ORIGINAL ARTICLE

Injury history as a risk factor for incident injury in youth soccer

K L Kucera, S W Marshall, D T Kirkendall, P M Marchak, W E Garrett Jr

Br J Sports Med 2005;**39**:462–466. doi: 10.1136/bjsm.2004.013672

See end of article for authors' affiliations

Correspondence to: K L Kucera, Department of Epidemiology, University of North Carolina, Chapel Hill, NC 27599-7435, USA; kkucera@email.unc.edu

Accepted 18 January 2005

Objectives: To determine if athletes with a self reported history of previous injury have a higher incident injury rate than athletes without a self reported injury history.

Methods: A prospective cohort study of Classic League soccer players playing at the level under 12 through under 18. Injury history forms were mailed to all registering Classic League soccer players in the North Carolina Youth Soccer Association during 1997–2000 (n = 7000); 1483 (19%) returned the baseline questionnaire and were followed up for injuries.

Results: There were 5139 player-seasons of follow up and an estimated 171 957 athlete-exposures. More than half self reported an injury history (59.7%). Overall, the unadjusted incidence rate was 4.6 (95% confidence interval (CI) 4.3 to 4.9) incident injuries per 1000 athlete-exposures. Multivariate generalised Poisson regression modelling indicated that players with one previous injury had a twofold greater risk of incident injury (IRR = 2.6; 95% CI 2.0 to 3.3), and those with two or more previous injuries had a threefold greater risk of incident injury (IRR = 3.0; 95% CI 2.3 to 3.8) compared with athletes with no previous injuries.

Conclusions: Injury history was associated with an increased injury rate. This suggests that, even in these youth soccer players, those with an injury history may be at higher risk.

Soccer is the most popular sport worldwide for adults and youth,[1] with over 200 national associations representing about 200 million active players, of whom 40 million are women.[2] The Soccer Industry Council of America estimates that 18.2 million Americans, 13.8 of who were under 18 years of age, played organised soccer in 2000.[3]

Previous injury and inadequate rehabilitation have been shown to be the most important intrinsic predictors for subsequent injury.[4–8] Van Mechelen *et al*[9] reported that previous injury, with an odds ratio of 9.41 (95% confidence interval 2.80 to 31.58), was one of the strongest independent predictors for sports injury. Powell *et al*,[10] in a population based study, reported that in high school soccer 8.4% (148/1765) of injuries to boys and 10.4% (184/1771) of injuries to girls were reinjuries. Ekstrand and Tropp,[4] in a one year prospective cohort study of male adults, found 2.3 times greater risk of injury for soccer players with a history of ankle problems. A recent study by Arnason *et al*[8] found that adult male soccer players with a history of ankle or knee sprain were at an increased risk of subsequent sprain injury to the ankle (odds ratio (OR) = 5.3; 95% CI 1.5 to 19.4) or knee (OR = 4.6 95%; 95% CI 1.6 to 13.4).

Youth sports injuries in non-school sport settings are rarely attended by trained health professionals, and the reinjury risk may be increased in this population because of inadequate treatment and rehabilitation. The primary purpose of this study was to examine self reported injury history as a risk factor for incident injury in a group of young soccer players participating in the North Carolina Youth Soccer Association (NCYSA) Classic Soccer League. A secondary purpose was to determine if previous lower limb, ankle, and knee injury influence reinjury rate at those body locations. Lower limb, specifically the ankle and knee, are the body parts most often injured in youth soccer.[6 10–21] No previous soccer studies have used multivariate regression techniques to describe the association between predictor variables and the rate of soccer injury.

METHODS

The NCYSA Classic Soccer League is one of the highest levels of team soccer competition in the state of North Carolina, second only to the Olympic Development Program. Classic League soccer comprises about 5000 boys and 2000 girls divided into seven levels of competition: under 12 (U12), under 13 (U13), under 14 (U14), under 15 (U15), under 16 (U16), under 17 (U17), and under 18 (U18). Divisions are based on birth year at the beginning of the season, but players sometimes play in higher levels at the league's discretion. Girls and boys teams compete separately: level U12 to U14 boys and girls play fall (autumn) and spring seasons, level U15 to U18 boys play only the spring season, and level U15 to U18 girls play in the fall season. At the coaches' discretion, teams generally play 14 games (two per weekend) and hold 20 (two a week) practices in a season. In game situations, coaches are required to play every player listed on the game roster, thus guaranteeing each player some game time.

