



## Sports and recreational injuries: regional rural injury study-II: impact on agricultural households and operations

L S Kurszewski, S G Gerberich, R C Serfass, et al.

*Br J Sports Med* 2006 40: 527-535 originally published online March 17, 2006  
doi: 10.1136/bjism.2005.023903

---

Updated information and services can be found at:  
<http://bjsm.bmj.com/content/40/6/527.full.html>

---

*These include:*

### References

This article cites 30 articles, 17 of which can be accessed free at:  
<http://bjsm.bmj.com/content/40/6/527.full.html#ref-list-1>

### Email alerting service

Receive free email alerts when new articles cite this article. Sign up in the box at the top right corner of the online article.

---

### Topic collections

Articles on similar topics can be found in the following collections

[Statistics and research methods](#) (35 articles)

---

### Notes

---

To request permissions go to:  
<http://group.bmj.com/group/rights-licensing/permissions>

To order reprints go to:  
<http://journals.bmj.com/cgi/reprintform>

To subscribe to BMJ go to:  
<http://journals.bmj.com/cgi/ep>

## ORIGINAL ARTICLE

## Sports and recreational injuries: regional rural injury study-II: impact on agricultural households and operations

L S Kurszewski, S G Gerberich, R C Serfass, A D Ryan, C M Renier, B H Alexander, K Ferguson Carlson, A S Masten

*Br J Sports Med* 2006;**40**:527–535. doi: 10.1136/bjsm.2005.023903

See end of article for authors' affiliations

Correspondence to:  
Dr Gerberich, Regional Injury Prevention Research Center, Division of Environmental Health Sciences, School of Public Health, University of Minnesota, MMC 807, 420 Delaware St SE, 1260 Mayo, Minneapolis, MN 55455, USA; gerbe001@umn.edu

Accepted 9 February 2006

**Objectives:** To identify the incidence, severity, and potential risk factors for sports/recreational injuries incurred by children and adults in a five state, rural, Midwest, agricultural household population.

**Methods:** Computer assisted telephone interviews that included questions about all injuries were completed for eligible, participating households for 1999; 16 538 people participated, including 8488 children less than 20 years of age. Rates and 95% confidence intervals were calculated, and causal models guided multivariate models.

**Results:** Of a total of 2586 injuries, 1301 (50%) were not related to agricultural activity. Among these, 733 (28%) were associated with sports/recreational activities including multiple person sports (64%), general play activities (19%), and single person sports (14%). The overall rate was 46.4 injury events per 1000 persons per year. Rates for children were 99.4 for boys and 64.3 for girls. For adults (aged 20 and above), rates were 11.9 for men and 4.8 for women. For children, 93% received health care, 44% were restricted for seven or more days, and 18% lost agricultural work time of seven or more days; the respective proportions for adults were 88%, 45%, and 17%. Multivariate analysis for children showed increased risks for Nebraska residents, males, and those 10–14 or 15–19 years. For adults, increased risks were identified for males and those 20–24 years; decreased risks were observed for Nebraska residents and those 45–54 years.

**Conclusions:** Sports/recreational activities are an important source of injury with relevant consequences for this population, including significant restricted daily activity and lost agricultural work time. Key findings provide a basis for further study to address these burdens.

Sports/recreational activities are increasingly popular among all age groups, although these activities carry some risk of injury. In 1997, 62% of high school students reported participating in one or more sports teams,<sup>1</sup> and data from 1999 to 2001 indicated that 64% of adults participated in leisure time physical activity.<sup>2</sup> Based on research in the United States, it has been estimated that approximately four million sports/recreational injuries were treated in US hospital emergency departments; these injuries accounted for more emergency department visits than those involving motor vehicle occupants (3.5 million).<sup>3</sup> Internationally, studies have shown sports/recreational injuries in various settings to be an important source of injury morbidity.<sup>4–10</sup>

To date, research on sports/recreational injuries have been predominantly descriptive and often limited to specific types of sports. Moreover, few efforts have focused on rural populations. Recently, a need for population based sports/recreational injury research has been identified, particularly for rural populations.<sup>11</sup> Nordstrom *et al*<sup>12</sup> reported that 39% of all injury episodes in their rural study population resulted from sports/recreational activities. In the regional rural injury study-I, a population based study of agricultural households, it was found that 31% of all non-agricultural activity related injuries were sports/recreational injuries.<sup>13</sup> The goals of the present study were to identify the incidence and severity of, and potential risk factors for, sports/recreational injuries in a rural US Midwestern population.

## METHODS

Data for this study were derived from the 1999 regional rural injury study-II,<sup>14</sup> a population based study of agricultural operation households with children in Minnesota, Wisconsin,

North Dakota, South Dakota, and Nebraska; 16 000 operations (3200 per state) were randomly selected from the United States Department of Agriculture's National Agricultural Statistics Service (NASS) Master List Frame of Agricultural Operations. This study was approved by the University of Minnesota Institutional Review Board. Letters from investigators and respective state NASS offices were mailed to each operation to invite participation; these letters included information about the study, abiding by federal guidelines. Trained NASS interviewers conducted all interviews using a computer assisted telephone interview instrument developed by the research team.<sup>15</sup> Initial interviews obtained informed consent, established eligibility, and enrolled eligible households that agreed to participate. Households were eligible if they: were the agricultural operator's household and included children younger than 20 years of age (<20) as of 1 January 1999; produced >\$1000 of agricultural goods in the previous year or were involved in a Conservation Reserve Program; and were actively farming or ranching or involved in a Conservation Reserve Program, as of 1 January 1999.

