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The prevalence of low back pain among former elite cross-country skiers, rowers, orienteers and nonathletes – a 10-year cohort study

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Abstract

Background: Some cross-sectional studies have suggested that the prevalence of low back pain (LBP) may be high among endurance athletes with repetitive back loading, but there are no large, prospective cohort studies addressing this issue.

Purpose: To compare the prevalence of symptoms of low back pain (LBP) among former endurance athletes with different loading characteristics on the lumbar region: cross-country skiing (flexion loading), rowing (extension loading) and orienteering (no specific loading), as well as a non-athletic control group.

Study design: Prospective cohort study among cross-country skiers, rowers and orienteers, as well as a non-athletic control group, with 10-year follow-up.

Methods: Self-reported questionnaire on LBP adapted for sports based on standardized Nordic questionnaires for musculoskeletal symptoms. Responders were 173 rowers, 209 orienteers, 242 cross-country skiers and 116 control subjects (88% of the original cohort).

Results: There were no group differences between the athletic groups and the control group with regard to the two main outcomes: reported LBP the previous 12 months ($P=0.66$) and frequent LBP the past year (>30 days with LBP) ($P=0.14$). More rowers reported frequent LBP the past year than orienteers (adjusted OR=2.32; CI: 1.02 to 5.28). Occupational changes due to LBP were reported more often by rowers (13%) compared to skiers (7%) and orienteers (3%) ($P=0.002$). A training volume >550 hours a year was a risk factor for reporting LBP during the previous 12 months compared to a training volume <200 hours a year (adjusted OR=2.51; CI: 1.26 to 5.02). A previous episode with LBP was associated with LBP later in life (adjusted OR=3.02; CI: 2.22 to 4.10).

Conclusion: LBP was not more common among former endurance athletes with specific back loading compared to non-athletes. The results indicate that years of prolonged and repetitive flexion or extension loading in endurance sports does not lead to more LBP. However, a large training volume the past year and previous episodes with LBP are risk factors for LBP.

Comparing the sports of rowing, cross-country skiing and orienteering, it appears that while orienteering is protective, rowing can provoke LBP.

Key terms: Low back pain, endurance sports, former athletes, cross-country skiing, rowing, orienteering, control subjects.

Introduction

Low back pain (LBP) is a common complaint in the general population. However, it is not clear whether athletes are at higher risk for LBP.⁷ In sports requiring extreme flexibility in extension or with high loads on the spine (gymnastics, wrestling and weight lifting), there have been several studies examining radiological changes and LBP prevalence.^{5;9;16;20;21;24} Studies among wrestlers⁹ and gymnasts²⁰ report an increased prevalence of LBP among athletes compared to nonathletes. Radiographic investigations have shown injury to the endplate or ring apophysis among athletes in these sports;^{20;21} degenerative disc disease was also significantly more common among 24 gymnasts compared to 16 nonathletes.²⁰ However, it remains unclear whether this correlates with a higher rate of LBP.⁷

The consequences of repetitive extension and flexion loading in endurance sports are not clear. Bergstrom et al.⁶ showed a higher prevalence of LBP among 31 skiers compared to 14 control subjects. In contrast, Alricsson & Werner¹ reported a higher LBP prevalence among 993 control subjects compared to 120 cross-country skiers. A cross-sectional study among 398 rowers showed that the most common injury was low back pain.¹⁹ A survey among 1632 former intercollegiate rowers showed that the lifetime prevalence of back pain was 51.4%.²² A 10-year review of medical records showed that LBP represented 15% and 25% of all injuries among male and female rowers, respectively.¹² Although studies suggest that LBP is as common in the general population as among former athletes,^{4;16;24} there are few studies with an appropriate design and sufficient follow-up. Thus, our understanding of the consequences of repetitive back loading over a number of years is limited.

