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INJURIES

Risk of injury according to participation in specific physical activities: a 6-year follow-up of 14 356 participants of the SUN cohort

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Background Physical activity is generally accepted as a healthy habit. Nevertheless, its associated risk to cause injuries has not been sufficiently evaluated. Measuring this risk more precisely would contribute to giving more accurate health advice to the general population.

Methods Data are from participants (60% women, mean age 38 years) in a cohort of university graduates in Spain (1999–2008). Among other exposures and outcomes, they self report on frequency of participation in several physical activities over 1 year, and on incidence of sports-related injuries after 2, 4 or 6 years follow-up. Participation in 17 physical activities was categorized as a dichotomous variable (yes/no) and also according to average time per week spent in each one. Proportional hazards regression was used to estimate the adjusted relative risks [hazard ratios (HRs)] of incident injury associated with each specific physical activity or with total weekly energy expenditure in leisure-time activity [metabolic equivalents (METs)-h/week]. Statistical analyses were stratified by sex.

Results We identified 1658 incident sports-related injuries among 14 356 participants after a median follow-up of 4.6 years. When we adjusted for overall energy expenditure (METs-h/week) in other activities, age and body mass index (BMI), a higher risk of injury was associated with participation in soccer, other team sports, skiing, tennis, running and athletics (HRs ranging from 1.50 to 1.86) among men. With the exception of soccer (rarely practiced by women in Spain), similar results were found for women (HRs ranging from 1.61 to 2.04). Walking, gymnastics, swimming, mountain hiking and gardening were associated with a low injury risk.

Conclusions Despite the healthy effects of physical activity, we consider that the higher risk for injuries related to soccer, team sports, skiing, tennis, running or athletics should be taken into consideration when advice for more physical activity is given to the general population. Daily routine physical activities such as walking or gardening should be encouraged.

Keywords Sports, cohort studies, athletic injuries

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Introduction

It is a commonly accepted fact that sport activities lead to a higher incidence of injuries compared with not practising sports. Several relevant cohort studies have described the incidence of injuries related to specific sports.[1–6] However, there is scarcity of prospective evidence about the risk associated with the different types of physical activity. The only publication we are aware of that aimed to assess the longitudinal relationship between different types of physical activity and the incidence of injury is that of Parkkari *et al*.[6] They conducted a 1-year prospective cohort study assessing such a relationship in 3363 Finnish participants aged 15–74 years. Physical activities lasting >15 min were recorded and the incidence of acute and overuse injury was studied. The relative risk of sport-related injury was higher in squash, team sports, judo, contact sports or other martial arts, basketball, soccer, ice hockey, volleyball and baseball.[6] Other similar studies have been conducted among younger people.[1,3–5,7,8]

The objective of our study was to assess the relationship between various types of physical activities (those of daily living and sports) and injury incidence due to them in a cohort of Spanish adults.

Methods

The 'Seguimiento Universidad de Navarra' (SUN) study is an open enrolment multipurpose prospective cohort of university graduates from Spain that started at the end of 1999.[9] Recruited participants complete a baseline comprehensive self-administered questionnaire (Q_0) and are followed up through biannual mailed questionnaires, which include questions on certain risk factors and outcomes. A more detailed description of the sample population, follow-up data and data collection strategies has been published elsewhere.[9]

At baseline, participants are asked to provide a categorical value to the time invested in 17 physical activities (e.g. walking, cycling, various sports and others as listed in Tables 1 and 2) in the previous year. They are to report both on time spent on a weekly basis (10 categories from never to $\geqslant$11 h/week) and on the number of months in 1 year that they participated in each activity. These questions on exercise frequency have been validated and shown to correlate to actual metabolic equivalents (METs).[10] Participants were classified according to whether they participated or not in a particular activity and to the average time spent in this participation. Average MET consumption per each activity was derived from the Compendium of Physical Activities,[11] and it defines the ratio of energy for each physical activity to the metabolic rate while sitting quietly. The number of average METs in each activity was weighted by the weekly and monthly participation in that activity thus rendering a value of total physical activity (MET-hours) in a week (METs-h/week).[10]