Subsequently, households that met the eligibility criteria and agreed to participate received comprehensive packets containing a letter describing the first full length interview along with information cards to record demographics and injury information for all household members for each six-month period to facilitate data collection.<sup>15</sup> A comparable packet was mailed before the second full interview. As an incentive for participation, all households were eligible to

**Abbreviations:** GEE, generalised estimating equation; ICD-9-CM E-Codes 800–999, International Classification of Diseases-Ninth Revision, External Cause Codes; NASS, National Agricultural Statistics Service

**Table 1** Major sources of sports/recreational injuries among child and adult agricultural household members: regional rural injury study-II, 1999

Sports/recreational injury category	Children				Adults				Total			
	Male (n = 421)		Female (n = 246)		Male (n = 49)		Female (n = 17)		Male (n = 470)		Female (n = 263)	
	No	%	No	%	No	%	No	%	No	%	No	%
All multiple person sports/recreational activities	281	66.7	155	63.0	29	59.2	5	29.4	310	66.0	160	60.8
Basketball only	79	18.8	76	30.9	8	16.3	1	5.9	87	18.5	77	29.3
Football only	133	31.6	3	1.2	3	6.1	0	0	136	28.9	3	1.1
Play	81	19.2	58	23.6	2	4.1	0	0	83	17.7	58	22.1
Single person sports/recreational activities	47	11.2	29	11.8	14	28.6	10	58.8	61	13.0	39	14.8
Other/missing	12	2.9	4	1.6	4	8.2	2	11.8	16	3.4	6	2.3

Children are defined as <20 years of age and adults as ≥20 years of age. Multiple person sports/recreational activities include baseball, basketball, cheerleading/drill team, dancing, field hockey, football, ice hockey, martial arts, soccer, softball, track and field (selected by narrative), volleyball, water skiing, and wrestling. Play includes horseplay, physical education (general), play (general), and playground activities. Single person sports/recreational activities include aerobics, bicycling, boating, bowling, golf, gymnastics, hunting, ice fishing/fishing, ice skating, roller skating, in-line skating, running/jogging, skiing/snowboarding downhill, sledding, snowmobiling, swimming/diving, target practice/shooting, track and field (selected by narrative), weight lifting, trampoline, and rodeo activities. Other includes climbing a tree, climbing on a building, dirt bike racing, restoring an antique tractor, kickball, moving bleachers, playing frisbee, playing hacky sack, playing with a dog, racing, go-cart riding, running through a sprinkler, stunt driving, and surfing; bystanders to a hayride, sitting around a bonfire, and watching baseball.

enter a draw that provided an opportunity of at least one in 32 of receiving a \$100 US savings bond.<sup>16–18</sup> A follow up survey was sent to non-respondents in an attempt to determine whether the operations would have been eligible for participation.

Interviews were conducted during July 1999 and January 2000 to collect data for the respective previous six-month periods of 1999. The female head of household was the preferred respondent for injury information; the male head of household served as the respondent, as appropriate. Demographic data, injury occurrence, and information on pertinent agricultural and other exposures were collected for all members of the household (n = 16 538). A conceptual model, based on previously published information and expert knowledge, served as the basis for developing causal models<sup>15</sup> for both child and adult sports/recreational injuries.<sup>19</sup> These guided development of the data collection instruments, data analyses, and interpretation.

An injury was defined as any event resulting in one or more of the following: restriction of normal activities for four hours or more; loss of consciousness, loss of awareness, or amnesia for any length of time; use of professional health care. Sports/recreational injuries were defined as those resulting from organised, recreational, and general play activities. They were identified by both source classifications and injury narratives contained in the interviews. All persons of all ages were considered at risk of potential injury.

Data collection for each injury event included: activity; source/vehicle; associated circumstances; consequences including types of injury/diagnoses, health care received, restricted activity, impact on work activity; and other information recorded in narrative form. Injury event descriptions were coded by the research team using a simplified coding structure used in previous studies,<sup>13 20</sup> in combination with an expanded version of the International Classification of Diseases-Ninth Revision, External Cause Codes (ICD-9-CM E-Codes, 800–999).<sup>21</sup>

Injury event rates, calculated as injuries per 1000 persons per year, and 95% confidence intervals were calculated using univariate Poisson regression. These rates accounted for multiple injury events within each six-month period. Rates were adjusted for within household correlation using generalised estimating equations (GEEs).<sup>22</sup> Rates for missing levels were not calculated because of insufficient numbers. Potential selection bias due to non-response was partially accounted for by inversely weighting observed responses with

probabilities of response.<sup>23</sup> This was estimated as a function of the state of operation location, type of operation, and annual revenue by quintile from the NASS Master List Frame. To account for unknown eligibility among non-respondents, probability of eligibility was estimated for these same characteristics.<sup>24</sup> Denominators were based on the total number of eligible responses for each respective category. Odds ratios and 95% confidence intervals were calculated for risk of injury using multivariate logistic regression.<sup>25</sup> Causal models identified complex hypothesised interactions among potential confounders. They were used to select a minimum sufficient set of potential confounders when each exposure of interest was modelled in the multivariate analyses.<sup>19 26</sup>

## RESULTS

Among the 16 000 operations sampled, 4402 were eligible. Of these, 4122 (94%) operations participated in the first six-month interview and 3765 (86%) participated in both interviews. A total of 16 538 persons were residents on the operations (52% male, 51% under 20 years of age, and 99% white). Overall, 25% of operations refused participation.

A total of 2586 injury events were reported. Of these, 1301 (50%) were not related to agricultural activity, including 733 that were sports/recreational related. Of the 733 sports/recreational injuries, most occurred to males (64%) and those <20 years of age (91%).

There were 55 types of sports/recreational activity that resulted in injury. Multiple person sports were associated with over 60% of all injuries. Of those, over 40% were sustained in basketball and football (table 1). By major ICD-9 E-code classifications, E880–E888 (falls) (33%) and E916–E928 (other) (65%) comprised nearly all external causes of injury. By specific E-codes, injuries were classified primarily under E927 (overexertion and strenuous movements) for male (25%) and female (39%) children and male (45%) and female (47%) adults.

The most common types/diagnoses of sports/recreational injuries for children were sprains/strains (36%, boys; 48%, girls) and fractures/dislocations (31%, boys; 29%, girls). Among adults, men primarily sustained sprains/strains (45%), lacerations (16%), and fractures/dislocations (16%), and women primarily sustained sprains/strains (53%) and fractures/dislocations (29%). By anatomical location, children incurred injuries associated primarily with ankles (16%, boys; 24%, girls) and arms (16%, boys; 17%, girls), whereas adult involvement was varied (men: ankles, 16%, and fingers, 14%;

