Cross-sectional associations between the diversity of sport activities and the type of low back pain in adulthood

Running title: “Diversity of sport activities and type of LBP”

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Abstract

Leisure-time physical activity has a complex relationship with low back pain (LBP). Thus, we aimed to investigate whether the diversity of sport activities is associated with the type of LBP. In the FinnTwin16 study, 4246 (55% females) Finnish twins at mean age 34.1 years replied to a health behaviour survey in 2010-12. Based on participation in different sport activities, we created two measures of diversity: quantity (i.e., the number of sport activities: 1, 2, 3, 4, and ≥5) and quality (i.e., the type of sport activity: endurance, strength, body care, etc.). Based on the frequency, duration, and type of LBP, we created three groups: no history of LBP lasting more than one day, radiating LBP, and non-radiating LBP. The associations between the quantity and quality of sport activities and type of LBP were investigated with logistic regression analyses. Participation in ≥5 sport activities associated with less radiating and non-radiating LBP in analyses pooled across sex (odds ratio 0.46, 95% CI 0.30-0.69 and 0.66, 0.44-0.99, respectively). However, the associations attenuated after adjusting for several confounders. Participation in endurance sports was associated with less radiating (0.58, 0.43-0.76) and non-radiating (0.60, 0.44-0.81) LBP, whereas strength sports and body care only with less radiating LBP (0.76, 0.58-1.00 and 0.26, 0.09-0.74, respectively) adjusted for all sport types. On a sport-specific level, running and cycling were associated with less radiating and non-radiating LBP. In adulthood, the diversity of sport activities, particularly participation in endurance sports, may be associated with less radiating and non-radiating LBP.

Keywords: Cohort study, Exercise, Low back pain, Lumbago, Physical activity, Sciatica

Introduction

Low back pain (LBP) is a common and costly public health problem causing individual and societal burden worldwide (Hartvigsen et al., 2018). By definition, LBP is a symptom that can be caused by several pathologies, but often the specific nociceptive cause remains undetermined. One of the most common symptoms is LBP with related leg pain, which is described using several terms such as sciatica, lumbar radicular pain, or nerve root pain, and is related to a less favourable prognosis than LBP without leg pain (Kongsted, Kent, Albert, Jensen, & Manniche, 2012; Konstantinou & Dunn, 2008). Globally, the estimated point prevalences have ranged from 1.0 to 49.7% (mean 18.3%) for non-radiating LBP (Hoy et al., 2012), and between 1.6 and 13.4% for radiating LBP in adult populations (Konstantinou & Dunn, 2008), the latter increasing more with age. Among young Finnish adults, the annual incidence of moderate (8–30 days duration) non-specific LBP has been 13.2% and that of radiating LBP 8.6% (Shiri et al., 2010).

Poor general health, obesity, smoking, psychological stress and sleep problems are known risk factors for LBP (Parreira, Maher, Steffens, Hancock, & Ferreira, 2018), yet, the role of physical stress on the spine seems the most complicated. A heavy workload, lifting, and awkward positions are strong risk factors for LBP, whereas leisure-time physical activities and exercise may both predispose to and protect from LBP (Auvinen, Tammelin, Taimela, Zitting, & Karppinen, 2008; Heneweer, Staes, Aufdemkampe, Rijn, & Vanhees, 2011). Recent meta-analyses suggest that leisure-time physical activity (LTPA) could moderately reduce the risk of radiating (Shiri, Falah-Hassani, Viikari-Juntura, & Coggon, 2016) and chronic, non-specific LBP (Shiri & Falah-Hassani, 2017). However, conflicting evidence exists on a U-shaped association between PA and LBP indicating that both sedentary lifestyle and high PA level or intensity may predispose to radiating (Shiri et al., 2013) and non-radiating back pain (Schiltenwolf & Schneider, 2009), especially among females (Heneweer et al., 2011).

Several studies have investigated whether some sport activities predispose to more LBP than others, with varying results (Auvinen et al., 2008; Farahbakhsh et al., 2018; Fett, Trompeter, & Platen, 2019; Foss, Holme, & Bahr, 2012; Guddal et al., 2017; Noormohammadpour et al., 2016; Trompeter, Fett, & Platen, 2017). Among athletes (aged 12 to 40 years), high LBP prevalence has been reported for skiers, rowers, and floorball players, and lower prevalences for triathletes, orienteers, golfers, and shooters (Farahbakhsh et al., 2018; Foss et al., 2012; Trompeter et al., 2017). In a population-based adolescent sample, participation in extreme, strength, and technical sports has been related to increased LBP, but participation in endurance sports has been beneficial in the prevention of LBP (Guddal et al., 2017). Topical debate on early sport specialisation suggests that the diversity of LTPA, such as participation in different sport activities in adolescence, could help to avoid overuse injuries and protect from LBP (Auvinen et al., 2008; Fabricant et al., 2016). Yet, some studies have found no association between back pain and participation in several sports in adolescence (Mogensen, Gausel, Wedderkopp, Kjaer, & Leboeuf-Yde, 2007; Moradi, Memari, ShayestehFar, & Kordi, 2015). A population-based study among adults detected a cross-sectional association between participation in five or more sport activities and less weekly LBP, but no longitudinal association between number of sport activities in adolescence and frequency of LBP in adulthood (Kaartinen et al., 2019). Notably, previous findings are focused on non-specific LBP and are mostly derived from studies among specific populations, either athletes or adolescents, who differ from the general population in the causes and mechanisms of LBP (Daniels, Pontius, El-Amin, & Gabriel, 2011; Heneweer et al., 2011; Moradi et al., 2015; Purcell & Micheli, 2009).