A prospective cohort study was conducted to describe the association between self reported injury history and prospective incident injury. Fact sheets, consent forms, and injury history forms were included with NCYSA registration forms sent out to every player during 1997–2000. Players and their parents read about the study, signed the consent forms, and completed previous injury history information at the beginning of the season. In addition, detailed project descriptions were sent out to coaches and managers. Players who returned the consent forms were followed prospectively for incident injury from fall 1997 to spring 2000. This study was approved by the institutional review board of the Duke University Medical Center.

Incident injuries were reported by coaches by mail to NCYSA. Each week during the season, coaches filled out an

Abbreviations: CI, confidence interval; IR, injury incidence rate; IRR, injury incidence rate ratio; OR, odds ratio

Table 1 Injury incidence rates and unadjusted incidence rate ratios (n = 5139 athlete-seasons) and generalised adjusted incident rate ratios (n = 4453 athlete-seasons) for risk of incident injury in North Carolina Youth Soccer Association Classic League soccer players fall (autumn) 1997 to spring 2000

Variable	No of incident injuries	Athlete-exposures	Rate per 1000 athlete-exposures	95% CI*	Unadjusted rate ratio	95% CI*; CLR	Adjusted rate ratio†	95% CI; CLR
Previous injury								
None (ref)	187	75 683	2.5	2.1 to 3.0				
One	294	50 512	5.9	5.3 to 6.5	2.37	1.92 to 2.94; 1.53	2.57	2.00 to 3.29; 1.64
Two or more	306	44 429	6.9	6.1 to 7.7	2.79	2.25 to 3.46; 1.54	2.97	2.28 to 3.86; 1.69
Sex								
Male (ref)	467	109 957	4.3	3.9 to 4.7				
Female	320	60 666	5.3	4.7 to 6.0	1.24	1.06 to 1.45; 1.37	1.03	0.86 to 1.23; 1.43
Level								
U12–14 (ref)	271	76 510	3.6	3.1 to 4.1				
U15–18	516	94 114	5.5	5.0 to 6.0	1.54	1.30 to1.82; 1.40	1.33	1.08 to 1.65; 1.54
Position								
Midfield (ref)	241	58 937	4.1	3.6 to 4.7				
Defender	252	45 062	5.6	4.9 to 6.4	1.36	1.12 to 1.65; 1.47	1.23	1.00 to 1.51; 1.51
Forward	202	48 720	4.2	3.6 to 4.9	1.01	0.83 to 1.24; 1.50	1.01	0.82 to 1.23; 1.50
Goalkeeper	69	13 801	5.0	3.9 to 6.5	1.21	0.91 to 1.63; 1.80	1.00	0.73 to 1.37; 1.88
Soccer experience								
0–2 years (ref)	27	3626	7.5	5.2 to 1.09				
3–6 years	152	39 372	3.9	3.2 to 4.7	0.52	0.34 to 0.78; 2.29	0.52	0.34 to 0.80; 2.32
7–10 years	396	87 149	4.6	4.1 to 5.1	0.61	0.42 to 0.90; 2.17	0.62	0.42 to 0.92; 2.19
11–17 years	178	34 085	5.2	4.4 to 6.1	0.69	0.46 to 1.04; 2.25	0.62	0.40 to 0.97; 2.42
Classic League soccer experience								
0 years (ref)	99	17 094	5.8	4.7 to 7.3				
1–4 years	481	110 539	4.4	4.0 to 4.8	0.75	0.60 to 0.94; 1.59	0.65	0.50 to 0.83; 1.65
5–8 years	166	34 082	4.9	4.1 to 5.7	0.83	0.64 to 1.09; 1.72	0.53	0.39 to 0.72; 1.88
9–12 years	18	4904	3.6	2.2 to 5.9	0.61	0.36 to 1.05; 2.96	0.35	0.20 to 0.62; 3.17
BMI quartiles								
11.00–17.76 (ref)	157	43 474	4.0	3.4 to 4.6				
17.77–19.53	184	37 342	4.4	4.0 to 4.8	1.10	1.03 to 1.19; 1.16	1.00	0.92 to 1.08; 1.18
19.54–21.12	166	33 699	4.9	4.4 to 5.3	1.22	1.05 to 1.41; 1.34	0.99	0.84 to 1.17; 1.40
21.13–32.53	170	33 348	5.4	4.7 to 6.1	1.35	1.08 to 1.68; 1.56	0.99	0.77 to 1.27; 1.66