In the 2- and 4-year follow-up questionnaires participants were asked whether there had been any changes in their physical activity habits. In addition, whether any participant sustained sports-related injuries that required medical treatment (the outcome of interest) was asked in all follow-up questionnaires (Q_2, Q_4 and Q_6). A specific operational definition of 'medical treatment' was not provided in the mailed questionnaires to participants; however, the requirement that the sports-related injury was diagnosed by a medical doctor was specified twice in the questionnaire. Since the cohort is an open one, participants vary in how long they have been participating. Thus, we searched in every participant's follow-up questionnaire, and it could be that a participant had only 2-year follow-up data, 2- and 4-year follow-up data or 2-, 4- and 6-year follow-up data. If a sports injury was reported in several follow-up questionnaires, we included for analysis only the earliest one, i.e. we considered the individual subject and not the event as the unit of analysis.

Statistical analyses

The relationship between participation (yes/no) in each particular activity and the incidence of a sports-related injury that had required medical treatment was assessed using Cox proportional hazards regression. Each activity was examined separately, i.e. we did not consider the different activities as mutually exclusive. Therefore, every participant was included in all the categories of the physical activities in which he or she participated. Follow-up time was defined as time from the baseline assessment to the occurrence of a sports-related injury or to the last available follow-up questionnaire if no incident injury occurred. This assessment was done for men and for women separately, as previous studies show that the effects of sports on the incidence of injuries are different in men than in women.[1,6,7] The following variables were included for adjustment: age (quintiles), body mass index (BMI) (continuous) and METs-h/week spent in other activities (continuous), i.e. to assess the association between participation (yes/no) in a specific activity and injury risk we assessed the METs-h/week spent in the rest of activities and adjusted for that variable (continuous). Alternatively, we also conducted another analysis adjusting instead for participation (yes/no) in each of the other activities (with a dichotomous variable for each of the other activities), without adjusting for METs-h/week.

For some activities (only those associated with a high absolute rate of injury in the crude analysis and only if at least 5% of men or 5% of women participated in them), we also performed a more detailed assessment of the relationship between the weekly time spent in each of these activities (four categories: 0, 0–0.5, >0.5–2 and >2 h) and the risk of incident injury. In these analyses we adjusted for age, BMI and for the sum of the total weekly time spent in leisure-time physical activities (continuous).

Results

Data from 15 859 participants recruited up to November 2005, who had answered any of the three follow-up questionnaires (Q_2, Q_4 or Q_6), were analysed. Participants lost to follow-up were 1503. Thus, the retention rate was 90.5%. Among those participants with 6-year follow-up ($n = 7087$), only 2.2% (158) failed to return one or two of their intermediate (2- or 4-year) follow-up questionnaires. Among those participants with only 4-year follow-up ($n = 4029$), only 3.8% (155) failed to return their intermediate (2-year) follow-up questionnaire. In all these cases we used the last available questionnaire.

The average age of participants was 38.1 years [standard deviation (SD) 12.1] although people up to 85 years old were included. Mean total leisure-time METs-h/week was 24.5 (SD 22.2). In the SUN cohort, 11.5% of participants experienced a physical activity-related injury after a median follow-up of 4.6 years.

Table 1 shows the distribution of participants according to their total leisure-time physical activity (categories of METs-h/week) and to participation (yes/no) in specific activities. Mean age and BMI were computed within strata of each physical activity. Participation in cycling, running, tennis, soccer and athletics was predominantly done by men, whereas aerobics and gymnastics were more frequent among women. Players in team sports (including soccer) were younger, whereas those participating in gardening, walking or gymnastics were older. Mean BMI was lower among participants in almost every activity when compared with non-participants.

Table 1 Socio-demographic characteristics of 14 356 participants of the SUN cohort according to their participation in leisure-time physical activities