**Table 2** Severity measures associated with sports/recreational injuries: regional rural injury study-II, 1999

Severity measure	Children				Adults			
	Male		Female		Male		Female	
	No	%	No	%	No	%	No	%
Hospital admission								
No	404	96.0	239	97.2	45	91.8	17	100
Yes	17	4.0	7	2.8	4	8.2	0	-
Care location*								
None	31	7.4	19	7.7	4	8.2	4	23.5
Doctor's office	193	45.8	130	52.8	19	38.8	8	47.1
Hospital emergency room	136	32.3	68	27.6	16	32.7	4	23.5
Hospital in-patient	17	4.0	7	2.8	4	8.2	0	-
Dentist's office	11	2.6	6	2.4	2	4.1	0	-
Chiropractor's office	32	7.6	18	7.3	11	22.4	2	11.8
At scene of injury	22	5.2	11	4.5	2	4.1	1	5.9
Other healthcare facility	26	6.2	13	5.3	1	2.0	1	5.9
Length of restricted activities								
No restriction	63	15.0	26	10.6	8	16.3	0	-
>0 h to <4 h	16	3.8	17	6.9	2	4.1	0	-
4 h to <1 day	38	9.0	20	8.1	10	20.4	2	11.8
1 day to <7 days	131	31.1	62	25.2	11	22.4	3	17.6
7 days to <14 days	47	11.2	33	13.4	5	10.2	2	11.8
14 days to <1 month	57	13.5	32	13.0	4	8.2	2	11.8
1 month to <3 months	53	12.6	46	18.7	7	14.3	6	35.3
3 months+	16	3.8	10	4.1	2	4.1	2	11.8
Any lost agricultural work time								
No	265	62.9	180	73.2	31	63.3	9	52.9
Yes	156	37.1	66	26.8	18	36.7	8	47.1
Lost agricultural work time								
None	265	62.9	180	73.2	31	63.3	9	52.9
>0 h to <4 h	3	0.7	1	0.4	0	-	1	5.9
4 h to <1 day	9	2.1	3	1.2	6	12.2	0	-
1 day to <7 days	62	14.7	22	8.9	6	12.2	2	11.8
7 days to <14 days	19	4.5	15	6.1	1	2.0	2	11.8
14 days to <1 month	35	8.3	10	4.1	0	-	0	-
1 month to <3 months	22	5.2	14	5.7	4	8.2	3	17.6
3 months+	6	1.4	0	-	1	2.0	0	-
Missing/unknown/refused	0	-	1	0.4	0	-	0	-
Any other lost work time								
No	401	95.2	229	93.1	45	91.8	12	70.6
Yes	20	4.8	17	6.9	4	8.2	5	29.4
Other lost work time								
None	401	95.2	229	93.1	45	91.8	12	70.6
>0 h to <4 h	0	-	1	0.4	0	-	0	-
4 h to <1 day	2	0.5	1	0.4	1	2.0	0	-
1 day to <7 days	10	2.4	2	0.8	2	4.1	3	17.6
7 days to <14 days	0	-	4	1.6	1	2.0	0	-
14 days to <1 month	2	0.5	3	1.2	0	-	0	-
1 month to <3 months	5	1.2	5	2.0	0	-	1	5.9
3 months+	1	0.2	0	-	0	-	1	5.9
Missing/unknown/refused	0	-	1	0.4	0	-	0	-
Persistent problems								
No	368	87.4	214	87.0	35	71.4	11	64.7
Yes	53	12.6	31	12.6	14	28.6	6	35.3
Missing/unknown/refused	0	-	1	0.4	0	-	0	-

Children are defined as <20 years of age and adults as ≥20 years of age.  
\*Multiple responses possible.

women: knees, 29%, and fingers, 18%). A total of 42 brain injuries were incurred by children (7%, boys; 4%, girls) and adults (4%, men; 6%, women).

Children's sports/recreational injuries occurred most often at school (40%, boys; 45%, girls) and in sports/recreational areas (36%, boys; 31%, girls), followed by those on the agricultural operation (8%, boys; 11%, girls). Adult sports/recreational injuries occurred most often in sports/recreational areas (69%, men; 59%, women).

Injuries requiring hospital admission involved very small proportions of the study population. However, hospital emergency department care was used in respectively greater proportions (table 2). Overall, large proportions required some health care: male and female children, 93% and 92% respectively; male and female adults, 92% and 76% respectively. Female children and adults reported regular activity

restriction for one week or more in greater proportions than male children and adults. For female adults, this proportion was nearly twice that for male adults.

In concert with restricted activity, lost agricultural work time resulting from sports/recreational injuries was also reported. For female adults, restriction from agricultural work for one week to three months or more was more than twice that reported for male adults. Moreover, time lost from non-agricultural work for female adults was more than three times that for male adults. Female compared with male children also reported greater proportions of lost non-agricultural work time; however, the difference was not as great. As shown in table 2, persistent problems associated with the injuries were reported at the time of the interview for both male and female children and adults. These problems predominantly involved pain on movement or

**Table 3** Sports/recreational event rates per 1000 persons per year among agricultural household members: regional rural injury study-II, 1999

Exposure	Number exposed*	Number of injury events	Injury events per 1000 persons†
Total population	16537	733	46.4 (42.8 to 50.3)
Males			
Total	8539	470	57.0 (51.6 to 63.1)
Ages <20	4410	421	99.4 (89.4 to 110.6)
Ages 20+	4124	49	11.9 (8.9 to 16.0)
Females			
Total	7998	263	35.1 (30.6 to 40.2)
Ages <20	4077	246	64.3 (55.8 to 74.1)
Ages 20+	3917	17	4.8 (2.8 to 8.0)
Age groups (years)			
≤4	1108	37	34.6 (25.0 to 47.9)
5-9	1917	80	42.6 (33.7 to 53.9)
10-14	2643	272	112.4 (97.7 to 129.2)
15-19	2819	278	101.0 (88.7 to 114.9)
20-24	553	12	23.2 (13.2 to 40.7)
25-34	1059	7	6.1 (2.2 to 16.9)
35-44	3721	34	9.6 (6.8 to 13.7)
45-54	2277	11	5.0 (2.7 to 9.0)
55+	431	2	4.5 (1.1 to 17.8)
State of residence			
Minnesota	3178	125	44.1 (35.6 to 54.6)
Nebraska	3381	180	54.3 (46.5 to 63.5)
North Dakota	3498	155	45.6 (38.2 to 54.5)
South Dakota	3527	171	49.6 (41.9 to 58.6)
Wisconsin	2953	102	36.1 (29.2 to 44.5)
Educational status			
Incomplete (<20 years of age)	8487	667	82.5 (75.7 to 90.0)
Less than high school graduate	266	2	7.4 (1.9 to 29.2)
High school graduate/equivalency	3222	17	5.2 (3.3 to 8.4)
Technical school or some college	2897	37	12.8 (9.0 to 18.0)
College graduate/postgraduate	1652	10	7.3 (3.7 to 14.6)
Marital status			
Premarital age (<16 years of age)	6308	473	79.8 (72.0 to 88.5)
Married/living as married	7255	53	7.5 (5.6 to 10.0)
Never married	2770	205	76.0 (65.4 to 88.3)
Separated/divorced/widowed	187	2	10.8 (2.7 to 42.3)
Hours worked on own operation (weekly average)			
0	2765	100	38.1 (31.1 to 46.6)
>0-20	7715	457	61.1 (55.3 to 67.5)
>20-40	2287	111	51.4 (41.0 to 64.4)
>40-60	1446	26	17.5 (11.6 to 26.3)
>60-80	1290	19	14.5 (7.7 to 27.3)
>80	481	3	6.2 (2.0 to 18.9)
NA	553	17	45.2 (27.4 to 74.7)
Previous agricultural injury			
No	13387	621	48.4 (44.3 to 53.0)
Yes	3143	112	38.0 (30.6 to 47.1)