Our aim is to investigate whether the quantity and quality of sport activities is associated with radiating and/or non-radiating LBP among physically active general adult population. With sport activities, we refer to both competitive and recreational sports participated in during leisure time. Our hypothesis is that participation in several sport activities is associated with less radiating LBP, whereas non-radiating LBP is not associated with the quantity and quality of sport activities.

Methods

Sample

The population-based FinnTwin16 study investigates health behaviours in twins and their families. Virtually all twin births from 1975 to 1979 were identified from the Central Population Register and the first survey was mailed to twins in 1991–1995 a month after their 16th birthday. Follow-up surveys have been conducted at the mean ages of 17, 18, 24, and 34. The cohort has been described in detail elsewhere (Kaprio, Pulkkinen, & Rose, 2002; Rottensteiner et al., 2017). This study focused on the latest survey wave that was a web-based questionnaire conducted in 2010–12, with 4246 respondents (55% females) and a response rate of 72%.

With the aim to study the diversity of sport activities among those who do any PA, we identified twins who reported at least one sport activity and participated in LTPA at least once a month in their mid-thirties (n=3737, 57% females). We excluded 458 individuals with PA participation less than once a month, 51 individuals with no reported sport activities, 338 individuals with chronic diseases or disabilities (such as serious depression, osteoarthritis, or visual impairments) that hinder daily activities and 163 females who were pregnant during the survey.

The Ethics Committees of the Hospital District of Helsinki and Uusimaa and the Institutional Review Board of Indiana University, Bloomington, IN, USA have accepted the data collection protocol. The Ethics Committee of the Central Finland Hospital district approved the data collection of the fifth survey wave. Twins (or their parents) gave their written informed consent for participation in the study at each survey wave.

Leisure-time sport activities

In order to describe the diversity of LTPA, we utilised a multiple-choice question, "What is your LTPA like?", with 26 given choices and an open field with space for reporting additional sport activities (Supplement Document 1) (Rottensteiner et al., 2017). Based on these answers, we first created a sum variable to reflect the quantity of sport activities participated in. This variable was not normally distributed, thus, we created a new variable with five categories: 1, 2, 3, 4, and 5 or more sport activities (Kaartinen et al., 2019). Further, we considered the quality of sport activities (i.e., type of sport activities), and created nine categories of sport activities (Guddal et al., 2017): walking, endurance sports, strength sports, single games, team games, technical sports, aesthetic sports, combat sports, and body care. Activity categories with less than 30 participants were ignored. The full categorisation is shown in Supplement Table 1.

Low back pain

The survey included three different questions on back pain symptoms (Supplement Document 1). The first question was on the frequency of LBP during the past six months (never/seldom, approximately once a month, approximately once a week, and nearly every day). The second question enquired whether the back pain had ever lasted more than one day and, if yes, whether it had occurred 1–2, 3–9, or over 10 times. The third was a follow-up question for those who reported any back pain episode lasting more than one day, and asked how the pain was at its worst: 'sciatica' (pain that radiates to lower limb), 'lumbago' (sudden attack of pain), or 'other back disease, please specify'. Ultimately, we formed three groups based on reported symptoms: 1) individuals with radiating LBP among those who have ever had a back pain episode over one day + LBP at least once a month during the past six months + defined the worst pain as sciatica, 2) individuals with non-radiating LBP among those who have ever had a back pain episode over one day + LBP at least once a month during the past six months + defined the worst pain as lumbago, 3) individuals who reported no LBP lasting longer than one day including those who reported no weekly LBP and no back pain episodes lasting more than one day.