	Men ($n = 5794$)			**Women ($n = 8562$)**		
	Participation (%)	Mean age (SD)	Mean BMI (SD)	Participation (%)	Mean age (SD)	Mean BMI (SD)
Total leisure-time physical activity (METs-h/week)						
<5	9.5	45.1 (12.3)	26.4 (3.3)	11.8	36.9 (10.4)	22.8 (3.4)
5–10	12.8	43.7 (12.1)	26.0 (3.2)	16.9	35.5 (10.0)	22.3 (3.2)
10.1–20	25.0	42.8 (12.7)	25.7 (3.1)	28.4	34.9 (10.4)	22.1 (3.1)
20.1–30	18.3	43.7 (13.7)	25.4 (2.9)	18.1	35.1 (10.7)	22.1 (3.1)
>30	34.4	40.5 (12.9)	24.9 (2.8)	24.8	34.2 (10.4)	21.7 (2.6)
Participation in specific activities						
Walking	69.3	43.1 (13.2)	25.4 (3.0)	64.4	35.6 (10.7)	22.1 (3.0)
Swimming	33.4	40.1 (12.3)	25.1 (2.9)	36.5	34.2 (9.8)	22.0 (2.9)
Mountain hiking	28.7	40.4 (11.9)	25.0 (2.9)	23.8	34.1 (9.5)	21.8 (2.7)
Cycling	24.5	39.3 (11.4)	24.9 (2.8)	14.6	32.4 (9.2)	21.7 (2.7)
Gymnastics	15.5	42.7 (13.3)	24.8 (2.7)	19.5	35.9 (10.7)	21.8 (2.8)
Running	24.6	35.9 (10.6)	24.7 (2.7)	12.6	30.1 (8.3)	21.4 (2.3)
Gardening	21.3	45.3 (12.6)	25.6 (2.9)	14.2	39.2 (10.4)	22.5 (3.2)
Tennis	24.1	36.9 (10.7)	24.9 (2.7)	11.5	31.9 (8.8)	21.5 (2.6)
Aerobics	3.9	38.7 (13.6)	25.2 (3.0)	23.2	31.2 (8.9)	21.7 (2.7)
Stationary bicycle	14.5	41.7 (12.7)	25.5 (2.9)	15.5	33.6 (10.0)	22.1 (3.0)
Skiing	12.6	37.9 (2.8)	24.8 (2.7)	11.1	32.7 (9.1)	21.3 (2.4)
Soccer	15.6	31.6 (8.1)	24.5 (2.7)	1.1	26.3 (6.8)	22.0 (3.4)
Athletics[a]	8.6	34.0 (10.0)	24.1 (2.4)	2.0	29.0 (8.4)	21.1 (2.5)
Other team sports[b]	5.8	30.4 (8.1)	24.7 (2.8)	2.2	26.2 (6.4)	21.5 (2.5)
Sailing	2.8	39.1 (10.9)	25.1 (3.0)	1.1	34.3 (9.3)	21.2 (2.6)
Judo, karate, other martial arts	1.5	33.9 (10.4)	25.2 (2.9)	1.0	32.0 (9.5)	21.7 (2.7)
Other sports	8.6	39.6 (12.6)	25.3 (3.0)	5.5	35.3 (10.3)	21.8 (3.0)

[a]Including also 'more competitive and faster running'.
[b]Defined as 'basketball, handball or other similar team sports'.

Table 2 presents the incidence rate of injury according to total leisure-time physical activity (categories of METs-h/week) and to the participation (yes/no) in specific activities. A monotonically increasing trend in risk was observed for METs-h/week. Specific activities have been ranked in the table according to their injury-associated rates for men and women considered together (last column of Table 2). Participants in soccer, team sports other than soccer (basketball and handball), athletics, and sailing exhibited higher rates of injury. However, these estimates were crude and participation in sailing was observed only in a very small proportion of our cohort (1.8%). Walking, gardening and aerobics were associated with the lowest crude rates.

Cox regression models were adjusted to evaluate the relationship between participation in each activity and the risk that a participant may experience a sport-related injury (Table 3).

Among men, when we adjusted for METs-h/week in other activities, three sports stood out to have particularly strong harmful associations for injuries: soccer, other team sports and athletics. Other activities with a significantly higher risk among men were skiing, running and tennis (Table 3). Sailing was associated with a higher risk among men, but only 84 men in our cohort reported to participate in this sport. Among women, team sports [adjusted hazards ratio (HR) 2.04, 95% confidence interval (CI) 1.45–2.87] and skiing (2.02; 1.67–2.45) were the two sports with the highest risk. Running was also associated with a high risk among women. We used the estimates for men and women considered together with adjustment for all activities (entering all of them as dichotomous variables in the same model) to rank activities from the highest to the lowest risk (Table 3, last column).