Values in parentheses are 95% confidence intervals. Sports/recreational event rates were calculated using Poisson regression, adjusted for within household correlation using generalised estimating equations (GEEs)<sup>21</sup> and weighted for non-response.<sup>22, 23</sup>

\*Number responded/injured corresponding to total injuries.

†Sum of all injury counts based on person-time in half-years; annualised rate adjusted for within household correlation using GEEs<sup>21</sup> and weighted for non-response.<sup>22, 23</sup>

exertion and decreased range of motion. The most common injury types associated with persistent problems were, for male children and male and female adults respectively, sprains/strains (42%, 43%, and 67%) and fractures/dislocations (34%, 29%, and 33%); for female children, these were primarily sprains/strains (55%) and torn ligaments (16%).

Injury consequences varied with the major sport subcategories. For injuries sustained in the multiple person sports subcategory, male and female children (42%, 45%) and adults (41%, 60%) were restricted from activities for seven or more days. As a result of football injuries, male children were restricted for seven or more days (47%) and sustained greater consequences from basketball injuries than female children. Of female adults injured in single person sports, 90% were restricted for seven or more days and 50% reported losing other work time.

As shown in table 3, the overall annualised rate for sports/recreational injuries was 1.6 times higher for males than for

females. Additional rates, for the total population, are also identified in the table. Table 4 presents rates for boys and girls separately, and table 5 presents rates for men and women separately.

Rates for the basketball and single person sports subcategories were similar for males (10.1 and 7.2) and females (9.8 and 6.0). Increased rates, associated with general play activities, were more common in the youngest age categories (0-4 years, 28.2; 5-9 years, 28.5; and 10-14 years, 20.3).

Multivariate analyses (table 6), based on persons at risk, identified increased risks for children who were: residing in Nebraska compared with Minnesota; male; and 10-14 or 15-19 years of age compared with those ≤4 years. Although the risk was also increased for children whose head of household educational status was incomplete, compared with college graduate/postgraduate, the small numbers resulted in an unstable estimate. For children who had sustained a previous agricultural injury, the increased risk was suggestive. The

**Table 4** Sports/recreational event rates per 1000 persons per year in child (<20 years of age) agricultural household members: regional rural injury study-II, 1999

Exposure	Boys		Girls	
	Number exposed* (injury events)	Rate† (95% CI)	Number exposed* (injury events)	Rate† (95% CI)
Total population	4410 (421)	99.4 (89.4 to 110.6)	4077 (246)	64.3 (55.8 to 74.1)
Age groups (years)				
<4	574 (23)	42.3 (27.9 to 64.0)	534 (14)	27.1 (16.1 to 45.5)
5-9	960 (44)	47.6 (35.2 to 64.4)	957 (36)	37.7 (26.6 to 53.4)
10-14	1395 (166)	126.5 (106.8 to 149.8)	1248 (106)	97.3 (77.3 to 122.5)
15-19	1481 (188)	130.7 (111.3 to 153.5)	1338 (90)	68.4 (55.2 to 84.8)
State of residence				
Minnesota	865 (62)	79.3 (59.9 to 104.8)	791 (43)	64.5 (43.9 to 94.7)
Nebraska	884 (111)	127.6 (104.9 to 155.2)	861 (61)	74.7 (56.7 to 98.3)
North Dakota	946 (87)	93.3 (72.7 to 119.6)	830 (56)	70.1 (53.3 to 92.1)
South Dakota	939 (106)	115.6 (93.8 to 142.4)	852 (52)	63.5 (46.4 to 86.7)
Wisconsin	776 (55)	76.4 (56.3 to 103.7)	743 (34)	46.9 (33.3 to 66.1)
Marital status				
Premarital age (<16 years of age)	3248 (283)	92.2 (81.0 to 104.8)	3060 (190)	67.6 (57.3 to 79.7)
Married/living as married	4 (1)	380.5 (94.8 to 1,526.4)	0	-
Never married	1157 (137)	120.5 (100.1 to 145.1)	1012 (56)	56.0 (42.6 to 73.7)
Hours worked on own operation (weekly average)				
0	811 (36)	46.2 (33.1 to 64.4)	1289 (59)	48.5 (37.2 to 63.2)
>0-20	2593 (276)	110.2 (96.7 to 125.7)	2481 (162)	67.4 (57.3 to 79.4)
>20-40	707 (83)	121.4 (96.9 to 152.1)	166 (18)	136.5 (67.8 to 274.9)
>40-60	128 (12)	92.0 (49.4 to 171.3)	13 (1)	84.8 (14.1 to 511.0)
>60-80	30 (5)	174.9 (35.3 to 867.5)	0	-
>80	0	-	0	-
NA	136 (9)	95.8 (49.5 to 185.3)	122 (6)	79.2 (32.3 to 194.3)
Previous agricultural injury				
No	3896 (353)	94.9 (84.4 to 106.8)	3826 (228)	63.1 (54.7 to 72.8)
Yes	514 (68)	136.0 (107.1 to 172.5)	250 (18)	87.0 (46.4 to 163.1)

Sports/recreational event rates were calculated using Poisson regression, adjusted for within household correlation using generalised estimating equations (GEEs)<sup>21</sup> and weighted for non-response.<sup>22, 23</sup> Rates presented for total population are for within household adjustments, not within age and sex adjustments.

\*Number responded/injured corresponding to total injuries.