In 2000, Bahr et al.³ compared the prevalence of LBP between different endurance sports (cross-country skiing, rowing and orienteering) with different loading patterns on the lumbar region. In skiing, athletes mainly load the low back during forward flexion of the hip, while in rowing low back is mainly stressed in backwards extension.^{17;18} Orienteering, long distance off-track running, was included as an athletic control group without specific back loading. The results from 2000 showed that LBP was somewhat more common among cross-country skiers and rowers than orienteers and a group of non-athletic controls. However, the aim of the present study was to

follow up the same cohort 10 years later to investigate whether excessive flexion and extension loading on the lumbar spine in endurance sports cause subsequent low back pain.

Materials and methods

This is a prospective cohort study based on a cross-sectional survey from 2000. The recruitment of participants and inclusion criteria are detailed elsewhere.³ The follow-up study was approved by the Regional Committee for Research Ethics and the Data Inspectorate.

Study population

The cross-sectional survey from 2000 included 841 subjects; 199 rowers, 227 orienteers, 257 cross-country skiers and 158 control subjects. Three participants had died since 2000, and we were unable to find a valid address for 29 participants (3.9%). A questionnaire was sent to the remainder of the cohort and anyone who did not return the questionnaire was contacted by telephone; they were asked to complete the questionnaire over the phone. In total, 173 rowers (91.1% of those with a valid address), 209 orienteers (93.7%), 242 cross-country skiers (95.7%) and 116 control subjects (79.5%) completed the new questionnaire. Thus, the final sample consisted of 740 participants (88% of the original cohort).

The questionnaire

The original questionnaire was developed based on standardized Nordic questionnaires, which have been validated to study the prevalence of occupational musculoskeletal symptoms.^{2,14} The Nordic questionnaire included questions about LBP, defined as “pain, ache, or discomfort in the low back with or without radiation to one or both legs.” We included the following standard questions from the Nordic questionnaire, as detailed elsewhere:³

- Have you ever experienced LBP?
- Have you experienced LBP during the previous 7 days?
- How many days during the past 12 months have you had LBP?
- Have you been examined or treated for LBP by a physician, physical therapist, chiropractor, or other health personnel as an outpatient during the previous 12 months?

- Have you ever had to change your occupation or working assignments because of LBP?

New questions related to physical activity levels at work and leisure the past 10 years were included. These were as follows (the control group answered only the last question):

- How many years of competitive experience do you have?
- How many hours have you trained during the past year? (five categories: <200 h, 200-399 h, 400-549 h, 550-699 h and ≥ 700 h)
- What has been your main profession during the past five years? (profession was later classified into one of the following categories by two health professionals: Physically demanding, sedentary and varied work tasks)

The athlete groups were asked to report their level of sport participation for each year from 2001 to 2010, as one of the following four categories:

- Elite: Competing at the national/international level
- Competition: Regular training and participation in competitions in their sport
- Exerciser: ≥ 3.5 hours of exercise a week
- Physically inactive: <3.5 hours of exercise a week

Statistical analyses

The data were analyzed using SPSS (v. 18.0 for Windows, SPSS, Evanston, IL). Responses to different LBP questions reported in 2000 were compared between non-respondents and respondents using chi-square tests with continuity correction or Fischer's Exact test p-values reported. Subject characteristics are reported as the mean with standard deviations. Group and sex differences with regard to age, competitive experience and level of activity the previous 10 years were assessed using general linear model analysis of variance; Bonferroni- adjusted P-values were used in group comparisons. Logistic regression analysis assessed group and sex differences in training volume the past year using training volume (< 400 h and ≥ 400 h) as a dependent variable and sport and sex as covariates. Ordinal logistic regression analysis assessed the group and sex differences in days of pain the previous 12 months. Days of pain was grouped into four

different categories. Odds ratios (OR) with 95 % confidence intervals (CI) are reported. Group and sex differences in the distribution of occupational physical activity levels were assessed using chi-square tests. We also used chi-square tests for comparing low back pain prevalence between groups. Binary logistic regression analyses were used to examine potential risk factors for LBP, using LBP the previous 12 months (yes/no) and frequent LBP (>30 days with LBP the last year) (yes/no) as outcomes. As independent variables we used group (skiing, rowing, orienteering, nonathletes) as exposure variable and sex, age, occupation, competition, level of activity the previous 10 years, training volume during the past year, LBP during the past year in 2000 and frequent LBP in 2000 as potential confounding variables. Both unadjusted and adjusted OR with 95 % CI are reported. Differences were considered statistically significant if the two-tailed P value was less than 0.05.