Incidence rate and unadjusted rate ratio used generalised Poisson regression model.
*95% confidence interval computed under standard large sample Poisson assumptions.[22]
†Generalised Poisson regression model rate ratio estimates are adjusted for all other covariates with complete data (n = 4453).
CLR, Confidence limit ratio (upper confidence limit divided by lower confidence limit[25]); BMI, body mass index (kg/m^2).

injury card containing team name, player identification number, injury date, injury type, and injury location. Injuries were defined, previous or incident, as any injury that resulted in a player being removed for part or all of a practice or game and/or miss subsequent practices or games. For the purposes of this study, lower limb injury was defined as injury to the hip, groin, thigh, knee, lower leg, ankle, foot, or toes. Knee injury was defined as any injury to the knee joint or knee cap. Ankle injury was defined as any injury to the ankle.

The main exposure under investigation in this study was self reported previous injury at baseline divided into three categories: no previous injury, one previous injury, and two or more previous injuries. Details about the previous injuries were obtained along with the following player information: sex, date of birth, level of competition, height, weight, usual playing position from the previous playing year, years of organised team soccer experience, and years of Classic League soccer experience.

Person-time at risk for injury was conceptualised as the number of athlete-exposures, game, and practice exposures combined, per season. In this study, individual level athlete data on athlete-exposures was not obtained. We therefore estimated athlete-exposures by subtracting from the average of 14 games and 20 practices per player an estimate of time lost because of injury. Our estimate of time lost because of injury was based on detailed phone interviews with 220 players who were questioned about their 1999–2000 prospective injuries. Number of practices and games lost was averaged by body part and subtracted from the overall exposure estimate. The average number of practices and games lost was estimated to be 4.67 for ankle injuries, 6.98 for knee injuries, 5.67 for lower limb injuries, and 4.47 for all other injuries. For example, the athlete-exposures for a player in one season who had one injury (an ankle injury) in the season are calculated as follows:

Total athlete-exposures = (34 practices and games) − (4.67 × 1 ankle injury that season) = 29.33 athlete-exposures

Injury incidence rates (IR = the number of incident injuries/number of athlete-exposures per season) and incidence rate ratios (IRR = exposed IR/unexposed IR) were computed along with 95% confidence intervals (95% CI) using a generalised Poisson regression model.[22] This model uses a log-link function and an over-dispersed Poisson model for residual variation, with the rate denominator (number of player-seasons at risk calculated above) included in the model as an offset term. In this study, there were repeated observations on the same players over time (multiple injuries per person over multiple seasons), creating statistical dependence (within subject correlation). To account for this, a Generalised Estimating Equation model[23 24] was used. The IRs and IRRs were stratified by the covariates of interest. On the basis of the results of stratified analysis, a multivariate model was fitted.

Effect modification was examined by comparing stratum specific estimates. Confounding was assessed using the log confounding risk ratio:

$\ln\text{CoIRR} = |\ln(\text{crude IRR}/\text{adjusted IRR})|$.

There were missing values for position, years of team experience, years of Classic League experience, and body mass index (BMI) in the data. In all, 15% of player-seasons

Table 2 Modification of injury history as a risk factor for incident injury in North Carolina Youth Soccer Association Classic League soccer players fall (autumn) 1997 to spring 2000: adjusted incidence rate ratios stratified by playing level and playing position (n = 4453 athlete-seasons)

	One previous injury versus none		Two or more previous injuries versus none	
	IRR	95% CI; CLR	IRR	95% CI; CLR
Adjusted estimates stratified by playing level*				
U12–14	2.47	1.67 to 3.64; 2.18	3.69	2.43 to 5.59; 2.30
U15–18	2.44	1.79 to 3.35; 1.87	2.57	1.88 to 3.52; 1.88
Adjusted estimates stratified by playing level and position†				
Among U12–14				
Defenders	1.28	0.71 to 2.28; 3.20	2.10	1.16 to 3.80; 3.27
Goalkeepers	1.84	0.91 to 3.76; 4.15	2.10	0.96 to 4.60; 4.80
Forwards	4.02	2.49 to 6.52; 2.62	5.21	3.14 to 8.64; 2.75
Midfielders	3.04	1.92 to 4.81; 2.50	5.41	3.35 to 8.75; 2.61
Among U15–18				
Defenders	1.37	0.89 to 2.10; 2.36	1.55	1.01 to 2.37; 2.35
Goalkeepers	1.97	0.97 to 4.02; 4.16	1.55	0.76 to 3.17; 4.19
Forwards	4.31	2.62 to 7.08; 2.71	3.84	2.29 to 6.43; 2.81
Midfielders	3.25	1.96 to 5.39; 2.75	3.99	2.40 to 6.62; 2.76

