100 (18.2)	33 (6)	415 (75.7)	<0.0001
13 years	136 (24.8)	54 (9.9)	358 (65.3)	
15 years	174 (32.6)	29 (5.4)	331 (62)	

Significance was determined by the χ^2 method.

Handedness

Handedness was assessed using a self report measure developed by Porac *et al*.[17] The children were asked whether they used their left hand, right hand or either hand with which to write, use a rubber, throw a ball, and brush their teeth. Individuals were classified as left handed if they reported using their left hand for two or more of the activities and right handed if they reported using their right hand for three or four of the activities.[18]

Sports participation

Participation in sports activities was measured by a single question "During the last seven days, on how many days did you play sports?". Responses were coded into three categories: one to three days; four to six days; seven days.

The analysis reported below firstly considers the frequency of medically attended injuries reported in this sample. The frequency of sports related injury, the type and location of lesion sustained (using the recoded AIS scores), the severity and treatment received are then analysed. Analysis of gender, age, and handedness differences in sports related injuries are then presented, and finally the relation between sports related injuries and sports participation is considered. In all tables the data presented are the frequency of injury and corresponding percentage.

Results

Completed questionnaires were returned by 224 of the 270 selected classes (83% completion) giving a total of 4710 children. Table 1 shows the sample characteristics by age and sex.

Overall 42.1% of the sample reported a medically attended injury during the 12 month recall period. Of those injured, 15.5% reported being admitted for an overnight stay in hospital and 54.4% reported missing days of school as a result of injury. Injuries were significantly more frequent among boys than girls (47.7% and 36.7% respectively were injured; $\chi^2 = 56.3$, df = 1, $p<0.0001$). However, there were no significant age differences in the overall frequency of injuries reported (42% of 11 year olds, 43.8% of 13 year olds, and 40.7% of 15 year olds reported medically attended injuries; $\chi^2 = 2.92$, df = 2, NS). More details of the general patterns of injuries reported by this sample are presented in other published papers.[13]

A total of 32.2% of all injuries reported were the result of sports related activities: 25.1% occurred during formal sports activities and 7.9% were sustained during informal leisure activities. As shown in table 2, a significantly ($p<0.0001$) higher percentage of boys than girls reported a sports related injury (38.3% of boys compared with 24.1% of girls). There was also a significant increase in sports related injury with age (see table 2): sports related injuries formed a larger percentage of all injuries sustained by the 15 year olds (38%) than the 13 year olds (34.7%) or 11 year olds (24.2%).

In order to inspect more closely the characteristics of sports and leisure injuries compared with those resulting from other activities, a series of χ^2 analyses were computed. These examined in some detail the location of lesion, type of lesion, and proxy measures of injury severity (missed days of school, night in hospital, and MAIS).

There were significant differences in the type ($\chi^2 = 164.22$, df = 8, $p<0.0001$) of lesions associated with the different kinds of injury events (table 3). Fractures and dislocations were of equal frequency in all types of injury event (about 31%). However, strains and sprains, which were the most common form of sports related injury (33.7%), were less common informal sports (25.9%) and non-sports (15.7%) injuries. By contrast, wounds were relatively infrequent formal sports injuries (13.4%) but were more common informal sports (20.7%) and non-sports (39.9%) injuries.

There were also differences in the location of lesions resulting from different injury events ($\chi^2 = 143.64$, df = 8, $p<0.0001$). Here the patterns for formal and informal sports injuries were very similar, with the injuries occurring most frequently to the legs (57.6% and 51.7% respectively) and secondly to the arms (23.9% and 22.4% respectively). By contrast, leg and arm injuries were equally frequent in non-sports injuries (about 31%), and external and head/face injuries were more frequent than for sports related injuries (table 3).

As shown in table 3 there was some evidence for differences in severity between the different kinds of injury events. Although there were no

Table 3 Type and location of lesion according to the activity (frequency (%))