Results

Non-responders

When comparing the response to the different LBP questions in 2000 between non-responders (n=101) and responders (n=740), hospitalization (P=0.045), operation (P=0.026) and occupational changes (P=0.047) were reported more often among non-responders compared to responders.

Sample characteristics

Of the 740 participants, 10.3 % were characterized as elite athletes in 2000, most of these cross-country skiers. When adjusting for sex there were differences in age between groups (P<0.001) (Table 1). The orienteers were oldest with a mean age of 34±6 years. There was also a difference in age between sexes (P=0.009); men (33±6 years) were older than women (32±5 years). When adjusting for sex there were differences in competitive experience between groups (P<0.001). The orienteers had the longest competitive careers (17±9 years). Men reported longer competitive careers (15±8 years) than did women (13±8) (P=0.001).

Table 1 Subject characteristics (n=740) by sport and gender

	Skiing		Rowing		Orienteering		Nonathletes	
	Men (n=153)	Women (n=89)	Men (n=112)	Women (n= 61)	Men (n=117)	Women (n=92)	Men (n=72)	Women (n=44)
Age (yrs)	33±4	31±4	32±6	32±5	34±7	33±6	35±5	32±4
Competition (yrs)	17±6	15±5	9±5	6±4	18±9	15±9		

Results are shown as mean ± SD. Competition: Years of competitive participation in their sport

Physical activity levels

When adjusting for sex the rowers trained less than skiers (OR: 0.73, CI: 0.46 to 1.14). The orienteers trained fewer hours the past year compared to skiers (OR: 0.56, CI: 0.36 to 0.88) and rowers (OR: 0.77, CI: 0.46 to 1.27). When adjusting for group men trained more than women

(OR: 2.45, CI: 1.61 to 3.74). Paired group comparisons showed that skiers reported more years of competition the past 10 years compared to the orienteers ($P<0.001$) and rowers ($P<0.001$) (Figure 1). Orienteers also reported more years of competition compared to rowers ($P<0.001$). Finally, men reported more competition experience compared to women ($P=0.001$).

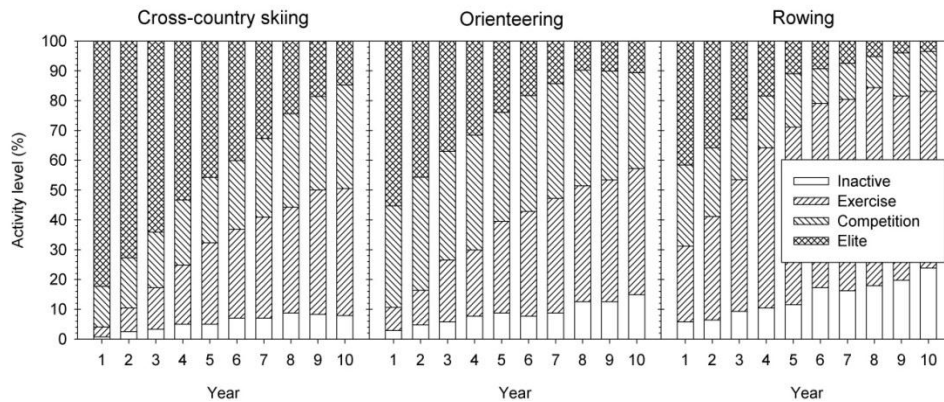


Figure 1. Activity level (%) by sport; categorized as elite, competition, exercise and inactive from 2001 (year 1) through 2010 (year 10) (n=621). The number of elite athletes has decreased gradually during the 10-year period, but 10.3% were still competing at the elite level in 2010.

