Work-related risk factors for lateral epicondylitis and other cause of elbow pain in the working population.

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Background: This study was designed to assess the relationship between work-related combined physical and psychosocial factors and elbow disorders (lateral epicondylitis and nonspecific disorders without lateral epicondylitis) in the working population.

Methods: A total of 3,710 workers (58% men) in a French region in 2002-2005 participated in physical examinations by occupational health physicians and assessed their personal factors and work exposure by self-administered questionnaire. Statistical associations between elbow disorders and risks factors were analyzed using multinomial logistic regression.

Results: A total of 389 (10.5%) workers had elbow pain without lateral epicondylitis and 90 (2.4%) workers had lateral epicondylitis. Age, body mass index (>25) and low social support (only for men) were significant risks factors. Hard perceived physical exertion combined with elbow flexion/extension (>2 hours/day) or/and wrist bending (>2 hours/day) were strong significant risk factors for elbow pain and epicondylitis: among men, adjusted Odds Ratio (ORa)=2.6(1.9-3.7) and ORa=5.6(2.8-11.3), respectively; among women, ORa=1.4(0.9-2.2) and ORa=2.9(1.3-6.5).

Conclusions: This study emphasizes the strength of the associations between combined physical exertion and elbow movements and lateral epicondylitis. Certain observed differences in associations with lateral epicondylitis and elbow pain only indicate the need for additional longitudinal studies on different stages of elbow disorders and known risk factors.

Keywords: Tennis elbow, Elbow pain, Prevalence, Work-related factors, Psychosocial factors

Introduction

Work-related upper extremity disorders are a major cause of complaints and disability in working populations[Staal et al., 2007]. Elbow pain and associated disorders, mostly lateral epicondylitis, are known to be one of the most common disorders of the arm in the general population [Bot et al., 2005], as lateral epicondylitis is a major arm disorder with an estimated prevalence of 0.7 to 4.0% in the general population [Shiri and Viikari-Juntura, 2011]. Lateral epicondylitis is the result of overuse of the extensor muscles, leading to inflammation or irritation of the tendon insertion [Walz et al., 2010]. The prevalence of lateral epicondylitis in workers whose job requires repetitive work ranges from 1.3 to 12.2% [Luopajärvi et al., 1979; Viikari-Juntura et al., 1991; Chiang et al., 1993; Ritz, 1995; Ono et al., 1998; Haahr and Andersen, 2003; Shiri et al., 2006; van Rijn et al., 2009].

Many studies have already established that lateral epicondylitis is associated with physically forceful occupational activities [Ritz, 1995; Ono et al., 1998; Leclerc et al., 2001; van Rijn et al., 2009; Walker-Bone et al., 2011], especially high force combined with high repetition [Chiang et al., 1993; Shiri et al., 2006] and awkward posture [Haahr and Andersen, 2003; Fan et al., 2009]. However, combinations of specific movements involving the elbows, such as elbow flexion and wrist bending and forceful activities have not been evaluated [Sluiter et al., 2001].

Furthermore, some psychological (depression) and psychosocial work factors (job strain, social support) have been reported to influence elbow symptoms [Leclerc et al., 2001; Haahr and Andersen, 2003; Walker-Bone et al., 2011], but these associations do not always remain significant after adjustment for physical work factors and no clear relationship has been demonstrated between psychosocial factors and musculoskeletal pain [Macfarlane et al., 2009; van Rijn et al., 2009].

Case definitions depending on the purpose of the study are also a subject of recent discussions, suggesting the need to consider several case definitions simultaneously [Palmer et al., 2011]. In this study, we used two case definitions, nonspecific elbow musculoskeletal disorders and lateral epicondylitis, and their potentially different associations with work-related risks factors. Using a French representative working population in 2002-2005, this study was designed to examine associations between elbow disorders and occupational risk factors, especially combined elbow movements in addition to psychosocial risk factors, and to compare the results obtained with two definitions of elbow disorders.

Material and methods

Study population

This cross-sectional study was conducted in the Loire Valley district of Central West France [Ha et al., 2009]. The economic structure of the region, which represents 5% of the French working population, is diversified and similar to most French regions [Roquelaure et al., 2006]. In France, at the time of this study, all salaried workers, including temporary and part-time workers, underwent a mandatory annual health examination by a qualified occupational physician (OP) in charge of the medical surveillance of a group of companies. A total of 83 OPs, representative of the region's OPs, participated in the study. Subjects were randomly selected from workers undergoing a regularly scheduled mandatory annual health examination between April 2002 and April 2005. All OPs were trained to randomly include workers and perform a standardized physical examination. Specific details have been described previously [Sluiter et al., 2001; Roquelaure et al., 2006].

Ethics Board Approval and Consent

All participants signed written informed consent and the study received approval from the French ethic committee, the French National Data Protection Committee (CNIL, Commission Nationale de l'Informatique et des Libertés).

Potential risk factors

The potential risk factors included personal factors and exposure to physical and psychosocial work factors (Tables 1 and 2). For personal factors, body mass index (BMI) and age, data were collected by self-administered questionnaire.