IRR, Incidence rate ratio; CLR, confidence limit ratio (upper confidence limit divided by lower confidence limit[25]).
*Generalised Poisson regression model stratified by playing level and adjusted for sex, playing position, years of playing experience, years of Classic League soccer experience, and body mass index.
†Generalised Poisson regression model stratified by playing position and playing level adjusted for sex, years playing experience, years of Classic League soccer experience, and body mass index.

were missing data on at least one of the above four variables. In pre-modelling analyses, there was very little difference in the strength of association for one injury versus no injury in the whole population versus the subgroup with complete information.

RESULTS

Descriptive statistics

A total of 1483 soccer players, on 212 Classic League teams, completed the baseline questionnaire; 37.4% were female and 62.6% were male. Mean (SD) age at baseline was 13 (1.9) years. Forty two percent of the population were 9–12 years old, 32% were 13–14 years old, 22% were 15–16 years old, and 4% were 17 years and older. The proportion of Classic League players who returned the baseline questionnaire was low—about 20%. Even though prospective injury data were collected on the entire Classic League population (including those who did not return the baseline questionnaire), we included in this analysis only the injury and baseline data from the 1483 who returned the baseline questionnaire, as the latter was the only source of data on retrospective injury history.

Playing position was evenly distributed across the cohort (27.2% defenders, 29.1% forwards, and 35.6% midfielders) except for goalkeepers (8.1%). Sixty percent of respondents reported a previous injury: 30.5% had one previous injury, 14.7% had two previous injuries, 14.5% had three or more previous injuries, and 40.3% had no previous injuries. During the three years of follow up, 40.7% of players sustained at least one incident injury.

The 1483 players accumulated 5139 player-seasons of follow up. The majority of exposure time occurred in the spring seasons: 2874/5139 (55.9%). Thirty six players were followed for one season, 163 for two seasons, 701 for three seasons, 412 for four seasons, and 171 for five or six seasons. U15 to U18 players represented 55.4% of all player-seasons. This population had a mean of 8.2 years of team soccer experience (range 0–17) and a mean of 3.0 years of Classic League experience (range 0–12). BMI was normally distributed: mean (SD) 19.54 (2.6) kg/m^2 (range 11.00–32.53).

At baseline, 47% (691/1483) of players self reported a history of injuries to the lower limb, 20.2% (300/1483) reported a history of ankle injuries, and 16.8% (249/1483) reported a history of knee injuries. During the course of follow up, 28.9% (429/1483) of players sustained incident injuries to the lower limb, 12.7% (189/1483) had incident ankle injuries, and 8.3% (123/1483) had incident knee injuries. Injuries to other body areas represented 13.1% (194/1483) of players at baseline and 11.7% (174/1483) of players during follow up.

During 1997–2000, 66.9% (605/905) of incident injuries were to the lower leg and 10.2% (92/905) were to the upper extremity. Of the lower leg injuries, 16.5% (149/905) were to the knee and 26.4% (239/905) were to the ankle. Of the injuries that had a type listed, the three most common types of injury during follow up were sprains at 35.9% (272/756), contusions at 28.8% (218/756), and fractures at 12.3% (93/756). Ankle sprains at 20.5% (155/756), knee sprains at 9.9% (75/756), and knee contusions 5.2% (39/756) were the three most common injury site by type combinations.

Injury incidence and unadjusted rate ratios

Table 1 shows IRs and IRRs for all categories of covariates for all participants. We observed 4.6 incident injuries per 1000 athlete-exposures (95% CI 4.3 to 4.9) overall during follow up for all participants.