As shown in Figure 2, there were differences in the distribution of occupational physical activity between groups ($P<0.001$). The control group had the highest proportion of physically demanding occupations compared to the athlete groups. Sedentary occupations were seen more often among the rowers and orienteers. There was no sex difference in the distribution of occupational physical activity ($P=0.26$).

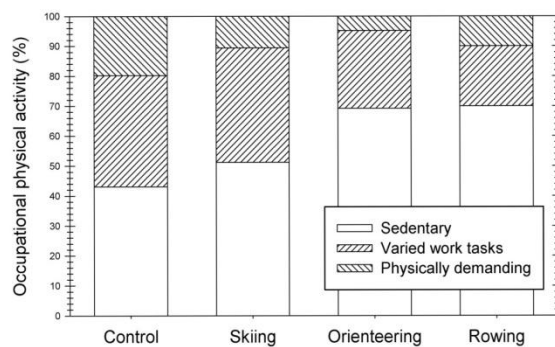


Figure 2. Distribution of occupational physical (%) activity level: sedentary, varied work tasks and physically demanding by groups: skiing, orienteering, rowing and control (n=734).

Low back pain questions

Table 2 gives an overview of the responses to the LBP questionnaire. In paired group comparisons there were no significant differences between groups in the response to any of the following questions: LBP ever, LBP the previous 12 months and LBP the previous 7 days. A significantly larger proportion of rowers and skiers reported having received outpatient medical assistance than among orienteers and the control group. In paired group comparisons a greater proportion of rowers reported making occupational changes due to LBP compared to skiers and orienteers. The control group reported more occupational changes than the orienteers.

Table 2 Responses (%) to the various LBP questions by group (n=740)

	Skiing	Rowing	Orienteering	Control	<i>P</i> value
LBP ever	69	68	61	64	0.30
LBP previous 12 months	55	57	49	53	0.43
LBP previous 7 days	17	19	18	20	0.93
Outpatient medical assistance	23*+	24*+	15	11	0.007
Occupational change	7	13*×	3	11*	0.002

Paired group comparisons between groups: * denotes different from the orienteering group; × denotes different from skiing group; + denotes different from nonathletic control group.

LBP = low back pain

As illustrated in Figure 3 the rowers reported a significantly higher proportion with pain days compared to the orienteers (OR: 1.55, CI: 1.06 to 2.25; $P=0.024$) when adjusting for sex. The other group comparisons did not reach statistical significance.

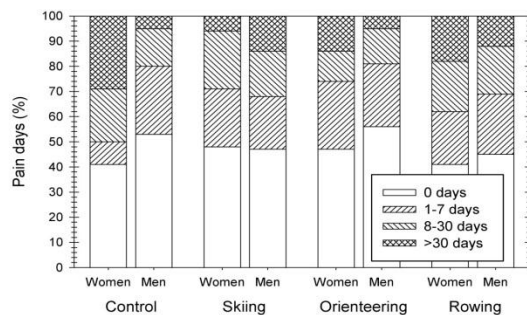


Figure 3. Proportion of subjects according to the number of pain days reported during the previous 12 months by sport (control, skiing, orienteering, rowing) and gender (n=739).

Risk factors for low back pain

Logistic regression analyses were performed to assess the impact of a number of potential risk factors for LBP, using LBP the previous 12 months as outcome (yes/no). As illustrated in Table 3, the only significant risk factor was having experienced LBP the previous 12 months in 2000 ($P<0.001$).

Table 3 Logistic regression analysis of risk factors for LBP during the previous 12 months (yes/no) by group (n=734)

Variables	Unadjusted OR			Adjusted OR		
	95 % Confidence limits of odds ratio			95 % Confidence limits of odds ratio		
	OR	LB	UB	OR	LB	UB
Sport						
- Non-athletes	1			1		
- Skiing	0.88	0.55	1.41	0.96	0.60	1.53
- Orienteering	0.93	0.63	1.38	0.88	0.55	1.43
- Rowing	0.73	0.49	1.09	1.16	0.70	1.92
Sex						
- Female	1			1		
- Male	1.16	0.86	1.58	0.89	0.65	1.23
Age (per year)	1.01	0.96	1.04	1.01	0.98	1.04
Occupation						
- Sedentary	1			1		
- Physically demanding	1.49	0.90	2.45	1.37	0.81	2.33
- Varied	1.36	0.98	1.88	1.31	0.92	1.85
LBP previous 12 months in 2000	3.04	2.25	4.11	3.02	2.22	4.10