	Formal sports	*Informal sports*	*Non-sports*	*Significance (p value)*
Type of lesion				
Fracture/dislocation	128 (31.2)	36 (31)	338 (30.6)	<0.0001
Sprain/strain	138 (33.7)	30 (25.9)	173 (15.7)	
Wound	55 (13.4)	24 (20.7)	441 (39.9)	
Concussion	8 (2)	2 (1.7)	56 (5.1)	
Other	81 (19.8)	24 (20.7)	96 (8.7)	
Location of lesion				
Head/face	28 (6.8)	11 (9.5)	194 (17.6)	<0.0001
Neck/spine	29 (7.1)	6 (5.2)	26 (2.4)	
Upper limb	98 (23.9)	26 (22.4)	345 (31.3)	
Lower limb	236 (57.6)	60 (51.7)	348 (31.5)	
External	19 (4.6)	13 (11.2)	191 (17.3)	
Severity measures				
Night in hospital				
Yes	43 (10.5)	16 (13.8)	178 (16.1)	<0.02
No	365 (89.5)	100 (86.2)	925 (83.9)	
Missed school days				
Yes	224 (54.8)	65 (57)	599 (54.5)	NS
No	185 (45.2)	49 (43)	500 (45.5)	
MAIS				
Minor (1)	266 (65.4)	78 (67.8)	782 (71.1)	NS
Moderate/severe (2/3)	141 (34.6)	37 (32.2)	318 (28.9)	

Significance was determined by the χ^2 method.

Table 4 Sex distribution in sports injuries (frequency (%))

	Boys	*Girls*	*Significance (p value)*
Type of lesion			
Fracture/dislocation	120 (33.5)	44 (26.2)	<0.01
Sprain/strain	107 (29.9)	61 (36.3)	
Wound	61 (17)	18 (10.7)	
Concussion	9 (2.5)	1 (0.6)	
Other	61 (17)	44 (26.2)	
Location of lesion			
Head/face	26 (7.3)	13 (7.7)	<0.003
Neck/spine	14 (3.9)	21 (12.5)	
Upper limb	83 (23.2)	41 (24.4)	
Lower limb	209 (58.4)	87 (51.8)	
External	26 (7.3)	6 (3.6)	
Severity measures			
Hospital overnight			
Yes	48 (13.4)	11 (6.6)	<0.02
No	310 (86.6)	155 (93.4)	
Missed school days			
Yes	196 (55.2)	93 (55.4)	NS
No	159 (44.8)	75 (44.6)	
MAIS			
Minor (1)	222 (62.4)	122 (73.5)	<0.01
Moderate/severe (2/3)	134 (37.6)	44 (26.5)	

Significance was determined by the χ^2 method.

Table 5 Age distribution in sports injuries (frequency (%))

	11 years	*13 years*	*15 years*	*Significance (p value)*
Type of lesion				
Fracture/dislocation	37 (27.8)	72 (37.9)	55 (27.1)	<0.05
Sprain/strain	41 (30.8)	55 (28.9)	72 (35.5)	
Wound	28 (21.1)	26 (13.7)	25 (12.3)	
Concussion	5 (3.8)	3 (1.6)	2 (1)	
Other	22 (16.5)	34 (17.9)	49 (24.1)	
Location of lesion				
Head/face	16 (12)	12 (6.3)	11 (5.4)	NS
Neck/spine	5 (3.8)	13 (6.8)	17 (8.4)	
Upper limb	31 (23.3)	44 (23.2)	49 (24.1)	
Lower limb	69 (51.9)	109 (57.4)	118 (58.1)	
External	12 (9)	12 (6.3)	8 (3.9)	
Severity measures				
Hospital overnight				
Yes	15 (11.3)	31 (16.3)	13 (6.5)	<0.01
No	118 (88.7)	159 (83.7)	188 (93.5)	
Missed school days				
Yes	68 (51.9)	123 (64.7)	98 (48.5)	<0.005
No	63 (48.1)	67 (35.3)	104 (51.5)	
MAIS				
Minor (1)	95 (71.4)	108 (58.1)	141 (69.5)	<0.05
Moderate/severe (2/3)	38 (28.6)	78 (41.9)	62 (30.5)	

Significance was determined by the χ^2 method.

differences in MAIS scores, of the two proxy measures of severity, a higher percentage of non-sports injuries resulted in the adolescent spending a night in hospital, but this was not matched by any increase in the likelihood of missing school.

As the above indicates little difference between formal and informal sports injuries, the two categories were collapsed to examine the gender and age distribution of sports injuries in Scottish adolescents, and the relation between sports related injury and handedness and sports participation.

Table 6 Distribution of sports injuries by handedness (frequency (%))

	Left	*Right*	*Significance (p value)*
Sports injury	48 (24.9)	420 (33.5)	<0.01
Non-sports injury	145 (75.1)	835 (66.5)	
Severity measures			
Hospital overnight			
Yes	9 (18.8)	40 (9.6)	<0.05
No	39 (81.3)	378 (90.4)	
Missed school days			
Yes	35 (72.9)	221 (52.9)	<0.01
No	13 (27.1)	197 (47.1)	
MAIS			
Minor (1)	29 (61.7)	277 (66.3)	NS
Moderate/severe (2/3)	18 (38.3)	141 (33.7)	

Significance was determined by the χ^2 method.