Covariates

Several well-known covariates for PA and LBP were used in our analyses (Bauman et al., 2012; Parreira et al., 2018). Mental health was assessed with the 12-item General Health Questionnaire (GHQ-12) (Goldberg et al., 1997). The frequency of sleeping problems (troubles to fall asleep or waking up during the night) was categorised as never/seldom, approximately once a month, approximately once a week, and nearly every day. Smoking status was categorised as current (combining daily and occasional smoking), former, and never smokers. BMI (kg/m^2) was calculated based on twins' self-reported height and weight. The level of LTPA was based on the survey data including active commuting and calculated as leisure-time Metabolic Equivalent of Task (ltMET-h/day) (Ainsworth et al., 2011; Makela et al., 2017). The education level (highest achieved degree) was categorised as compulsory (9 years), vocational secondary, academic secondary, and tertiary (university or polytechnic college). Categories for the work activity level were: light (sedentary/some walking), heavy (frequent walking/lifting/digging etc.), and not working/studying at the moment (Makela et al., 2017).

Statistical analysis

We conducted all the analyses with the Stata statistical package version 15 (Stata corp, 2017). Descriptive data were summarised by calculating frequency counts with percentages for categorical variables and means with standard deviations (SD) for continuous variables by the type of LBP. To explore whether the quantity and quality of sport activities was associated with radiating or non-radiating LBP, we used logistic regression analyses. The level of statistical significance was set at p<0.05.

All analyses were conducted separately for males and females, and when no sex interaction was detected we also conducted analyses pooled across sex. We adjusted all analyses for age during the survey. The analyses between the quantity (number) of sport activities and type of LBP were additionally adjusted for general and mental health, sleeping problems, smoking, BMI, level of LTPA, education level, and physical load at work. The analyses between the quality (type) of sport activities and type of LBP were adjusted for participation in other sport type categories (Guddal et al., 2017), and these analyses were conducted only when the sample size was at least 30 individuals. Since observations between the members of a twin pair may be correlated, we controlled for the clustering of twins within pairs by using robust estimators of variance in all analyses.

Results

Characteristics

Descriptive data are presented in Table 1 by sex and the type of LBP. Males reported more radiating LBP (23.3% vs. 22.5%) and non-radiating LBP (25.8% vs. 16.7%) compared to females, respectively. The mean number of sport activities participated in were similar for males 3.2 (SD 1.4) and females 3.1 (SD 1.4). For both sexes, the highest number of sport activities was found in the group of no LBP lasting longer than one day. Males who reported more than one sport activity also reported less non-radiating LBP, whereas females with more than one sport activity reported less radiating LBP (Supplement Figure 1).
Individuals with radiating LBP most often reported average or poor health status. They also reached the highest GHQ-12 scores, indicating mental distress. Both males and females who have never had LBP lasting

over one day reported higher levels of LTPA and lower BMI. Smoking, sleep problems, lower education and heavier physical workload were more commonly reported in the radiating and non-radiating LBP groups than in the group of no LBP lasting longer than one day (Table 1).

Quantity of sport activities

In the age-adjusted analyses, participation in at least 5 sport activities was associated with less radiating and non-radiating LBP among males, whereas with only less radiating LBP among females (Figure 1). The odds ratios (OR) (with 95% confidence intervals (CIs)) were 0.52 (95% CI 0.28-0.97) for radiating LBP among males participating in at least 5 sport activities and 0.50 (95% CI 0.27-0.90) and 0.48 (95% CI 0.27-0.85) for non-radiating LBP among males participating in 3 and at least 5 sport activities, respectively. Among females participating in 3 and at least 5 sport activities, ORs for radiating LBP were 0.54 (95% CI 0.33-0.89) and 0.41 (95% CI 0.24-0.71), respectively.

In the pooled analyses adjusted for age and sex, participation in 3 or more sport activities was associated with significantly less radiating LBP with the following ORs: 0.57 (95% CI 0.38-0.84) for 3, 0.61 (95% CI 0.39-0.95) for 4, and 0.46 (95% CI 0.30-0.69) for at least 5 sport activities. In similar analyses, participation in 3 and at least 5 sport activities was associated with less non-radiating LBP, with ORs 0.58 (95% CI 0.38-0.88) and 0.66 (95% CI 0.44-0.99), respectively. After adjusting for the covariates presented in the methods, the direction of the estimates remained but became statistically non-significant in both sex-specific and pooled analyses (Figure 1).

Quality of sport activities

In regard to the quality of sport activities, participation in endurance and strength sports, as well as body care activities, was associated with less radiating and/or non-radiating LBP (Table 2). Among males, participation in endurance sports was associated with less radiating (OR=0.58; 95% CI 0.37-0.90) and less non-radiating LBP (OR=0.52; 95% CI 0.34-0.78) when adjusted only by age. In similar analyses among females, participation in endurance and strength sports were associated with less radiating LBP (OR=0.55; 95% CI 0.37-0.80 and OR=0.58; 95% CI 0.40-0.84, respectively). The associations remained statistically significant when adjusting for participation in other types of sport activities and when pooling males and females together.