Table 4 presents the HR for incident sports-related injury according to the weekly time of exposure to

Table 2 Incidence density of injury according to physical activity—The SUN Project 1999–2008

	Injury rate (incidence density)						
	Men			Women			Overall[a]
	Cases	(Person-years)	Rate/10^3	Cases	(Person-years)	Rate/10^3	Rate/10^3
By total leisure-time physical activity (METs-h/week)							
<5	50	(2675)	18.7	34	(4950)	6.9	11.0
5–10	77	(3523)	21.9	61	(7010)	8.7	13.1
10.1–20	219	(7021)	31.2	148	(11 897)	12.4	19.4
20.1–30	197	(5130)	38.4	130	(7645)	17.0	25.6
>30	493	(9240)	53.4	249	(10 183)	24.5	38.2
Total	1036	(27 589)	37.6	622	(41 685)	14.9	23.9
By practice of specific activities							
Soccer	311	(4347)	71.5	15	(461)	32.5	67.8
Other team sports[b]	125	(1577)	79.3	37	(920)	40.2	64.9
Athletics[c]	164	(2296)	71.4	32	(845)	37.9	62.4
Sailing	55	(723)	76.1	15	(454)	33.0	59.5
Judo, karate, other martial arts	27	(402)	67.2	12	(398)	30.2	48.8
Running	391	(6752)	57.9	150	(5201)	28.8	45.3
Skiing	213	(3506)	60.8	147	(4686)	31.4	43.9
Tennis	390	(6824)	57.2	129	(5006)	25.8	43.9
Cycling	343	(6780)	50.6	144	(6112)	23.6	37.8
Stationary bicycle	194	(3886)	49.9	127	(6278)	20.2	31.6
Mountain hiking	369	(7943)	46.5	211	(9978)	21.1	32.4
Swimming	434	(9184)	47.3	285	(15 210)	18.7	29.5
Gymnastics	193	(4225)	45.7	166	(8041)	20.6	29.3
Walking	754	(19 140)	39.4	444	(26 707)	16.6	26.1
Gardening	213	(5786)	36.8	86	(5741)	15.0	25.9
Aerobics	56	(1061)	52.8	205	(9683)	21.2	24.3

[a]The overall rate (men and women together) has been used to rank activities according to the rates of injury of subjects who participated in them.
[b]Defined as 'basketball, handball or other similar team sports'.
[c]Including also 'more competitive and faster running'.

Table 3 HRs (95% CI) for incident injury associated with participation (yes vs no) in specific activities—The SUN Project 1999–2008