Exposure regarding work status and occupational risk factors was assessed by a self-administered questionnaire on the basis of previous epidemiologic and ergonomic studies.

Most risk factors were defined and quantified according to the Saltsa consensus [Sluiter et al., 2001]. We particularly focused on characteristics of tasks and movements. Response categories were initially available on a 4-level Likert-type scale, as follows: never or practically never, rarely (less than 2 hours per day), often (2 to 4 hours per day) and always (more than 4 hours per day). Use of vibrating tools, elbow flexion and extension, and extreme wrist bending posture were dichotomized as less than or more than 2 hours per day due to the small number of cases. High repetitiveness was defined by doing repetitive actions more than 4 hours per day. The Borg Rating of Perceived Exertion Scale, ranging from 6 to 20 and dichotomized into less than hard exertion (6 to 13) and hard exertion to exhaustion (14 to 20), was used as a proxy of physical workload.

To assess the combination of effort and manual work, we defined a five-level variable by combining elbow flexion/extension, wrist bending and perceived physical exertion. Elbow flexion/extension and wrist bending for more than 2 hours per day were considered interchangeably and called “elbow movements”. Combined physical exposure was defined by five classes: 1) light physical exertion and no elbow movements; 2) light physical exertion and at least one elbow movements; 3) hard physical exertion and no elbow movements; 4) hard physical exertion and one elbow movements; 5) hard physical exertion and two elbow movements. The first three categories 1), 2) and 3) were aggregated in the final model (model 3).

Psychosocial risk factors at work were assessed according to the Demand-Control-Support model using the validated French version of the Job Content Questionnaire: Job Strain and social support were used in two classes based on the thresholds defined in the national French SUMER survey [Niedhammer et al., 2006; Roquelaure et al., 2006].

Job title was available from the self-administered questionnaire and we used a classification in three categories: blue collar, low-level white collar and executives. This variable was used to describe exposure according to categories of workers. More detailed occupational categories were not explored because of the wide variety of job titles in the survey with a small number of workers in each category.

Medical history and prior history of at least one of the major upper-extremity musculoskeletal disorders (among six main musculoskeletal disorders: rotator cuff syndrome, lateral epicondylitis, ulnar entrapment syndrome at the elbow, carpal tunnel syndrome, wrist tendinitis, De Quervain' disease, [Roquelaure et al., 2006]) were assessed during the clinical examination by the OP.

Outcome

The OPs assessed outcome by performing a standardized physical examination, which applied the methodology and clinical tests of the Saltsa consensus for lateral epicondylitis: activity-dependent pain directly located around the lateral epicondyle for at least 4 days over the last week and local pain on resisted wrist bending at the examination [Sluiter et al., 2001]. The OPs performed these examinations to diagnose epicondylitis only for workers who reported elbow pain. Workers with elbow pain but without lateral epicondylitis were considered to be workers with nonspecific elbow disorders called 'elbow pain only' in the following results, including also medial epicondylitis, radial nerve entrapment, elbow osteoarthritis, and ulnar nerve entrapment if they were symptomatic at the elbow. Actually, no other cause of elbow disorders was included in the surveillance program in view of the low prevalence of other diagnoses [Shiri et al., 2006; van Rijn et al., 2009; Shiri and Viikari-Juntura, 2011]. Cases of ulnar nerve entrapment at the elbow were disregarded in this study, in view of the small number of cases and the fact that symptoms were not necessarily experienced at the elbow [Sluiter et al., 2001; Descatha et al., 2004].

The outcome defined for this study was a three-level variable considering the absence of elbow pain, the presence of elbow pain only, and lateral epicondylitis. Bilateral elbow musculoskeletal disorders in the same subject were counted as one disorder, corresponding to the most specific diagnosis (a subject with epicondylitis and contralateral elbow pain was considered to be a case of epicondylitis).

Statistical analysis

Statistical analysis consisted of univariate and multivariate polytomic logistic regressions with Wald tests. Odds ratios (OR) were compared between elbow pain only and lateral epicondylitis using Wald tests. The multivariate analyses performed resulted in the following three models:

- Model 1: model with individual characteristics, repetition, physical exertion, and social support,
- Model 2: model with individual characteristics, repetition, combined physical work exposure including physical exertion, elbow flexion/extension and wrist bending, and social support
- Model 3: same as model 2, but with aggregation of low categories for combined physical work exposure.

These models included the known associations with epicondylitis (age) and were selected considering the correlation between variables and the objective of this analysis using the pre-selected variables that were significant at $p<0.20$ in univariate analysis among men or women. Models restricted to workers with at least 10 years at the same job (cut-off used in the original questionnaire) were also carried out.

All the analyses were performed separately for men and women, taking into account sex-related differences in levels of exposure [Messing et al., 2009; Silverstein et al., 2009]. Khi-2 tests were also performed in order to detect differences between the distribution of exposures among men and women. Similar models for men and women were presented. Data analyses for this paper were generated using SAS 9.3 software (SAS Institute Inc., Cary, NC, USA). Statistical significance was defined as $p<0.05$.