†Sum of all injury counts based on person-time in half-years; annualised rate adjusted for within household correlation using GEEs<sup>21</sup> and weighted for non-response.<sup>22, 23</sup>

95% CI, 95% confidence interval.

subcategories of football (1.9; 95% CI 1.2 to 3.0) and multiple person sports (1.4; 95% CI 1.1 to 1.9) were also associated with increased risks. Reduced risk was identified for households with six or more children, compared with those with only one child.

For adults (table 7), increased risks were identified for: being male; being 20-24 years of age compared with 35-44 years; and having completed technical school or some college, compared with completion of high school. The risk of sports/recreational injuries was increased for people with previous agricultural injury, but the confidence interval included 1.0. In contrast with findings for the children, a reduced risk was observed for Nebraska, compared with Minnesota residents. A reduced risk was also observed for being 45-54 years of age compared with 35-44 years.

## DISCUSSION

Results indicate that sports/recreational injuries contribute substantially to the injury burden of rural, agricultural families living in the Midwest. These injuries not only accounted for nearly one third of all injuries but also resulted in measurable consequences including restricted activity and lost agricultural work time. This problem was particularly salient for female adults.

Among inherent study limitations, a potential limitation of this study is recall bias. Participants may have been more likely to remember and report more severe injuries. To address this potential bias, the reporting periods involved six-month data collection periods which have been shown to improve reporting validity.<sup>20, 27</sup> The use of information packets and forms on which participants could record information

about their injury events throughout the study period were also used to decrease recall bias.

Although the response rate among known eligible households was relatively high, there was also potential for some selection bias from non-participation. Adjustments for non-response, based on data from the NASS Master List Frame of Agricultural Operations, were made to minimise this potential bias using the strategy of Horvitz and Thompson.<sup>23</sup> Owing to the nature of the study, specific exposure data for each sports/recreational activity could not be obtained. Thus the estimates identified are considered conservative given that the entire population would probably not have been exposed to some of the sports/recreational activities studied. To minimise misclassification, the data collection instruments were subjected to rigorous development and testing, and interviewers had thorough training before each interview period. A conceptual model provided a basis for the design of the interview instruments. This model also served as a basis for the development of a more complex causal model and relevant applications<sup>19</sup> which enabled selection of a minimum sufficient set of potential confounders when each exposure of interest in the multivariate analyses was modelled.<sup>19</sup>

Although there is a possibility for changes over time within a study population, there is evidence of no difference in rates between the present study and recent data for 2001 which were collected in a comparable manner. This includes rates for the total population, males, females, children, and adults.<sup>28</sup>

Most population based sports/recreational research has focused on high school athletes in school settings<sup>5, 6, 9, 29-33</sup>; relatively few large population based sports/recreational

**Table 5** Sports/recreational event rates per 1000 persons per year in adult (20 or older) agricultural household members: regional rural injury study-II, 1999

Exposure	Men		Women	
	Number exposed* (injury events)	Rate† (95% CI)	Number exposed* (injury events)	Rate† (95% CI)
Total population	4124 (49)	11.9 (8.9 to 16.0)	3917 (17)	4.8 (2.8 to 8.0)
Age groups (years)				
20–24	307 (10)	35.1 (19.2 to 64.5)	246 (2)	8.4 (2.1 to 33.5)
25–34	418 (6)	13.3 (4.2 to 41.8)	641 (1)	1.4 (0.2 to 10.1)
35–44	1791 (24)	13.5 (9.1 to 20.2)	1930 (10)	6.0 (3.0 to 12.1)
45–54	1318 (7)	5.4 (2.6 to 11.4)	959 (4)	4.3 (1.6 to 11.6)
≥55	290 (2)	6.6 (1.6 to 26.5)	0	–
State of residence				
Minnesota	789 (14)	17.8 (10.5 to 30.0)	730 (6)	10.5 (4.2 to 26.4)
Nebraska	842 (7)	7.9 (3.8 to 16.5)	789 (1)	1.3 (0.2 to 8.9)
North Dakota	882 (10)	12.0 (6.5 to 22.3)	839 (2)	2.8 (0.7 to 11.2)
South Dakota	880 (9)	10.5 (5.5 to 20.1)	856 (4)	4.6 (1.7 to 12.4)
Wisconsin	731 (9)	12.5 (5.5 to 28.4)	703 (4)	5.7 (2.2 to 15.2)
Educational status				
Less than high school graduate	178 (2)	11.0 (2.7 to 43.8)	0	–
High school graduate or equivalency	1831 (14)	7.5 (4.5 to 12.7)	1391 (3)	2.1 (0.7 to 6.6)
Technical school or some college	1405 (29)	21.1 (14.3 to 31.2)	1492 (8)	5.1 (2.5 to 10.2)
College graduate/postgraduate	707 (4)	5.6 (2.1 to 14.9)	945 (6)	8.6 (3.5 to 21.3)
Marital status				
Married/living as married	3626 (37)	10.2 (7.2 to 14.4)	3624 (15)	4.6 (2.7 to 8.0)
Never married	357 (10)	29.8 (16.1 to 54.9)	244 (2)	8.5 (2.1 to 33.9)
Separated/divorced/widowed	137 (2)	14.5 (3.7 to 57.2)	0	–
Hours worked on own operation (weekly average)				
0	49 (2)	52.7 (13.4 to 206.9)	615 (3)	5.0 (1.6 to 15.5)
>0–20	548 (11)	19.6 (10.9 to 35.1)	2087 (8)	4.6 (2.1 to 10.0)
>20–40	710 (6)	8.3 (3.7 to 18.4)	704 (4)	5.5 (2.0 to 14.9)
>40–60	1045 (12)	11.4 (6.5 to 20.1)	259 (1)	3.6 (0.5 to 25.5)
>60–80	1169 (14)	11.8 (6.4 to 21.8)	0	–
>80	443 (3)	6.6 (2.1 to 20.5)	0	–
NA	160 (1)	9.4 (1.3 to 66.3)	135 (1)	11.8 (1.7 to 83.8)
Previous agricultural injury				
No	2365 (26)	11.1 (7.6 to 16.3)	3292 (14)	4.2 (2.5 to 7.1)
Yes	1753 (23)	13.2 (8.4 to 20.7)	625 (3)	7.7 (2.1 to 28.5)

Sports/recreational event rates were calculated using Poisson regression, adjusted for within household correlation using generalised estimating equations (GEEs)<sup>21</sup> and weighted for non-response.<sup>22, 23</sup> Rates presented for total population are for within household adjustments, not within age and sex adjustments.

\*Number responded/injured corresponding to total injuries.