Concerning the specific sport activities (with 30 or more participants), running was associated with less radiating LBP (OR=0.49, 95% CI 0.33-0.73) and running, cycling, cross-country skiing, and ice/roller skating were associated with less non-radiating LBP among males (OR=0.49, 95% CI 0.34-0.71; OR=0.61, 95% CI 0.42-0.89; OR=0.63, 95% CI 0.41-0.96, and OR=0.40, 95% CI 0.21-0.78, respectively). Among females, participation in running, cycling, weight training, downhill skiing/snowboarding, and yoga/Pilates was associated with less radiating LBP (OR=0.50, 95% CI 0.35-0.71; OR=0.64, 95% CI 0.46-0.89; OR=0.64, 95% CI 0.44-0.93; OR=0.39, 95% CI 0.18-0.84; and OR=0.24, 95% CI 0.07-0.81, respectively). When pooling males and females together, statistically significant associations remained between participation in running or cycling and both less radiating and non-radiating LBP. The case was similar between yoga or Pilates and less non-radiating LBP (Table 3).

Discussion

This study examined how diversity of LTPA, described as the quantity and quality of sport activities, is associated with LBP. We found that participation in several sport activities in adulthood was associated with less radiating LBP in both sexes and less non-radiating LBP among males, but the associations attenuated when adjusting for several confounders. When the quality of sport activities was considered, pooling males and females together, participation in endurance sports was associated with less radiating and non-radiating LBP. Additionally, strength sports and body care activities were associated with less radiating LBP. On a sport-specific level, running was associated with less radiating and non-radiating LBP among males, whereas cycling, cross-country skiing, ice or roller skating were related to less non-radiating LBP. Among females, participation in running, cycling, weight training, downhill skiing or snowboarding, and yoga or Pilates were associated with less radiating LBP.

In our sample, the inverse association between participation in several sport activities and both radiating and non-radiating LBP lasting more than one day attenuated when we adjusted for several confounders, including LTPA level and physical load at work. This was in line with our previous findings from the FinnTwin16 study suggesting that participation in more sport activities is associated with less LBP in adulthood (Kaartinen et al., 2019). Our previous study included similar adjustments but a larger sample (n=3201), which could indicate that the smaller sample size (n=1200) partly explains the attenuation of associations in this current study. Similar studies among general adult populations are scarce, whereas the multifactorial nature of LBP is well-known (Hartvigsen et al., 2018). Studies among adolescents have increasingly addressed the potential harms and benefits of sport specialization (Fabricant et al., 2016). In a Finnish cohort study (N=6945), participation in multiple sports seemed to protect from the harms of a single risk sport in adolescence (Auvinen et al., 2008). In contrast, a cross-sectional survey among Danish adolescents (N=439) found no association between back pain and the number of sporting hours, the number of sports, or participation in sports in general (Mogensen et al., 2007). Additionally, a review on risk factors of LBP among athletes found moderate evidence for no association between LBP and participation in other sports (Moradi et al., 2015). However, this could be due to different characteristics between athletes and non-athletes, as well as training volumes and repetitive loads. Our suggestive population-based findings on the association between participation in several sport activities and less radiating and non-radiating LBP could be partly explained by the higher LTPA levels among individuals participating in more sport activities. Although we adjusted for LTPA levels, we suppose that participation in several sport activities may additionally increase the likelihood of sustaining LTPA levels throughout the changing seasons in Finland.

We found that participation in endurance sports was associated with less radiating LBP among both sexes and less non-radiating LBP among males. Similarly, participation in endurance sports was associated with less LBP in cross-sectional population-based studies among Norwegian adolescent girls and Finnish adolescents (Auvinen et al., 2008; Guddal et al., 2017). Among adult athletes, lower LBP prevalence has been detected among triathletes, orienteers, and runners (Farahbakhsh et al., 2018; Foss et al., 2012; Trompeter et al., 2017; Videman et al., 1995), but higher prevalences have been reported for skiers and rowers (Foss et al., 2012; Trompeter et al., 2017). In our population-based sample, cross-country skiing (n=384) and rowing (n=38) were not related to the increased level of LBP. However, these sport activities are very season-specific in Finland: rowing is mostly a summertime and skiing a wintertime sport. In addition to endurance sports, we found that participation in body care activities was associated with less radiating LBP, which is in line with clinical evidence that yoga and Pilates may improve back-related function and reduce pain (Skoetz et al., 2017; Yamato et al., 2016).

Interestingly on a sport-specific level, we detected more radiating and non-radiating LBP among those who engaged in walking or swimming, but without statistical significance. Yet, reviewed evidence indicated that physical activities like walking, cycling, and swimming practiced at moderate intensity may help to maintain fitness and control pain among patients with chronic LBP after rehabilitation (Ribaud et al., 2013). These are all activities that are relatively easy to engage in and adjustable regarding intensity. Thus, our cross-sectional findings about these sport types and also body care may also reflect the recommendations given to individuals with LBP, as well as their preference for walking and swimming while suffering LBP.