There was a positive association between self reported injury history and incident injury in this population. Players with an injury history were injured at a rate 2.56 (95% CI 2.17 to 3.01) times higher than those without an injury history. Players with one previous injury had a 2.37 (95% CI 1.92 to 2.94) times higher rate of injury, and those with two or more previous injuries had a rate of injury 2.79 times (95% CI 2.25 to 3.46) higher than those with no previous injury.

Without adjustment for other covariates, female players were injured at a higher rate than male players, and U15 to U18 players had a higher rate of injury than U12 to U14 players (table 1). The injury rate was roughly the same for all positions. The injury rates tended to fall with increasing soccer and Classic League experience. Increasing BMI was associated with an increased injury rate. We had few players (1.9%) who were overweight (BMI greater than or equal to 25) and therefore we were unable to examine the injury risk in this subgroup.

Table 3 Incident rate ratios for subgroup analyses by anatomical site for risk of incident injury in North Carolina Youth Soccer Association Classic League soccer players fall (autumn) 1997 to spring 2000 (n = 4453 athlete-seasons)

	One previous injury at that site versus none		Two or more previous injuries at that site versus none	
	IRR	95% CI; CLR	IRR	95% CI; CLR
Ankle*	4.19	2.97 to 5.92; 1.99	8.16	4.89 to 13.61; 2.78
Knee†	5.84	4.04 to 8.44; 2.09	3.96	1.96 to 7.99; 4.08
Lower limb†	2.79	2.18 to 3.58; 1.60	3.67	2.81 to 4.78; 1.70

IRR, Incidence rate ratio; CLR, confidence limit ratio (upper confidence limit divided by lower confidence limit[25]).
*Generalised Poisson regression model for ankle injuries adjusted for player level.
†Generalised Poisson regression model for knee and lower limb injuries; no covariate adjustment.

Adjusted rate ratios

There was very little modification by playing position and level (table 2). In addition, none of the covariates studied (years of team experience, years of Classic League experience, sex, BMI, playing position, and level) showed any major confounding of the previous injury-incident injury association (table 1). Multivariate analysis indicated no difference in the rate of injury between male and female players when adjustment was made for other covariates and likewise for player position and BMI.

Subgroup analyses

To explore further the reinjury effect, we conducted subgroup analyses at three anatomical sites: knee, ankle, and lower limb. Because of small cell sizes, few covariates could be included in these models. In general, the association between previous injury and incident injury was even stronger when restricted to specific anatomical sites (table 3).

Sensitivity analyses

This study relied on coach report of incident injuries, and our finding of a positive association could be due to bias if coaches tended to under-report injuries in subjects with a positive injury history. A simple deterministic sensitivity analysis[22] was performed to explore the potential for bias from under-reporting of incident injury between the exposed and unexposed. Assuming 100% outcome specificity for exposed and unexposed groups, 100–70% outcome sensitivity in the exposed group, and 90–60% outcome sensitivity in the unexposed group, and no more than 10% difference between outcome sensitivity values of exposed and unexposed groups, the corrected unadjusted IRRs for one previous injury versus none, 2.37, ranged from 2.02 to 2.69, and for two previous injuries versus none, 2.79, ranged from 2.44 to 3.19.

Injury data on players who consented to participate but did not return baseline questionnaires could not be included in our analysis, as we had no data on injury history if the baseline questionnaire was not returned. This group was a large proportion of all the players (about 80%). We conducted a second sensitivity analysis to explore the potential for selection bias due to the low number of players who filled out the form. As long as the difference in the return rates between injury incident positive and injury incident negative subjects was no more than 10% in the injury history positive group—that is, 15% return versus 25% return—the corrected rate ratio for both associations were in the region of 1.5, indicating a smaller but still elevated effect of injury history on incidence of injury.

DISCUSSION

This analysis estimated an injury rate 2.6 times higher in athletes with at least one previous injury compared with athletes without any previous reported injury. The knee was at a nearly sixfold increased risk for one previous knee injury versus none, and the ankle was at a fourfold greater risk if the athlete had a previous ankle injury. Increasing years of soccer experience indicated a protective association in this study and may suggest a survival effect where uninjured players are more likely to continue playing soccer. These findings are consistent with the nature of youth soccer where kicking, planting, sprinting, jumping, and cutting are performed on undulating natural grassy terrain, which can be highly stressful for the foot and ankle structures.