	Men			Women			Total (men & women)	
	Age-adjusted	Multivariate adjusted[a]	Multivariate adjusted[b]	Age-adjusted	Multivariate adjusted[a]	Multivariate adjusted[b]	Adjusted HR (95% CI)[b]	P^c
Soccer	1.89 (1.63–2.19)	1.86 (1.61–2.16)	1.51 (1.28–1.78)	1.95 (1.16–3.28)	1.34 (0.79–2.26)	0.71 (0.38–1.32)	1.46 (1.25–1.70)	<0.001
Skiing	1.58 (1.35–1.84)	1.48 (1.27–1.72)	1.27 (1.08–1.51)	2.37 (1.96–2.85)	2.02 (1.67–2.45)	1.76 (1.43–2.18)	1.44 (1.27–1.64)	<0.001
Athletics	1.91 (1.61–2.26)	1.64 (1.36–1.97)	1.44 (1.19–1.74)	2.56 (1.79–3.67)	1.75 (1.21–2.53)	1.16 (0.77–1.75)	1.37 (1.16–1.63)	<0.001
Running	1.59 (1.39–1.82)	1.53 (1.34–1.74)	1.21 (1.04–1.41)	2.38 (1.97–2.88)	1.85 (1.52–2.25)	1.62 (1.29–2.03)	1.34 (1.18–1.52)	<0.001
Sailing[d]	1.74 (1.32–2.30)	1.74 (1.32–2.29)	1.41 (1.05–1.89)	2.57 (1.54–4.30)	1.70 (0.99–2.91)	1.31 (0.74–2.33)	1.29 (1.00–1.68)	0.05
Other team sports	1.87 (1.54–2.27)	1.73 (1.42–2.11)	1.28 (1.03–1.58)	2.57 (1.83–3.61)	2.04 (1.45–2.87)	1.60 (1.09–2.37)	1.27 (1.05–1.53)	0.01
Tennis	1.53 (1.35–1.75)	1.50 (1.31–1.70)	1.19 (1.03–1.37)	1.85 (1.52–2.25)	1.61 (1.32–1.96)	1.19 (0.95–1.49)	1.21 (1.07–1.37)	0.002
Other sports	1.42 (1.17–1.72)	1.30 (1.08–1.58)	1.11 (0.91–1.37)	1.67 (1.26–2.22)	1.46 (1.10–1.95)	1.36 (1.01–1.82)	1.16 (0.98–1.37)	0.08
Stationary bicycle	1.41 (1.21–1.65)	1.31 (1.12–1.54)	1.17 (0.99–1.39)	1.54 (1.27–1.87)	1.32 (1.08–1.61)	1.15 (0.93–1.42)	1.15 (1.01–1.32)	0.03
Cycling	1.39 (1.22–1.58)	1.30 (1.14–1.48)	1.11 (0.96–1.29)	1.68 (1.39–2.03)	1.36 (1.12–1.65)	1.11 (0.90–1.38)	1.11 (0.98–1.25)	0.09
Aerobics	1.32 (1.00–1.73)	1.21 (0.92–1.59)	0.88 (0.66–1.19)	1.62 (1.36–1.93)	1.45 (1.22–1.73)	1.20 (0.99–1.46)	1.10 (0.95–1.29)	0.21
Swimming	1.32 (1.17–1.50)	1.22 (1.08–1.39)	1.10 (0.95–1.26)	1.48 (1.26–1.73)	1.30 (1.11–1.53)	1.04 (0.86–1.26)	1.10 (0.98–1.23)	0.10
Gymnastics	1.30 (1.11–1.52)	1.23 (1.05–1.44)	1.05 (0.88–1.24)	1.52 (1.27–1.81)	1.31 (1.09–1.57)	1.10 (0.90–1.34)	1.08 (0.95–1.23)	0.26
Mountain hiking	1.23 (1.09–1.40)	1.12 (0.98–1.27)	0.97 (0.84–1.12)	1.62 (1.37–1.92)	1.35 (1.14–1.60)	1.16 (0.95–1.41)	1.03 (0.91–1.15)	0.66
Walking	1.16 (1.01–1.33)	1.06 (0.92–1.21)	0.90 (0.77–1.05)	1.36 (1.14–1.72)	1.07 (0.89–1.28)	0.92 (0.75–1.13)	0.91 (0.81–1.03)	0.15
Gardening	1.09 (0.94–1.27)	0.97 (0.77–1.22)	0.90 (0.77–1.06)	1.04 (0.83–1.32)	1.00 (0.86–1.17)	0.75 (0.59–0.96)	0.85 (0.74–0.97)	0.02
Judo, martial arts	1.35 (0.92–1.99)	1.19 (0.81–1.76)	0.81 (0.53–1.23)	1.87 (1.05–3.32)	1.50 (0.84–2.67)	1.09 (0.57–2.07)	0.76 (0.53–1.08)	0.13

The reference category includes all subjects who do not participate in each specific activity.
[a]Adjusted for age (quintiles), BMI and for total physical activity (METs-h/week) due to other activities.
[b]Adjusted for age (quintiles), BMI and for participation in any other activity shown in the table (yes/no).
[c]P-values for the adjusted analyses with men and women together.
[d]Based on only 84 subjects at risk (males) and 37 subjects at risk (females).

Table 4 HRs (95% CI) for incident injury according to weekly time of exposure to selected activities