Contrary to previous studies, we detected no statistically significant risk sports for LBP. Among adolescents, both strength and gym training have been related to more LBP (Auvinen et al., 2008; Guddal et al., 2017), whereas in our sample, females who participated in strength sports had less radiating LBP. When comparing former athletes to control subjects, maximal weight lifting has been related to greater lumbar degeneration among former athletes, who, however, reported less back pain and did not significantly differ in hospitalisations or disability pensions (Videman et al., 1995). In young athletes, martial arts and games, such as volleyball, have been shown to be associated with higher incidence of LBP (Daniels et al., 2011; Noormohammadpour et al., 2016). In contrast, no higher back pain prevalence has been detected in elite athletes who engaged in repetitive overhead activities, such as volleyball or tennis, compared to physically active controls (Fett et al., 2019). In our sample, only a few (n=53) participated in volleyball, showing no significant association with more radiating LBP, while tennis and badminton seemed to be associated with less radiating LBP. Interestingly, participation in combat sports seemed to be associated with less radiating but more non-radiating LBP in our sample, which could be due to the characteristics of combat sports that include a relatively high risk of direct trauma. In our analyses pooled across sex, the highest, but non-significant, ORs for both types of LBP were detected in gymnastics, which has previously been found to be a risk sport among adolescents and young athletes (Auvinen et al., 2008; Purcell & Micheli, 2009).

Of note, in the interpretation of our results and previous findings is the considerable difference between adolescent and adult populations, as well as athletes. The main causes of LBP in adult populations are mechanics and osteoarthritis, while trauma spondylolysis/spondylolisthesis and hyperlordosis are common among adolescents (Daniels et al., 2011). Evidence among athletes indicates that sport type, repetitive loads, and training frequency are musculoskeletal risk factors of LBP (Moradi et al., 2015). Moreover, among young athletes, sports involving repetitive extension, flexion, and rotation have been identified as risk factors for LBP (Purcell & Micheli, 2009), but no such association has been detected among former endurance athletes compared to non-athletes (Foss et al., 2012). In general, large training volumes and previous LBP have been identified as risk factors for future LBP in athletes, adolescents, and adults (Auvinen et al., 2008; Foss et al., 2012; Heneweer et al., 2011). Moreover, LBP in adult populations is a multifactorial symptom, the development of which may involve work- and household-related physical activities and poor general or mental health to a stronger degree than LTPA (Hartvigsen et al., 2018).

FinnTwin16 is a large population-based sample including Finnish twins whose LTPA levels, measured as ltMETs , are comparable to adults globally (Hallal et al., 2012). However, we used selective inclusion criteria based on the frequency, duration, and type of LBP aiming to have distinctive categorisations, which somewhat restricted our sample size especially when analysing the quality of sport activities. The proportions of individuals with an episode of radiating or non-radiating LBP lasting more than one day in our sample were within the range of previous global estimates (Hoy et al., 2012; Konstantinou & Dunn, 2008), but due to differing definitions not comparable with previous Finnish estimates (Shiri et al., 2010). Overall, our sample may be considered representative, carefully chosen and controlled for.

The main limitations in our study are the cross-sectional design and possible recall bias. With only cross-sectional results, we are unable to determine the direction of the association, and reverse causality is possible (i.e., a history of LBP can hinder participation in some sport activities more than others). However, our survey gathered information on participation in sport activities and LBP not just recently but during the past six months. The short recall period was used to reduce the recall bias that is common in survey studies.

Self-reported PA participation is generally overestimated (Klesges et al., 1990), whereas patients with pain may notably underestimate their PA levels, thus counterbalancing the estimates (Kremer, Block, & Gaylor, 1981). Common for all self-reports, the test–retest reliability for back pain also depends on question wording and recall period, but is relatively good for questions similar to ours that relate to "ever" having back pain (Gill et al., 2016). Unfortunately, we were unable to use standardised definitions for radiating and non-radiating LBP (Kongsted et al., 2012; Konstantinou & Dunn, 2008). However, this is a common limitation in studies based on large health behaviour surveys. In addition, we lacked information on the frequency and mean duration of each sport activity, as well as possible regular participation in competitions, which may moderate the detected associations. Future studies should further explore a potential dose-response relationship between sport activities and types of LBP.

Conclusions

To our knowledge, no previous study has investigated the associations between the quantity and quality of sport activities and type of LBP in a population-based sample of young adults. Our results offer support to encourage participation in diversity of sport activities, and especially in endurance sports like running and cycling. Moreover, we suggest that participation in diversity of sport activities among the general adult population may load the musculoskeletal system in a more balanced way and improve motor control, which could prevent stress on the spine and reduce the amount of acute and chronic injuries. However, our findings should be further explored by using longitudinal designs, large population-based samples with more objective LTPA records and standardised LBP measurements.