OR=odds ratio, LB=lower bound, UB=upper bound, LBP=low back pain

To examine the potential effect of years of competition, activity level during the previous 10 years and training volume during the past year, the control group had to be excluded. Including

the three athlete groups and using orienteering as the reference group, a training volume of >550 hours per year was a risk factor for reporting LBP during the previous 12 months compared to a training volume <200 hours per year (adjusted OR=2.5; CI: 1.26 to 5.02).

We also performed a logistic regression analysis on the entire cohort, using more than 30 days with LBP (yes/no) as the dependent variable (Table 4). A varied occupation (P=0.029) and having reported more than 30 days with LBP the previous 12 months in 2000 (P<0.001) were risk factors for frequent LBP.

Table 4 Logistic regression analysis of risk factors for frequent LBP (>30 days) (yes/no) during the previous 12 months by group (n=732)

Variables	Unadjusted OR			Adjusted OR		
	95 % Confidence limits of odds ratio			95 % Confidence limits of odds ratio		
	OR	LB	UB	OR	LB	UB
Sport						
- Non-athletes	1			1		
- Skiing	0.64	0.34	1.21	0.68	0.35	1.30
- Orienteering	0.54	0.28	1.06	0.58	0.29	1.16
- Rowing	0.87	0.46	1.67	1.11	0.57	2.20
Sex						
- Female	1			1		
- Male	0.67	0.43	1.04	0.65	0.41	1.03
Age (per year)	1.02	0.98	1.06	1.01	0.97	1.05
Occupation						
- Sedentary	1			1		
- Physically demanding	1.57	0.77	3.20	1.50	0.72	3.15
- Varied	1.82	1.14	2.93	1.75	1.06	2.88
> 30 days with LBP previous 12 months in 2000	3.15	1.76	5.64	3.14	1.73	5.72

OR=odds ratio, LB=lower bound, UB=upper bound, LBP=low back pain

Finally, we also restricted the analysis to the athlete groups to assess the effect of years of competition, activity level during the previous 10 years and training volume during the past year, using more than 30 days with LBP as the dependent variable. The sport rowing was a factor that influenced frequent LBP compared to orienteering as reference group (adjusted OR=2.32; CI: 1.02 to 5.28). Occupations classified as varied were risk factors for frequent LBP (adjusted OR=1.91; CI: 1.05 to 3.45). Frequent LBP in 2000 influenced frequent LBP during the past year.

Discussion

The main finding of this study is that LBP was not more common among former athletes than among non-athletic control subjects. The results from the cross-sectional study in 2000 on the same cohort,³ showing a somewhat higher prevalence of LBP among skiers and rowers, seem to have been balanced out during the 10-year follow-up period. However, frequent LBP during the past year, having made occupational changes or having received outpatient medical assistance was reported more frequently by rowers.

Study strengths and limitations

This is the first prospective cohort study with a long-term follow-up, a large number of participants and which includes a non-athletic control group to assess LBP among athletes. The drop-out rate was low, <10% if we take deaths and missing addresses into account. Back loading in sports activity and occupation was mapped during the past 10 years for each participant. Thus, the study design was appropriate to examine the consequences of repetitive back loading in sports on subsequent LBP.