		Men			Women		
	Time/week	*N*	Age-adjusted	Multivariate adjusted[a]	*N*	Age-adjusted	Multivariate adjusted[a]
Total leisure-time physical activity							
Total time of exposure	<1 h	330	1 (ref.)	1 (ref.)	554	1 (ref.)	1 (ref.)
	1–5 h	2423	1.78 (1.22–2.60)	1.79 (1.22–2.62)	3933	2.24 (1.31–3.86)	2.26 (1.31–3.88)
	5.01–10 h	1817	2.52 (1.72–3.68)	2.55 (1.74–3.73)	2714	3.29 (1.91–5.64)	3.31 (1.92–5.68)
	>10 h	1224	3.14 (2.14–4.61)	3.20 (2.18–4.69)	1361	4.75 (2.75–8.22)	4.81 (2.78–8.32)
Specific activities							
Soccer	None	4862	1 (ref.)	1 (ref.)	8461	1 (ref.)	1 (ref.)
	<30 min	278	1.51 (1.19–1.92)	1.51 (1.18–1.92)	74	2.21 (1.26–3.85)	1.70 (0.97–2.98)
	30 min to 2 h	487	1.97 (1.65–2.36)	1.95 (1.63–2.34)	16	1.16 (0.29–4.68)	0.66 (0.16–2.69)
	>2 h	167	2.69 (2.09–3.47)	2.31 (1.78–2.99)	11	5.54 (1.78–17.31)	2.82 (0.89–8.90)
Other team sports	None	5426	1 (ref.)	1 (ref.)	8358	1 (ref.)	1 (ref.)
	<30 min	166	1.43 (1.08–1.90)	1.42 (1.07–1.88)	118	1.26 (0.69–2.31)	0.98 (0.54–1.79)
	30 min to 2 h	141	1.92 (1.43–2.58)	1.78 (1.32–2.39)	44	5.99 (3.56–10.10)	5.80 (3.44–9.78)
	>2 h	61	2.98 (2.08–4.29)	2.26 (1.56–3.29)	42	3.24 (1.88–5.57)	1.96 (1.13–3.41)
Athletics	None	5280	1 (ref.)	1 (ref.)	8374	1 (ref.)	1 (ref.)
	<30 min	143	1.52 (1.12–2.06)	1.35 (0.99–1.84)	99	1.40 (0.79–2.50)	1.24 (0.70–2.21)
	30 min to 2 h	232	1.63 (1.26–2.11)	1.50 (1.16–1.95)	65	3.45 (1.94–6.12)	2.21 (1.23–3.98)
	>2 h	139	2.71 (2.07–3.55)	2.08 (1.54–2.81)	24	9.30 (4.80–18.02)	3.30 (1.60–6.79)
Running	None	4333	1 (ref.)	1 (ref.)	7411	1 (ref.)	1 (ref.)
	<30 min	478	1.40 (1.15–1.70)	1.42 (1.17–1.73)	580	2.24 (1.75–2.86)	1.94 (1.51–2.48)
	30 min to 2 h	683	1.52 (1.28–1.80)	1.46 (1.23–1.73)	458	2.73 (2.12–3.54)	2.06 (1.57–2.69)
	>2 h	300	2.02 (1.61–2.53)	1.60 (1.26–2.04)	113	2.10 (1.15–3.82)	1.12 (0.60–2.10)
Skiing	None	4935	1 (ref.)	1 (ref.)	7379	1 (ref.)	1 (ref.)
	<30 min	490	1.58 (1.32–1.89)	1.56 (1.30–1.86)	680	2.06 (1.62–2.62)	1.91 (1.50–2.44)
	30 min to 2 h	268	1.23 (0.95–1.60)	1.12 (0.87–1.46)	377	2.82 (2.19–3.62)	2.34 (1.81–3.02)
	>2 h	101	2.43 (1.77–3.32)	2.02 (1.47–2.78)	126	3.03 (1.99–4.62)	2.01 (1.29–3.11)
Tennis	None	4335	1 (ref.)	1 (ref.)	7458	1 (ref.)	1 (ref.)
	<30 min	607	1.44 (1.21–1.71)	1.43 (1.20–1.71)	756	1.52 (1.20–1.93)	1.40 (1.10–1.77)
	30 min to 2 h	617	1.62 (1.37–1.93)	1.56 (1.31–1.86)	229	1.97 (1.37–2.82)	1.67 (1.17–2.40)
	>2 h	235	1.78 (1.38–2.28)	1.49 (1.15–1.93)	119	3.68 (2.49–5.43)	2.52 (1.69–3.76)

[a]Adjusted for age (quintiles) and BMI. The estimates for each specific activity were also adjusted for total time/week spent in leisure-time physical activity (continuous).

total physical activity and to the time spent in specific activities. We included in this assessment only those activities associated with a higher risk and with ⩾5% of either men or women participating in them.

Among men, a monotonically increasing dose–response trend was observed for four activities: soccer, other team sports, athletics and running. Among women this trend was apparent only for athletics and tennis (Table 4).