†Sum of all injury counts based on person-time in half-years; annualised rate adjusted for within household correlation using GEEs<sup>21</sup> and weighted for non-response.<sup>22, 23</sup>

95% CI, 95% confidence interval.

studies have been conducted.<sup>7, 34, 35</sup> The present comprehensive study of agricultural operation household members enabled data collection on persons of all ages, resulting in identification of a variety of types of sport/recreational injury and injury consequences that occurred in assorted locations, including agricultural operations (9% of the total sports/recreational injuries), an environment in which work and sports/recreational activities may be intertwined.

Children incurred the vast majority of sports/recreational injuries, primarily in multiple person sports. Identified patterns of injury types/diagnoses and anatomical locations are largely consistent with other research, both population and clinical based.<sup>4–7, 10, 30, 35–37</sup> However, in addition to study method variations, differences due to injury definitions have been noted, suggesting that standardising definitions would aid future research comparability. Implementation of more comprehensive surveillance efforts would enable trend detection and serve as a basis for more in-depth studies of specific sports/recreational problems. Additional descriptive sport and recreational E-codes, currently limited in this area, would also assist in future research.

Although only a small proportion of those who sustained sports/recreational injuries were admitted to hospital, substantial proportions of the study population received some form of healthcare treatment. This suggests that hospital surveillance alone is not adequate for identifying the magnitude of the problem. Sports/recreational injuries

resulted in both restriction from regular activities and lost agricultural work time, which may affect not only the individual, but potentially entire households and respective agricultural operations. When children are involved, other household members may require time away from their work to provide care, leaving the work of both the children and adults unfinished. Previous research has alluded to these effects of lost work time, although not specifically in an agricultural setting and not in this detail.<sup>4, 34, 38–40</sup> These injuries appeared to have an important burden on the operations and require further study. Moreover, high proportions of female adults experienced lost time consequences from their injuries but required less health care, a finding that also requires further investigation.

Evidence of persistent problems underscores the potential long term consequences of injuries, not only for individuals, but also for the entire agricultural operation. Similar consequences have been identified in previous major population based studies<sup>13, 20</sup> by the same investigators. Sandelin *et al*<sup>4</sup> reported that most persistent problems were largely associated with sprains, a finding analogous to that identified in this study. Further research is warranted to examine the total impact of these problems on households and associated operations.

High injury rates per 1000 persons were particularly evident for male and female children who worked for more than 20 hours but less than or equal to 40 hours a week on

**Table 6** Multivariate analyses: personal risk of any sports/recreational activity related injury among child (<20 years of age) agricultural household members: regional rural injury study-II, 1999

Exposure	No responded	No of events	OR	95% CI
<b>State of residence*</b>				
Minnesota	1627	97	Referent	–
Nebraska	1725	155	1.5	1.1 to 2.0†
North Dakota	1716	126	1.2	0.8 to 1.6
South Dakota	1772	142	1.2	0.9 to 1.7
Wisconsin	1464	83	0.9	0.6 to 1.2
<b>Sex‡</b>				
Male	4324	371	1.5	1.3 to 1.8†
Female	3980	232	Referent	–
<b>Age (years)¶</b>				
≤ 4	1092	36	Referent	–
5–9	1890	76	1.2	0.8 to 1.8
10–14	2579	245	3.3	2.2 to 4.9†
15–19	2736	245	2.9	2.0 to 4.4†
<b>Head of household educational status§</b>				
Incomplete (age <20)	3	1	27.7	4.9 to 157.7†
<High School graduate	71	1	0.2	0.03 to 1.5
High school graduate	2240	142	0.8	0.7 to 1.1
Technical school or some college	3383	246	0.9	0.7 to 1.1
College graduate/postgraduate	2600	212	Referent	–
<b>Previous agricultural injury**</b>				
No	7544	522	Referent	–
Yes	752	80	1.3	1.0 to 1.7
<b>Hours worked per week††</b>				
0	2097	92	Referent	–
>0–20	5069	392	1.0	0.8 to 1.3
>20–40	869	91	1.1	0.8 to 1.6
>40–60	141	11	0.8	0.4 to 1.6
>60–80	33	2	0.7	0.2 to 3.1
<b>Number of children on agricultural operation‡‡</b>				
1	1000	75	Referent	–
2	2702	204	1.1	0.8 to 1.4
3	2672	206	1.1	0.8 to 1.5
4	1199	85	1.0	0.7 to 1.5
5	440	22	0.8	0.5 to 1.2
6+	284	10	0.5	0.2 to 0.9†
<b>Head of household age group¶¶</b>				
20–24	7	1	2.1	0.3 to 15.1
25–34	711	27	0.5	0.3 to 1.0
35–44	4464	321	0.9	0.6 to 1.4
45–54	2662	222	1.1	0.7 to 1.7
55–<100	453	31	Referent	–

Odds ratios (OR) were adjusted for within household correlation using generalised estimating equations,<sup>21</sup> excluding level for missing values, and weighted for non-response.<sup>22, 23</sup>

\*Adjusted for age and sex.

†95% confidence interval excludes 1.

‡Adjusted for age and state.

¶Adjusted for sex, head of household age, and state.

§Adjusted for head of household age and state.

\*\*Adjusted for age, sex, state, and head of household education.

††Adjusted for age, head of household age, sex, number of children in the household, head of household education, and previous agricultural activity related injury.

‡‡Adjusted for head of household age, state, and head of household education.

¶¶No covariates included in this model.

the agricultural operation, which further enhances the potential burden of injury on the households and agricultural operations. In general, boys had higher rates for all sports/recreational categories and subcategories, and, overall,

youngsters aged 10–14 and 15–19 had the highest rates. These findings are consistent with previous population based studies.<sup>34, 35</sup>

**What is already known on this topic**

- Little is known about sports/recreational injuries in rural populations; data are based primarily on individual types of associated activity and include only injury event descriptions
- Estimates from previous studies indicate injury rates of 31–39% of the respective study populations that were associated with sports/recreational injuries

**What this study adds**

- This study adds unique population based data on rural sports/recreational injuries incurred in a five state region of the United States; it includes information on both youth and adults and considers sex differences, among others
- Findings on the burden of these injuries, involving significant restricted activity and lost work time, are of particular importance

**Table 7** Multivariate analyses: personal risk of any sports/recreational activity related injury among adult (20 years and above) agricultural household members: regional rural injury study-II, 1999