Over and above the finding that boys reported higher frequencies of sport related injury (see above), gender differences were also found in the type of sports injuries sustained by girls and boys (table 4). The injuries most frequently reported by boys were fractures and dislocations whereas girls most frequently sustained sprains and strains. Although the most common location for injuries in both genders was the lower limbs, the frequency of these was higher in boys than girls, and girls reported more neck and spine injuries. From the AIS codes, we found that injuries reported by boys were more severe, and this was in agreement with proxy measures of severity such as spending the night in hospital. However, another proxy measure, missing days of school because of sports injury, did not show significant gender differences (55% of both boys and girls).

In addition to the finding that the percentage of injuries resulting from sports activities increased with age and were most frequent among older children (see above), age trends in the types of lesion sustained were rather difficult to discern (table 5). At all ages, fractures/dislocations and sprains/strains were the most frequently reported types of injuries. Frequency of fractures/dislocations peaked at age 13 making them the most common type of sports injury, but at 15 years the most frequent injuries were strains/sprains. There was no overall association between age and the location of sports injury; across all ages, adolescents most often injure their legs during sports related activities. The most striking age trends were in relation to injury severity, for which the 13 year olds consistently reported more nights in hospital, more missed days of school, and more moderate/severe injuries as indexed by MAIS.

Left handed adolescents were less likely than right handed adolescents to sustain sport related injuries (24.9% of left handers reported a sports related injury compared with 33.9% of right handers). There was no handedness effect in the type or location of lesions. However, analysis of the proxy injury severity measures showed that the sports injuries that left handers sustained tended to be more severe; more left handers than right handers spent a night in hospital (18.8% *v* 9.6%) and missed days of school (72.9% *v* 52.9%) because of sports injuries (table 6).

Finally, we investigated the effect of the level of sports participation on the frequency of injuries. Analysis of sports participation responses showed that 31.9% of the sample reported that they played sports on one to three of the preceding seven days, 45.3% on four to six days, and 22.8% on all seven days. There was a significant difference between these three sport participation groups in the overall frequency of medically attended injury reported over the 12 month recall period (33.7% of those playing sports on one to three days, 42.5% of those playing sports on four to six days, and 53.4% of those playing sports on

Table 7 Levels of sports participation in relation to sports injuries (frequency (%))

	1–3 days	*4–6 days*	*7 days*	*Significance (p value)*
Injury events				
Sports rate	84 (16.1)	233 (44.6)	205 (39.3)	<0.0001
Non-sports rate	315 (28.8)	512 (46.8)	266 (24.3)	
Lesion location				
Head/face	3 (3.6)	18 (7.7)	16 (7.8)	NS
Neck/spine	6 (7.1)	18 (7.7)	11 (5.4)	
Upper limbs	27 (32.1)	52 (22.3)	44 (21.5)	
Lower limbs	41 (48.8)	133 (57.1)	121 (59)	
External	7 (8.3)	12 (5.2)	13 (6.3)	
Lesion type				
Fracture/dislocation	30 (35.7)	66 (28.3)	65 (31.7)	NS
Sprain/strain	25 (29.8)	82 (35.2)	61 (29.8)	
Wound	8 (9.5)	34 (14.6)	37 (18)	
Concussion	0 (0)	4 (1.7)	6 (2.9)	
Other	21 (25)	47 (20.2)	36 (17.6)	
Severity measures				
Hospital overnight				
Yes	3 (3.6)	25 (10.8)	31 (15.1)	<0.05
No	81 (96.4)	206 (89.2)	174 (84.9)	
Missed school days				
Yes	46 (54.8)	127 (54.5)	114 (56.4)	NS
No	38 (45.2)	106 (45.5)	88 (43.6)	
MAIS				
Minor (1)	56 (67.5)	159 (68.5)	127 (62.6)	NS
Moderate/severe (2/3)	27 (32.5)	73 (31.5)	76 (37.4)	

Significance was determined by the χ^2 method.

seven days reported injury; $\chi^2 = 94.75$, df = 2, $p<0.0001$). This suggests that a high level of sports participation is associated with a greater risk of injury. Analysis then explored whether high levels of sport participation were associated with sports related injuries in particular. As shown in table 7 children who play sport regularly are significantly more likely to report a sports injury than those who play sport less frequently ($p<0.0001$). Not surprisingly, of those who played sport everyday, 43.5% sustained their injuries during sports activities compared with only 21% of those who reported playing sports on only one to three days a week. Those in the high sports participation group also reported more serious injuries in that they were significantly more likely to spend a night in hospital (table 7).