Previous youth soccer studies report frequencies and incidence of injury, rather than rate ratios as we have in this study, and use a variety of injury definitions. Price *et al*[20] in a two year prospective study of male youth academy soccer players aged 9–19 found that only 3% of reported injuries were reinjuries. However, they did not include injuries before their study and used an injury definition of more than 48 hours of lost time. Soderman *et al*[26] followed 153 female youth soccer players for one season and found that 41% of traumatic injuries were re-injuries. Previous injuries were gathered retrospectively and injuries were recorded if they resulted in absence from one practice or game. One recent study of adult male soccer players examined risk factors in a multivariate model. Arnason *et al*[8] reported previous injury as a risk factor for subsequent ankle and knee injury (OR = 5.3 (95% CI 1.5 to 19.4) and OR = 4.6 (95% CI 1.6 to 13.4)). Findings from this study of adult soccer players are in general agreement with the results from our study of youth players. The strong association observed between previous injury and incident injury in this young cohort suggests that more effective mechanisms for providing health services to these young athletes need to be explored, as treatment and rehabilitation of the original injury may be inadequate.

There is a potential for selection bias due to the low return rate of the baseline injury form. History forms were returned separately from the registration and consent form, and therefore players may have been less inclined to return them. There is no particular reason to think that the return rate would be differential with respect to exposure status, and sensitivity analysis indicated that our findings are reasonably robust to mild selection bias. We were unable to determine if coaches reliably reported all injuries. Previous studies recommend on-site reporting of injury information in prospective studies, as recall of details decreases over time.[27 28] However, a well established result in epidemiology is that under-reporting only biases the rate ratio estimates when recall is different with respect to exposure status. In the case of differential under-reporting, it would lead to bias in our results if the under-reporting were related to the athlete's exposure status. A simple sensitivity analysis indicated that our findings are robust to mild under-reporting bias.

The strength and uniqueness of this study is that it is a three year prospective follow up of a large number of youth soccer players. This study included the younger age groups: 9–13 years. There have been few studies that included players of this age. Finally, multivariate analysis techniques were used to determine the relation between outcome and exposure while controlling for covariates.

What is already known on this topic

A history of injury has been shown to be an important risk factor for future injury in soccer. Knee and ankle are commonly injured body sites in soccer. Players competing in higher levels are injured more often than those in lower levels.

What this study adds

A multivariate analysis supports injury history as a strong predictor of incident injury in youth soccer and underscores the importance of prevention, treatment, and rehabilitation of the original injury. We observed a protective effect of increasing experience, which may indicate a survival effect.

In this study of youth soccer players, almost 60% reported a previous history of injury. Previous injury status was a strong predictor of incident injury. There was limited modification by playing position and level. For specific anatomical areas such as ankle, knee, and lower limb, the effect of previous injury on incident injury was stronger overall when compared with results from all previous injuries.

ACKNOWLEDGEMENTS

A study of this breadth could not be completed without the assistance of many colleagues. We acknowledge the administration of the NCYSA Kathy Robinson (president), Tom Mosier (database manager), Rachael Jones (administrative assistant), and Mark Moore (Classic program coordinator), and all the Classic team coaches and administrators. This would not have been completed without their help. At the Duke University K Lab, data collection and reduction was made possible by Tony Seaber, Tony Francisco, Kyle Leonard, Uttama Sharma, Jason Hurst, Trina Sanatmauro, Wesley Dowd, and Scott Colby. Erez Morag and Mario LaFortune of the Nike Sport Research Lab were advisors in the design, development, and conduct of this project. This project was funded by a grant from Nike Inc.

Authors' affiliations

K L Kucera, S W Marshall, Department of Epidemiology, University of North Carolina at Chapel Hill, NC, USA
D T Kirkendall, Department of Orthopaedics, University of North Carolina at Chapel Hill
P M Marchak, Duke University, Durham, NC, USA
W E GarrettJr, Department of Orthopaedics, Duke University