Exposure	No responded	No of Events	OR	95% CI
State of residence*				
Minnesota	1481	20	Referent	–
Nebraska	1602	8	0.3	0.1 to 0.8†
North Dakota	1651	12	0.5	0.3 to 1.1
South Dakota	1712	13	0.5	0.3 to 1.1
Wisconsin	1385	11	0.6	0.3 to 1.2
Sex‡				
Male	4008	47	2.6	1.4 to 4.7†
Female	3823	17	Referent	–
Age (years)¶				
20–24	542	12	2.1	1.1 to 4.1†
25–34	1035	5	0.5	0.2 to 1.2
35–44	3621	34	Referent	–
45–54	2216	11	0.5	0.2 to 0.96†
55–<100	417	2	0.4	0.1 to 1.6
Educational Status§				
<High school graduate	252	2	1.5	0.3 to 6.8
High school graduate	3143	17	Referent	–
Technical school or some college	2828	35	2.3	1.2 to 4.1†
College graduate/post graduate	1604	10	1.8	0.8 to 4.1
Previous agricultural injury**				
No	5494	40	Referent	–
Yes	2323	24	1.4	0.8 to 2.5
Hours worked per week††				
0	661	5	Referent	–
>0–20	2625	19	0.8	0.3 to 2.3
>20–40	1407	10	0.5	0.2 to 1.9
>40–60	1299	13	0.6	0.2 to 2.0
>60–80	1251	12	0.5	0.1 to 1.8
>80	466	3	0.4	0.1 to 1.8
Number of children on agricultural operation‡‡				
1	2247	19	Referent	–
2	2838	28	1.2	0.7 to 2.2
3	1845	12	0.9	0.4 to 1.9
4+	893	5	0.7	0.2 to 1.9
Marital status¶¶				
Married/living as married	7062	50	Referent	–
Never married	584	12	1.7	0.7 to 4.2
Separated/divorced/widowed	177	2	1.3	0.3 to 5.7

Odds ratios (OR) were adjusted for within household correlation using generalised estimating equations,<sup>21</sup> excluding level for missing values, and weighted for non-response.<sup>22, 23</sup>

\*Adjusted for age and sex.

†95% confidence interval excludes 1.

‡Adjusted for age and state.

¶Adjusted for sex and state.

§Adjusted for age, sex, and state.

\*\*Adjusted for age, sex, state, marital status, and highest education level.

††Adjusted for age, sex, marital status, highest education level, previous agricultural injury, and number of children in the household.

‡‡Adjusted for state, age, marital status, and highest education level.

¶¶Adjusted for age, sex, state, and highest education level.

Through multivariate analyses, potential risk factors were identified. Males and those in the age groups of 10–14, 15–19, and 20–24 years appeared to be at increased risk of sports/recreational injury. However, although it is quite likely that participation in these age groups was greater than for other age groups, given expected exposures to various sports and recreational activities, absolute conclusions could not be drawn from this dataset. A suggestive increased risk was also found with an agricultural injury history. It is difficult to compare such findings with previous studies including multivariate analyses,<sup>9, 41</sup> because those focused on injury and sport specific types. Additional surveillance and/or focused studies would enable evaluation of relevant effects of policies and specific intervention measures based on identified potential risk factors from this and other studies.

For Nebraska residents, those <20 years were at increased risk whereas those 20+ years were at decreased risk of injury. The fact that over 30% of all football injuries were sustained by Nebraska boys under the age of 20 may account for some

of this risk, as these injuries had greater consequences than those for other multiple person sports. Given that over half of these football injuries resulted in some lost agricultural work time, further research on the role of football in overall injuries is warranted.

In summary, sports/recreational activities are an important source of injury morbidity, and relevant consequences for this agricultural population include significant restricted daily activity as well as restriction from agricultural work time. Results of this study indicate the need for further research, especially population based efforts, to identify specific risk factors that provide a basis for development of strategies to reduce this injury burden on the agricultural population and relevant operations.

## ACKNOWLEDGEMENTS

Support for this study was provided by: the National Institute for Occupational Safety and Health (NIOSH), Centers for Disease Control and Prevention, Department of Health and Human Services

(R01 CCR514375); the National Occupational Research Agenda Program, Midwest Center for Occupational Health and Safety, University of Minnesota (NIOSH T42/CCT510-422); and the Regional Injury Prevention Research Center, Division of Environmental Health Sciences, School of Public Health, University of Minnesota, Minneapolis, Minnesota. We are grateful for collaboration with, and assistance from, the United States Department of Agriculture, National Agricultural Statistics Service, including the five state offices, and the respective Agricultural Extension Service and state representatives. Most importantly, without the interest of, and commitments made by, the households selected in the five state region, this important study would not have been possible.

#### Authors' affiliations

**L S Kurszewski, R C Serfass**, Kinesiology, University of Minnesota, St Paul, MN, USA

**S G Gerberich, A D Ryan, B H Alexander, K F Carlson**, Regional Injury Prevention Research Center, Division of Environmental Health Sciences, School of Public Health, University of Minnesota, Minneapolis, MN, USA

**C M Renier**, Division of Education and Research, St Mary's/Duluth Clinic Health System, Duluth, MN, USA

**A S Masten**, Institute of Child Development, Psychology, University of Minnesota, Minneapolis

Funding: National Institute for Occupational Safety and Health (NIOSH), Centers for Disease Control and Prevention, Department of Health and Human Services. Grant numbers: R01 CCR514375; T42/CCT510-422. The authors' work is independent of the funders.

Competing interests: none declared

Presented at: American Public Health Association, Annual Meeting, Washington, DC, November 2004; Co-Best Paper Award, Student Paper Competition, Injury Control and Emergency Health Services section.