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Table 1 Characteristics of the study sample by sex and type of low back pain

	Low back pain					
	MALES			FEMALES		
	No LBP > 1 day	Radiating	Non-radiating	No LBP > 1 day	Radiating	Non-radiating
N (%)	331 (48.2%)	160 (23.3%)	196 (28.5%)	568 (60.8%)	210 (22.5%)	156 (16.7%)
Age (y) – mean (SD)	34.0 (1.2)	34.0 (1.1)	34.1 (1.1)	34.0 (1.1)	34.1 (1.2)	34.1 (1.2)
Number of sport activities – mean (SD)	3.7 (2.1)	3.4 (2.2)	3.3 (2.0)	3.5 (1.9)	2.9 (1.6)	3.4 (2.0)
Leisure-time PA (MET-h/day) – mean (SD)	5.1 (4.1)	4.4 (3.1)	4.3 (3.2)	4.4 (3.7)	3.9 (3.4)	3.8 (3.0)
BMI (kg/m^2) – mean (SD)	25.1 (3.1)	26.4 (4.3)	25.9 (3.3)	23.3 (4.1)	24.6 (4.6)	24.5 (5.7)
GHQ-12 score – mean (SD)	9.4 (5.0)	11.3 (5.9)	9.7 (4.8)	10.2 (4.9)	11.7 (5.5)	11.0 (5.4)
Health status – n (%)						
- **Very or fairly good**	306 (93.1%)	122 (76.3%)	161 (82.2%)	517 (91.2%)	159 (75.7%)	127 (81.4%)
- **Average**	23 (7.0%)	34 (21.3%)	33 (16.8%)	42 (7.4%)	49 (23.3%)	26 (16.7%)
- **Fairly or very poor**	0 (0%)	4 (2.5%)	2 (1.0%)	8 (1.4%)	2 (1.0%)	3 (1.9%)
Sleeping problems – n (%)						
- **Never or seldom**	181 (55.0%)	62 (39.0%)	80 (41.2%)	283 (50.0%)	82 (39.2%)	52 (33.6%)
- **Monthly**	70 (21.3%)	44 (27.7%)	58 (29.9%)	144 (25.4%)	57 (27.3%)	47 (30.3%)
- **Weekly**	67 (20.4%)	38 (23.9%)	43 (22.2%)	100 (17.7%)	47 (22.5%)	38 (24.5%)
- **Nearly every day**	11 (3.3%)	15 (9.4%)	13 (6.7%)	39 (6.9%)	23 (11.0%)	18 (11.6%)
Smoking status – n (%)						
- **Current[a]**	76 (23.2%)	71 (33.7%)	60 (30.8%)	112 (19.8%)	56 (26.1%)	38 (24.4%)
- **Former**	59 (18.0%)	43 (27.0%)	57 (29.2%)	116 (20.5%)	52 (25.1%)	31 (19.9%)
- **Never**	192 (58.7%)	45 (28.3%)	78 (40.0%)	338 (59.7%)	101 (48.8%)	87 (55.8%)
Education level – n (%)						
- **Compulsory**	6 (1.8%)	11 (6.9%)	8 (4.1%)	5 (0.9%)	6 (2.9%)	5 (3.2%)
- **Vocational secondary**	87 (26.3%)	89 (55.6%)	75 (38.3%)	162 (26.8%)	74 (35.2%)	38 (24.4%)
- **Academic secondary**	42 (12.7%)	10 (6.3%)	31 (15.8%)	69 (12.2%)	42(20.0%)	23 (14.7%)
- **Tertiary (university or polytechnic college)**	196 (59.2%)	50 (31.3%)	82 (41.8%)	342 (61.2%)	88 (41.9%)	90 (57.7%)
Work activity level – n (%)						
- **Light[b]**	262 (79.4%)	83 (51.9%)	127 (64.8%)	394 (69.6%)	108 (51.4%)	92 (59.0%)
- **Heavy[c]**	57 (17.3%)	67 (41.9%)	67 (34.2%)	106 (18.7%)	63 (30.0%)	43 (27.6%)
- **Not working or studying**	11 (3.3%)	10 (6.3%)	2 (1.0%)	66 (11.7%)	39 (18.6%)	21 (13.5%)

BMI, body mass index; GHQ-12, the 12-item General Health Questionnaire; LBP, low back pain; MET, Metabolic Equivalent of Task; PA, physical activity; SD, standard deviation

[a]Including occasional smokers

[b]Sedentary/some walking

[c]Frequent walking/lifting/digging, etc.