Discussion

Sports and leisure injuries represent an important risk to the health of Scottish adolescents. In the Scottish population of 11 to 15 year olds, 32.2% of all medically attended injuries over a 12 month recall period resulted from sports related activities. This is comparable with figures found in other countries such as the United States[5] and New Zealand.[8–10] Clearly, there is a need to improve the safety of sports and leisure activities so that the long term health benefits of exercise are not offset by the injury morbidity that so frequently results.

The characteristic sports injury is qualitatively different from injuries sustained during other activities. The most common types of injury sustained during sports and leisure activities in adolescence are strains/sprains and fractures/dislocations, and the part of the body most often injured are the limbs, particularly the lower limbs. Strains and sprains were important across both age and gender, but seemed to be especially characteristic of the injuries sustained by girls and by 15 year olds. The high level of strains highlights the potential importance of warming up, cooling down, and stretching exercises before and after sports and leisure participation.[10 19] If time was devoted to these exercises, the instances of strains might be reduced with no added financial costs. Furthermore, if adolescents are taught the importance of such exercises in school physical education classes, they may also generalise this practice to less formal leisure pursuits. However, before such an injury prevention strategy is adopted, it is essential to ascertain the efficacy of these practices in reducing risk of injury through detailed scientific studies.

Analysis of injury severity measures showed that the 13 year olds seem to suffer more severe sports related injuries than 11 or 15 year olds, as indexed by the proxy measures of nights spent in hospital and missed days of school, and also by MAIS. This appears to result from the high frequency of fractures and dislocations within this age group. There is no reason to suppose this is simply a reporting phenomenon. Adolescents of this age may be engaged in different and intrinsically more hazardous sports and leisure activities. They may also have poorer body control because of physical maturation and the onset of puberty, which may lead to more severe injuries. Growth spurts associated with puberty may cause problems because of the time lag in the growth of bone and soft tissue—for example, in Osgood-Schlatter's disease. Also the calcification of bone during growth spurts may lead to increased injury risk because of increased stiffness of the bone, leading to decreased shock absorbing capabilities. Finally, 13 year olds may not possess the level of skill required to participate in sports and leisure activities safely. Detailed analysis of school rugby injuries for example shows that almost 30% of such injuries occur at the beginning of the season and might be reduced by a more intensive period of preseason training which would increase skill levels.[20] It is likely that all three factors outlined above have a role in the severity of injuries among 13 year olds, but without more detailed analysis of the actual sports engaged in it is difficult to ascertain which is the most important and consequently how best to reduce the severity of sports injuries at this age.

Left handedness has been found to be a risk factor for increased injury in both adults and children.[14 18 21] We have not found that left handed adolescents report more sports injuries, but the sports injuries sustained by left handers are more severe than those of right handers and more likely to result in hospitalisation. The reason is difficult to identify. It could be the use of right handed sports equipment, maturational coordination effects, or choice of sports activities engaged in. Again there is a need for more detailed information about the nature of the sports engaged in by left handers, especially since left handers have been shown to excel in some sports—for example, tennis, cricket, boxing, and fencing. Schools need to be aware that handedness seems to be important in increasing the chances of incurring serious injury during sports activities, which sometimes warrants hospitalisation.

Our results show that increased levels of participation are associated with a higher percentage of sports related injury. The question we asked resulted in a very high level of self reported sports participation. It seems likely that respondents used a very broad definition of "sport", possibly including many informal and unsupervised leisure activities such as playing football with their friends. Children who claim to play sport everyday report a far higher percentage of injury due to sports than to non-sports activities, which suggests that there is indeed an association between high levels of sports participation and increased risk of sports related injury.

It is important to remember that sports and leisure activities do not inevitably have to involve injury. In a study of elite adolescent athletes aged 8 to 16 years[22] who trained extremely frequently, it was found there was less than one injury per 1000 hours of training and that most of the injuries were minor. One interpretation of these findings is that once children develop training skills, sports and leisure activities become less intrinsically injurious.

Aside from the general use of warm up and cooling down exercises which are important for all sports activities,[10 19] there are a number of other ways to reduce the incidence and severity of sports related injuries. These include the provision and appropriate use of protective clothing, improvements in the design of sports equipment, structurally safe sports and leisure facilities, changes to rules to accommodate the age of the participants, and higher standards of coaching and teaching.[4] The specific strategy adopted to prevent sports related injuries will vary according to the particular sport, as the injury profiles of each sport differ markedly.[23] The injury profiles of different sports require more detailed analysis before sport specific injury prevention strategies can be developed and implemented among adolescents.[20] There has been little evaluation of many measures aimed to reduce injury as this would require completion of the audit cycle which has seldom been achieved.