#### REFERENCES

- Pate RR**, Stewart GT, Levin S, *et al.* Sports participation and health-related behaviors among US youth. *Arch Pediatr Adolesc Med* 2000;**154**:904-11.
- Schoenborn CA**, Adams PF, Barnes PM, *et al.* Health behaviors of adults: United States, 1999-2001. National Center for Health Statistics. *Vital Health Stat 10* 2004;**219**:39-54.
- Burt CW**, Overpeck MD. Emergency visits for sports-related injuries. *Ann Emerg Med* 2001;**37**:301-8.
- Sandelin J**, Santavirta S, Lattila R, *et al.* Sports injuries in a large urban population: occurrence and epidemiological aspects. *Int J Sports Med* 1988;**9**:61-6.
- Backx FJG**, Erich WBM, Kemper ABA, *et al.* Sports injuries in school-ages children. An epidemiologic study. *Am J Sports Med* 1989;**17**:234-40.
- Backx FJG**, Beijer HJM, Bol E, *et al.* Injuries in high-risk persons and high-risk sports. A longitudinal study of 1818 school children. *Am J Sports Med* 1991;**19**:124-30.
- Mummery WK**, Spence JC, Vincenten JA, *et al.* A descriptive epidemiology of sport and recreation injuries in a population-based sample: results from the Alberta Sport and Recreation Injury Survey (ASRIS). *Can J Public Health* 1998;**89**:53-6.
- Dekker R**, Kingma J, Groothoff JW, *et al.* Measurement of severity of sports injuries: an epidemiological study. *Clin Rehabil* 2000;**14**:651-6.
- Grimmer KA**, Jones D, Williams J. Prevalence of adolescent injury from recreational exercise: an Australian perspective. *J Adolesc Health* 2000;**27**:266-72.
- 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.
- Finch C**, Mahoney M, Townsend M, *et al.* Rural sports and recreational injuries in Australia: what do we know? *Aust J Rural Health* 2003;**11**:151-8.
- Nordstrom DL**, Zwerling C, Stromquist AM, *et al.* Identification of risk factors for non-fatal child injury in a rural area: Keokuk County Rural Health Study. *Inj Prev* 2003;**9**:235-40.
- Gerberich SG**, Gibson RW, French LD, *et al.* The Regional Rural Injury Study-II (RRIS-II): a population-based effort. A report to the Centers for Disease Control, NTIS no PB94-134848. Atlanta: CDC, 1993.
- Gerberich SG**, Gibson RW, French LR, *et al.* Etiology and consequences of injuries among children in farm households: a regional rural injury study. A report to the Centers for Disease Control and Prevention, R01 CCR514375. Atlanta: CDC, 2003.
- Regional Rural Injury Study-II**. Regional Injury Prevention Research Center website. <http://ehs.umn.edu/riprc/riprc.html> (accessed 4 December 2005).
- Woodward A**, Douglas B, Miles H. Chance of free dinner increases response to a mail questionnaire. *Int J Epidemiol* 1985;**14**:641-2.
- Elkington JM**. A case-control study of farmwork-related injuries in Olmsted County, Minnesota [dissertation]. Minneapolis, MN: University of Minnesota, 1990.
- Boyle D**. Case-control of dairy cattle operation injuries [dissertation]. Minneapolis, MN: University of Minnesota, 1995.
- Greenland S**, Pearl J, Robins J. Causal diagrams for epidemiologic research. *Epidemiology* 1999;**10**:37-48.
- Gerberich SG**, Gibson RW, Gunderson PD, *et al.* The Olmsted Agricultural Trauma Study (OATS): a population-based effort. Report to the Centers for Disease Control. NTIS no PB92-107168/AS. Atlanta: CDC, 1991.
- U. S. Department of Health and Human Services. *Generic ICD-9-CM. Hospital version 1999*. Reno, NV: Channel Publishing, 1998.
- Liang KY**, Zeger SL. Longitudinal data analysis using generalized linear models. *Biometrics* 1986;**73**:13-22.
- Horvitz DG**, Thompson DJ. A generalization of sampling without replacement from a finite universe. *Am Stat Assoc J* 1952;**47**:663-85.
- Mongin SJ**. Adjustment for non-response in the Minnesota Nurses Study. Health Studies Research Report [online] 2001. <http://www1.umn.edu/eoh/NewsFiles/resreports.html> (accessed 5 March 2005).
- Rothman KJ**, Greenland S. *Modern epidemiology*. Philadelphia, PA: Lippincott-Raven Publishers, 1998, 79-91, 373-5.
- Hernan MA**, Hernandez-Diaz S, Werler MM, *et al.* Causal knowledge as a prerequisite for confounding evaluation: an application to birth defects epidemiology. *Am J Epidemiol* 2002;**155**:176-84.
- Braun BL**, Gerberich SG, Sidney S. Injury events: utility of self-report in retrospective identification in the USA. *J Epidemiol Community Health* 1994;**49**:604-5.
- Gerberich SG**, Alexander BH, Church TR, *et al.* Regional Rural Injury Study-II, Phase 2: Agricultural Injury Surveillance Technical Report, Centers for Disease Control and Prevention, R01 OH04270. Minneapolis: Regional Injury Prevention Center, University of Minnesota, 2004.
- Zariczny B**, Shattuck LJM, Mast TA, *et al.* Sports-related injuries in school-aged children. *Am J Sports Med* 1980;**8**:318-24.
- McClain LG**, Reynolds S. Sports injuries in a high school. *Pediatrics* 1989;**84**:446-50.
- Powell JW**, Barber-Foss KD. Injury patterns in selected high school sports: a review of the 1995-1997 seasons. *J Athl Train* 1999;**34**:277-84.
- Messina DF**, Farney WC, DeLee JC. The incidence of injury in Texas high school basketball. A prospective study among male and female athletes. *Am J Sports Med* 1999;**27**:294-9.
- Powell JW**, Barber-Foss KD. Sex-related injury patterns among selected high school sports. *Am J Sports Med* 2000;**28**:385-91.
- Conn JM**, Annett JL, Gilchrist J. Sports and recreation related injury episodes in the US population, 1997-99. *Inj Prev* 2003;**9**:117-23.
- 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.
- Zoch TW**, Cleveland DA, McCormick J, *et al.* Football injuries in a rural area. *WMJ* 1996;**95**:570-3.
- Rivara FP**, Calonge N, Thompson RS. Population-based study of unintentional injury incidence and impact during childhood. *Am J Public Health* 1989;**79**:990-4.
- Abernethy L**, MacAuley D. Impact of school sports injury. *Br J Sports Med* 2003;**37**:354-5.
- Krentz MJ**, Li G, Baker SP. At work and play in a hazardous environment: injuries aboard a deployed U.S. Navy aircraft carrier. *Aviat Space Environ Med* 1997;**68**:51-5.
- Hoy K**, Lindblad BE, Terkelsen CJ, *et al.* European soccer injuries. A prospective epidemiologic and socioeconomic study. *Am J Sports Med* 1992;**20**:318-22.
- Taylor BL**, Attia MW. Sports-related injuries in children. *Acad Emerg Med* 2000;**7**:1376-82.