Table 2: Categories of sport activities participated in and type of low back pain in adulthood

	MALES (N=687)					FEMALES (N=934)					BOTH SEXES (N=1621)				
	ADJUSTED FOR AGE										ADJUSTED FOR AGE & SEX				
Sport activity		**Radiating LBP**		**Non-radiating LBP**			**Radiating LBP**		**Non-radiating LBP**			**Radiating LBP**		**Non-radiating LBP**	
categories	**N**	**OR**	**95% CI**	**OR**	**95% CI**	**N**	**OR**	**95% CI**	**OR**	**95% CI**	**N**	**OR**	**95% CI**	**OR**	**95% CI**
Walking	330	1.37	0.94-1.98	1.13	0.79-1.60	726	1.25	0.85-1.84	1.26	0.80-1.97	1056	1.31	1.00-1.72	1.21	0.91-1.59
Endurance sports[a]	517	0.58*	0.37-0.90	0.52***	0.34-0.78	750	0.55**	0.37-0.80	0.71	0.46-1.12	1267	0.56***	0.42-0.75	0.60**	0.44-0.80
Strength sports[b]	288	0.83	0.56-1.24	0.97	0.67-1.41	285	0.58**	0.40-0.84	0.92	0.63-1.35	573	0.69**	0.53-1.90	0.93	0.71-1.22
Games															
- **Single[c]**	160	0.86	0.54-1.39	1.01	0.66-1.55	81	0.60	0.32-1.13	0.76	0.40-1.44	241	0.76	0.52-1.10	0.92	0.65-1.30
- **Team[d]**	250	0.91	0.61-1.37	0.97	0.68-1.41	75	0.95	0.54-1.68	0.74	0.37-1.50	325	0.92	0.67-1.28	0.92	0.66-1.27
Technical sports[e]	103	0.82	0.48-1.43	0.69	0.40-1.17	146	0.73	0.45-1.18	1.13	0.71-1.82	249	0.78	0.54-1.11	0.89	0.62-1.27
Aesthetic[f]	25					195	1.18	0.80-1.74	1.07	0.69-1.64	220	1.08	0.75-1.56	1.15	0.78-1.72
Combat sports[g]	30	0.53	0.17-1.64	1.21	0.53-2.79	12					42	0.37	0.13-1.08	1.33	0.66-2.66
Body care[h]	3					44	0.31*	0.11-0.88	0.63	0.26-1.54	47	0.28*	0.10-0.81	0.67	0.29-1.51

ADJUSTED FOR AGE, SEX, AND PARTICIPATION IN OTHER TYPES OF SPORT ACTIVITIES															
		Radiating LBP		**Non-radiating LBP**			**Radiating LBP**		**Non-radiating LBP**			**Radiating LBP**		**Non-radiating LBP**	
	N	**OR**	**95% CI**	**OR**	**95% CI**	**N**	**OR**	**95% CI**	**OR**	**95% CI**	**N**	**OR**	**95% CI**	**OR**	**95% CI**
Walking	330	1.25	0.86-1.84	1.11	0.77-1.60	726	1.14	0.76-1.70	1.24	0.79-1.97	1056	1.21	0.91-1.59	1.14	0.86-1.51
Endurance sports[a]	517	0.58*	0.37-0.91	0.54**	0.33-0.83	750	0.56**	0.38-0.82	0.70	0.45-1.10	1267	0.58***	0.43-0.77	0.60***	0.44-0.81
Strength sports[b]	288	0.91	0.61-1.36	1.04	0.71-1.52	285	0.64*	0.43-0.94	0.98	0.66-1.46	573	0.76*	0.58-1.00	0.98	0.74-1.29
Games															
- **Single[c]**	160	0.94	0.58-1.53	1.11	0.70-1.74	81	0.80	0.40-1.57	0.81	0.42-1.56	241	0.87	0.59-1.27	1.01	0.70-1.45
- **Team[d]**	250	0.93	0.61-1.42	1.02	0.69-1.51	75	1.00	0.56-1.78	0.78	0.38-1.59	325	0.96	0.68-1.35	0.96	0.69-1.34
Technical sports[e]	103	0.99	0.56-1.73	0.76	0.44-1.32	146	0.75	0.46-1.23	1.22	0.75-1.98	249	0.87	0.60-1.25	0.95	0.65-1.36
Aesthetic[f]	25					195	1.26	0.84-1.88	1.08	0.70-1.66	220	1.12	0.77-1.62	1.16	0.77-1.73
Combat sports[g]	30	0.53	0.17-1.66	1.17	0.49-2.79	12					42	0.39	0.13-1.11	1.28	0.63-2.60
Body care[h]	3					44	0.27*	0.09-0.79	0.59	0.24-1.44	47	0.26*	0.09-0.74	0.60	0.26-1.37

CI, confidence interval; LBP, low back pain; OR, odds ratio

*p<0.05 **p<0.01 ***p<0.001

[a] running, cycling, skiing, swimming, skating, orienteering, rowing/canoeing, cross training, spinning, row ergometer, diving, agility, ice swimming, wheelchair racing, aerobic

[b] gym training, weight lifting, body building, bodypump, kettle bell, circuit training, crossfit