In conclusion, this study provides epidemiological data on the frequency and distribution of sports related injury among a population of Scottish adolescents. The results show that sport injuries are frequent during this age range and that prevention strategies should be developed to reduce these injuries especially if increased participation in exercise is going to be encouraged. There remains the need for detailed research into injury associated with particular sports so that sports specific injury prevention strategies can be developed.

The authors would like to thank Dr Harry Campbell and Dr Stephen Platt for their helpful comments on an earlier draft of this paper. The research reported in this paper was funded by the Scottish Office Department of Health, although the opinions expressed are those of the authors, not the funding bodies.

1 Child Accident Prevention Trust. *Basic principles of accident prevention: a guide to action.* London: CAPT, 1989.
2 Scottish Office. *Scotland's health: a challenge to us all.* Edinburgh: HMSO, 1992.
3 Steptoe A, Butler N. Sports participation and emotional wellbeing in adolescents. *Lancet* 1996;**374**:1789–92.
4 Sahlin Y. Sports accidents in childhood. *Br J Sports Med* 1990;**24**:40–4.
5 Bijur PE, Trumble A, Harel Y, *et al*. Sports and recreation injuries in US children and adolescents. *Arch Pediatr Adolesc Med* 1995;**149**:1009–16.
6 Campbell H, O'Driscoll S. The epidemiology of leisure accidents in Scotland. *Health Bull (Edinb)* 1995:280–93.
7 Tursz A, Crost M. Sports related injuries in children. A study of their characteristics, frequency, and severity, with comparison to other types of accidental injuries. *Am J Sports Med* 1986;**14**:294–9.
8 Langley J, Cecchi J, Silva PA. Injuries in the tenth and eleventh years of life. *Australian Paediatrics Journal* 1987;**23**:35–9.
9 Chalmers DJ, Cecchi JD, Langley JD, *et al*. Injuries in the 12th and 13th years of life. *Australian Paediatrics Journal* 1989;**25**:14–20.
10 Lodge JF, Langley JD, Begg DJ. Injuries in the 14th and 15th years of life. *Journal of Paediatrics and Child Health* 1990;**26**:316–22.
11 Campbell H, Stone D. Preventing sport and leisure injuries. *BMJ* 1996;**313**:182–3.
12 Beattie TF, Currie CE, Williams JM, *et al*. How severe is childhood injury? *Injury Prevention* (in press).
13 Currie CE, Williams JM, Wright P, *et al*. Incidence and distribution of injury among schoolchildren aged 11–15. *Injury Prevention* 1996;**2**:21–6.
14 Coren S. Left-handedness and accident-related injury risk. *Am J Public Health* 1989;**79**:1040–1.
15 Wold B, Aaro L. *Health behaviour in school aged children, a WHO cross-national survey (HBSC): research protocol for the 1993–1994 study.* Bergen: Research Centre for Health Promotion, University of Bergen, 1994.
16 Association for the Advancement of Automotive Medicine. The abbreviated injury scale 1990 revision. Des Plaines, IL: Association for the Advancement of Automotive Medicine, 1990.
17 Porac C, Coren S, Duncan P. Life span age trends in laterality. *J Gerontol* 1980;**35**:715–21.
18 Wright P, Williams JM, Currie CE, *et al*. Left-handedness increases injury risk in adolescent girls. *Percept Mot Skills* 1996;**82**:855–8.
19 Kulund DN, Tottossy, M. Warm-up strength and power. *Orthop Clin North Am* 1983;**14**:427–48.
20 Lee AJ, Garraway WM. Epidemiologic comparison of injuries in school and senior club rugby. *Br J Sports Med* 1996; **30**:213–17.
21 Graham CJ, Dick R, Rickert VI, *et al*. Left-handedness as a risk factor for unintentional injury in children. *Pediatrics* 1993;**92**:823–6.
22 Baxter-Jones A, Maffulli N, Helms P. Low injury rates in elite athletes. *Arch Dis Child* 1993;**68**:130–2.
23 Kujala UM, Taimela S, Antti-Poika I, *et al*. Acute injuries in soccer, ice hockey, volleyball, basketball, judo, and karate: analysis of a national registry. *BMJ* 1995;**311**:1465–8.