Competing interests: none declared

REFERENCES

1 **Dvorak J**, Graf-Baumann T, Peterson L, *et al*. Editorial. *Am J Sports Med* 2000;**28**:S1.
2 **Dvorak J**, Junge A. Football injuries and physical symptoms: a review of the literature. *Am J Sports Med* 2000;**28**:S3–9.
3 **Soccer Industry Council of America (SICA)**. National soccer participation survey. www.ussoccer.com/templates/includes/about/sica_sps.pdf (accessed 25 Jun 2003).
4 **Ekstrand J**, Tropp H. Incidence of ankle sprains in soccer. *Foot Ankle* 1990;**11**:41–4.
5 **Ekstrand J**, Gillquist J. Soccer injuries and their mechanisms: a prospective study. *Med Sci Sports Exerc* 1983;**15**:267–70.
6 **Nielsen A**, Yde J. Epidemiology and traumatology of injuries in soccer. *Am J Sports Med* 1989;**17**:803–7.
7 **DuRant R**, Prendergrast R, Seymore C, *et al*. Findings from the preparticipation athletic examination and athletic injuries. *Am Dis Child* 1992;**146**:85–91.
8 **Arnason A**, Sigurdsson SB, Gudmundsson A, *et al*. Risk factors for injuries in football. *Am J Sports Med* 2004;**32**:S5–16.
9 **Van Mechelen W**, Twisk J, Molendijk A, *et al*. Subject-related risk factors for sports injuries: a 1-yr prospective study in young adults. *Med Sci Sports Exerc* 1996;**28**:1171–9.
10 **Powell J**, Barber-Foss K. Sex-related injury patterns among selected high school sports. *Am J Sports Med* 2000;**28**:385–91.
11 **Inklaar H**. Soccer injuries. I. Incidence and severity. *Sports Med* 1994;**18**:55–73.
12 **Keller C**, Noyes F, Buncher R. Medical aspects of soccer injury epidemiology. *Am J Sports Med* 1987;**15**:S105–12.
13 **Ekstrand J**, Gillquist J, Moller M, *et al*. Incidence of soccer injuries and their relation to training and team success. *Am J Sports Med* 1983;**11**:63–7.
14 **Powell J**, Barber-Foss K. Injury patterns in selected high school sports: a review of the 1995–1997 seasons. *J Athl Train* 1999;**34**:277–84.
15 **Nilsson S**, Roaas A. Soccer injuries in adolescents. *Am J Sports Med* 1978;**6**:358–61.
16 **Schmidt-Olsen S**, Bunemann LKH, Lade V, *et al*. Soccer injuries of youth. *Br J Sports Med* 1985;**19**:161–4.
17 **Schmidt-Olsen S**, Jorgensen U, Kaalund S, *et al*. Injuries among young soccer players. *Am J Sports Med* 1991;**19**:273–5.
18 **Junge A**, Dvorak J. Incidence of football injuries in youth players: comparison of players from two European regions. *Am J Sports Med* 2000;**28**:S47–50.
19 **Kakavelakis K**, Vlazakis S, Vlahakis I, *et al*. Soccer injuries in childhood. *Scand J Med Sci Sports* 2003;**13**:175–8.
20 **Price R**, Hawkins R, Hulse M, *et al*. The Football Association medical research programme: an audit of injuries in academy youth football. *Br J Sports Med* 2004;**38**:466–71.
21 **Junge A**, Cheung K, Edwards T, *et al*. Injuries in youth amateur soccer and rugby players: comparison of incidence and characteristics. *Br J Sports Med* 2004;**38**:168–72.
22 **Rothman K**, Greenland S. *Modern epidemiology*, 2nd ed. Philadelphia, PA: Lippincott-Raven Publishers, 1988.
23 **Liang K**, Zeger S. Longitudinal data analysis using Generalized Linear Models. *Biometrika* 1986;**73**:13–22.
24 **Zeger S**, Liang K. Longitudinal data analysis for discrete and continuous outcomes. *Biometrics* 1986;**42**:121–30.
25 **Poole C**. Low P-values or narrow confidence intervals: which are more durable? *Epidemiology* 2001;**12**:291–4.
26 **Soderman K**, Adolphson J, Lorentzon R, *et al*. Injuries in adolescent female players in European football: a prospective study over one outdoor soccer season. *Scand J Med Sci Sports* 2001;**11**:299–304.
27 **Twellaar M**, Verstappen F, Huson A. Is prevention of sports injuries a realistic goal? A four-year prospective investigation of sports injuries among physical education students. *Am J Sports Med* 1996;**24**:528–34.
28 **Braham RA**, Finch CF, McCrory P. Sports trainers have accurate but incomplete recall of injury details [comment]. *Br J Sports Med* 2003;**37**:561.