Nevertheless, there are some limitations which must be borne in mind when interpreting the results. First, the low response rate among the control subjects (73%) is a weakness, although higher than the cross-sectional study from 2000 (66%). Being asymptomatic could be a reason why some control subjects did not respond. However, to test whether there was a recruitment bias, we compared the prevalence of LBP reported for the previous 12 months in 2000 between responders and drop-outs in the control group and found no difference (P=1.00). The same was the case when we compared drop-outs to responders in each of the three athlete groups. Second, although this is a prospective cohort study in the sense that the cohort was identified 10 years ago

and their baseline LBP status was mapped at that time, some exposure variables (training and competition history) are based on retrospective recall and bias/inaccuracy might therefore occur. There is also recall bias related to the main outcome, LBP, although the two main variables chosen, LBP the previous 12 months (yes/no) and >30 days with LBP the past year (yes/no), were chosen to limit this. However, as the main exposure variable was type of sport (rowing vs skiing vs orienteering), we would argue that the measurement error related to exposure is minimal. As discussed by Bahr et al.,³ the questionnaire has been developed for use in the occupational setting, not sports. Finally, it should be noted that although there was a difference between respondents and drop-outs with regard to back-related hospitalization and surgery in 2000, the prevalence of these outcomes was very low and this finding should be interpreted with caution. Due to wide confidence intervals clinically important differences in LBP between groups may have been missed, so this should be kept in mind when interpreting the findings.

Prevalence and severity of low back pain

The two main outcomes in the study were LBP the previous 12 months (yes/no) and >30 days with LBP the past year (yes/no). These two outcomes were thought to be appropriate to best describe prevalence and severity of LBP, and were chosen to minimize recall bias. The results were almost identical whichever of these two main outcomes we used in the analyses (Tables 3 and 4). When using reported LBP the previous 12 months and frequent LBP (>30 days) the past year as outcomes, having experienced LBP during the past year in 2000 and having reported frequent LBP in 2000, respectively, were risk factors. This is in accordance with previous studies.^{8;10;13} The prevalence of LBP was similar between athlete groups with specific back loading and the general population, which is in accordance with other studies.^{4;16;24} This supports the hypothesis that repetitive back loading is safe. Nevertheless, a large training volume (>550 hours a year) is a risk factor for reporting LBP. The results indicate that rowers reported more frequent LBP during the past year compared to orienteers. In addition, occupational changes were reported more often by rowers (13%) compared to skiers (7%) and orienteers (3%) in a comparison within the athlete groups. This indicates that orienteering may be considered as a protective activity, while it appears that intensive rowing over time can provoke LBP.

In our study the skiers and rowers reported receiving outpatient medical assistance more often than orienteers and control subjects. One reason for this may be that LBP has a more disabling effect on elite skiers and rowers compared to the other groups, as many of them continued to compete in their sports. It is also possible that they had easier access to or a lower threshold for calling on medical assistance. However, this could also mirror the severity of LBP. In that case, outpatient medical assistance could be considered as a measure of the severity of LBP.

Risk factors for low back pain

When comparing LBP the previous 12 months between the different athlete groups, a training volume greater than 550 hours a year was a risk factor. This is in accordance with the results from 2000, showing that being an elite cross-country skier or rower was associated with LBP.³ Other studies have shown that the relationship between physical activity and LBP is U-shaped; meaning that both inactivity and excessive physical activity is associated with LBP.^{11;23} Still, it may be that athletes who continued to compete at the elite level and train this much had a lower threshold for reporting or recalling symptoms, as having LBP represents a limitation to participation.

When using frequent LBP as outcome, varied work tasks was a risk factor for frequent LBP compared to sedentary occupations. Recent reviews conclude that there is an association between whole body vibrations, carrying, occupational bending and LBP.^{15;25;26} In our study, the different occupations were classified into three categories, and misclassifications may have occurred. It is also possible that subjects have changed their profession because of LBP, and that the analysis showing varied work tasks as a risk factor simply is the result of occupational adaptations.

Conclusion

LBP was not more common among former endurance athletes with specific back loading compared to non-athletes, indicating that prolonged and repetitive flexion or extension loading in endurance sports does not lead to more LBP. However, a large training volume during the past year and previous episodes with LBP are risk factors for LBP. Comparing the sports of rowing,

cross-country skiing and orienteering, it appears that orienteering is a protective activity, while rowing can provoke LBP.

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