Discussion

Our findings show the close relation between some sports and injury; especially team sports showed a strong injury risk both among men and women. Physical activity is in general a healthy habit; however, the risk of injury associated with the participation in some activities needs also to be taken into account. Specifically, among men, a higher risk of injury in participants in soccer, other team sports and athletics was clearly apparent. On the contrary, walking, gardening, mountain hiking or swimming were not significantly associated with a higher risk of injuries. As for women, team sports other than soccer had an enormous detrimental association to injuries when the participation was >0.5 h/week. Both in men and women, to replace other sports by activities such as walking or gardening would reduce the risk of injury. The failure to find any association between soccer and injury in women could be explained by the fact that soccer is only seldom practiced in Spain by women. It must be considered that soccer is one of the most popular sports among men in Spain. As in other countries, soccer is also common among women, the lack of association between soccer and injury in our female participants might not be applicable to other countries. In any case, conclusions about soccer from this article should be generalized to those of team sports in general.

It seems clear that both in men and in women, team-based sports had a strong effect on injury incidence and thus, prevention efforts should be focused on them. Our results are similar to those of Parkkari *et al*., who found that commuting and lifestyle activities have low risk for injury, whereas the risk was higher in squash, contact and team sports. Interestingly, in their study, the absolute incidence of injuries was higher in commuting and daily living activities, as they were performed so often.[6]

Previous reports have been focused solely on specific sports and their conclusions are therefore limited only to the specific sports which the research addressed. Messina *et al*. selected 100 high-schools to survey the incidence of injury in the varsity teams. From these, 80 of the schools answered for the girl's teams and 75 for the boy's teams. They found that the risk of injury during a competitive game was higher than during usual participation and that females had greater risk of knee injuries (odds ratio 2.3).[7] Powell *et al*. studied the incidence of injuries in students participating in high-school sports and found higher incidence of injuries in males for various sports and higher risk for knee injury in girls.[8] Finch *et al*. prospectively followed up 1512 non-professional players of hockey, Australian football, basketball and netball. Injury rates were higher in Australian football and lower in netball. In addition, lower limb injuries were twice as common as those to the upper limb.[12] In comparison with these previous studies, our cohort allows a more comprehensive assessment of the risk associated with a wide variety of sports.

Study limitations and strengths

The precision of the results of the study may be limited by (i) the lack of studies validating the self-reported injury, (ii) the failure to record severity of injury and (iii) we do not know exactly in which sport did the injury occur—only that it did and the type and frequency of exercise that participants undertook. Furthermore, the number of people practicing some sports was relatively low and the frequency of those practicing it very often was even lower. However, we consider that these limitations do not influence on the validity of our results. The participants' quality as university graduates make it possible to surmise a significant validity of the factors and the outcome assessed in this study.[13] Other outcomes in the SUN Project have already been validated.[10,14] Data validity may also be threatened by a possible recall bias for those who had injuries, who may be more likely to differentially remember information on their physical activities. However, we have recorded information on physical activities at the baseline questionnaire (Q_0), before the incidence of injury occurred to avoid such bias.

Strengths of the study are its prospective design, which provides an adequate cause–effect temporal sequence, making it possible to point out team sports (including soccer) as the principal risk factor for injury in physical activity and, on the other hand, the protective effect of other daily life physical activities, such as walking or gardening. Also the relatively large sample (in comparison with previous reports) provides sufficient accuracy to the estimates of the effects.

Overall, this study points to a relationship between some sports and a higher injury incidence; most of all in team-based sports. We acknowledge the healthy effects of physical activity, but this study shows that not all of them are similar. This should be transferred to the population targeted recommendations of physical activities as good for health, stressing that it is better to participate in moderate physical activities, in agreement with the World Health Organization recommendations.[15]

Future research should be focused on the effect of each particular physical activity on the severity of injuries, and for risk factors—other than the physical activity—for more significant injuries, especially those risk factors which are modifiable. Also the study of the effect of each particular physical activity on general health would enlighten the conclusions made in this study.

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KEY MESSAGES

- Soccer, other team sports, skiing, athletics, running and tennis were associated with a high risk of injuries among men.
- Team sports, skiing, running, athletics and tennis were associated with a high risk of injuries among women.
- Walking, gardening, swimming or gymnastics did not noticeably increase the risk of injury in this cohort.
- Messages addressed to the general population promoting the participation in physical activity to prevent chronic disease should emphasize these lower-risk activities.

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