[c] badminton, squash, tennis, table tennis, golf, disc golf, footbag

[d] floorball, ice hockey, ice bandy, football (soccer), volleyball, basketball, Finnish baseball, beach volley, American football, ringette, handball, water polo, futsal, field hockey, rugby

[e] downhill skiing, snowboarding, water skiing, wakeboarding, surfing, skateboarding, horse riding, track & field, motor sports, sailing

[f] gymnastics, dancing, acrobatics

[g] martial arts, boxing, wrestling, fencing, capoeira

[h] yoga, Pilates, and stretching

Table 3 Participation in different individual sport activities and type of low back pain in adulthood

Sport activities	Males (N=687)					Females (N=934)					Both sexes (N=1621)				
		Radiating LBP		Non-radiating LBP			Radiating LBP		Non-radiating LBP			Radiating LBP		Non-radiating LBP	
	N	OR	95% CI	OR	95% CI	N	OR	95% CI	OR	95% CI	N	OR	95% CI	OR	95% CI
Walking	316	1.31	0.91-1.90	1.08	0.76-1.53	724	1.27	0.86-1.87	1.28	0.82-2.01	1040	1.30	0.99-1.69	1.15	0.88-1.51
Running	294	0.49***	0.33-0.73	0.49***	0.34-0.71	338	0.50***	0.35-0.71	0.70	0.48-1.03	632	0.50***	0.38-0.64	0.58***	0.45-0.76
Cycling	279	0.78	0.53-1.16	0.61***	0.42-0.89	370	0.64**	0.46-0.89	0.92	0.65-1.32	649	0.70**	0.55-0.90	0.74*	0.57-0.96
Cross-country skiing	189	0.93	0.60-1.42	0.63*	0.41-0.96	195	0.72	0.48-1.08	0.97	0.63-1.51	384	0.82	0.61-1.10	0.76	0.55-1.04
Swimming	133	1.31	0.83-2.07	1.04	0.66-1.62	254	1.03	0.72-1.48	1.20	0.81-1.77	387	1.13	0.85-1.50	1.11	0.83-1.49
Ice or roller skating	78	0.82	0.46-1.44	0.40**	0.21-0.78	68	0.85	0.44-1.64	1.27	0.66-2.42					
Weight training	284	0.82	0.55-1.22	0.94	0.65-1.37	262	0.64*	0.44-0.93	1.01	0.68-1.49	546	0.72	0.55-0.95	0.96	0.73-1.26
Aerobic	1					202	0.66	0.43-1.02	1.14	0.75-1.74					
Gymnastics	16					79	1.46	0.85-2.51	1.33	0.71-2.48	95	1.32	0.80-2.20	1.56	0.90-2.70
Dancing	10					133	0.98	0.61-1.56	0.86	0.52-1.43	143	0.92	0.58-1.44	0.87	0.54-1.40
Floorball	129	0.69	0.41-1.17	1.11	0.71-1.73	37	1.37	0.63-2.97	1.29	0.55-3.00	166	0.84	0.54-1.31	1.16	0.78-1.72
Football (soccer)	90	0.91	0.51-1.63	0.93	0.55-1.58	16					106	0.83	0.49-1.41	0.93	0.57-1.51
Ice hockey	76	1.55	0.84-2.87	0.90	0.48-1.68	2									
Volleyball	34	1.51	0.66-3.46	1.21	0.50-2.91	19					53	1.19	0.64-2.22	0.96	0.46-1.97
Badminton	89	0.73	0.39-1.37	1.15	0.70-1.90	29					118	0.75	0.44-1.26	1.01	0.65-1.58
Tennis	35	0.61	0.23-1.59	0.76	0.33-1.76	28					63	0.62	0.31-1.25	0.61	0.31-1.21
Golf	53	1.04	0.52-2.09	0.91	0.44-1.89	28					81	0.96	0.55-1.72	1.08	0.60-1.94
Downhill skiing or snowboarding	89	0.94	0.53-1.66	0.63	0.35-1.14	86	0.39*	0.18-0.84	1.13	0.64-1.98					
Horse riding	3					67	1.34	0.75-2.41	1.08	0.53-2.18	70	1.24	0.70-2.21	1.08	0.55-2.13
Orienteering											36	0.83	0.35-1.97	0.60	0.23-1.53
Rowing/canoeing											38	0.84	0.37-1.91	0.82	0.35-1.95
Combat sports	30	0.53	0.17-1.64	1.21	0.53-2.79	12					42	0.37	0.13-1.08	1.33	0.66-2.66
Yoga & Pilates	3					41	0.24*	0.07-0.81	0.67	0.28-1.65	44	0.23*	0.07-0.75	0.70	0.30-1.61

CI, confidence interval; LBP, low back pain; OR, odds ratio
*p<0.05 **p<0.01 ***p<0.001