Results

The study population consisted of 3,710 workers (58% men).

A total of 389 workers (229 (10.6%) men, 160 (10.3%) women) suffered from elbow pain during the 12-month period preceding the physical examination and 90 (51 (2.4%) men, 39 (2.5%) women) suffered from lateral epicondylitis.

Distribution of age, social support and elbow movements were similar between men and women. However, different distributions of others risks factors were observed between genders: women declared to be more exposed to job strain (p<0.001) and repetitiveness (p<0.001) and men to workload factors (for example, physical exertion in 2 category, p<0.001, or using vibrating tools, p<0.001).

Univariate results showed that the probability of suffering from elbow pain and epicondylitis increased considerably with age, reaching an odds ratio of 11.0 for men aged 50 years and older compared to men under 30 years (8.7 for women, respectively, Table 1-2). Moreover, workers older than 50 years more often suffered from epicondylitis than elbow pain only (for men: p=0.02; for women: p=0.09).

A history of at least one of the major upper-extremity musculoskeletal disorders was strongly associated with elbow pain (for men: OR 5.6, for women: OR 4.2) and epicondylitis (for men: OR 5.8, for women: OR 8.5). The association was stronger for epicondylitis than for elbow pain for women (p=0.06). Epicondylitis was simultaneously associated with other musculoskeletal disorders in 40 (44.4%) workers and 33 of them (82.5%) had epicondylitis and rotator cuff syndrome or carpal tunnel syndrome (possibly associated with other disorders). The probability of presenting other musculoskeletal disorders at physical examination (other than epicondylitis, 14.0% (12.9%-15.2%)) was increased by the presence of elbow pain only (31.6% (27.0%-36.2%)) and epicondylitis (44.4% (34.2%-54.7%)).

Manual workers had higher physical exposure; in particular, 25.1% of blue-collar workers were exposed to elbows flexion/extension, wrist bending and high physical exertion versus only 10.5% of low-level white-collar workers and 4.7% of executives.

Combined specific elbow movement and physical exertion was significantly associated with elbow pain and lateral epicondylitis, with higher risk for high physical exertion with elbow movement in univariate analyses (Tables 1 and 2) and a dose-response relationship on multivariate analyses among men (Table 3, models 2-3). Repetitive elbow movements (elbow flexion and wrist bending) with light physical exertion and hard physical exertion without repetitive elbow movements were not significantly associated with elbow pain and epicondylitis, compared to no elbow repetitive movement and light physical exertion (model 2).

In the final model (model 3), the strength of association was lower for elbow pain than for epicondylitis in men (not significant for women). These associations remained significant for men with more than 10 years in the same job (except for "workers less than 30 years old", for which it could not be estimated), with an adjusted odds ratio for the three cumulative exposures of 2.3 (1.4-3.9) for elbow pain only and 4.5 (1.9-10.8) for epicondylitis (not significant for women, 1.5 (0.7-3.1) and 1.6 (0.5-5.1), respectively). Low social support was the only psychosocial work risk factor associated with elbow pain and epicondylitis (only in men, Table 3). Being exposed to repetitive tasks was associated with elbow pain and epicondylitis in univariate analyses, but was not found to be significant anymore in the final multivariate model.

Discussion

This study highlights the association between lateral epicondylitis and elbow pain and a large range of personal and work-related factors.

The main results of this study are the strong association between specific and combined elbow exposure, such as combined elbow flexion/extension, wrist bending and perceived physical exertion, with elbow pain and lateral epicondylitis, even after adjusting for other factors. Low social support was the only psychosocial work risk factor associated with epicondylitis (only in men). Some exposures appeared to be associated in different ways with lateral epicondylitis versus elbow pain only.

These results clearly confirmed previous findings on the strong association between epicondylitis and combined workload measure including force (use of heavy tools, forceful lifting) [Chiang et al., 1993; Haahr and Andersen, 2003; Fan et al., 2009]. The combination of force and specific movement is similar to the awkward posture previously described, such as posture of hands and supination of the forearm [Haahr and Andersen, 2003; Fan et al., 2009]. Our results also suggest that the combination of force and specific elbow movements is strongly associated with elbow disorders. In a recent review, Van Rijn et al, found that major physical risk factors associated with lateral epicondylitis were handling tools heavier than 1 kg (ORs of 2.1-3.0), handling loads heavier than 20 kg at least 10 times per day (OR 2.6) and repetitive movements more than 2 hours per day (ORs of 2.8-4.7) [van Rijn et al., 2009].

Using vibrating hand tools more than 2 hours per day did not seem to be a risk factor in this study, in contrast with previous studies [Haahr and Andersen, 2003; Shiri et al., 2006]. The various ways of measuring vibrations and the cut-off value adopted could explain these differences. Results concerning repetitiveness differ from one study to another, which might be due to similar factors.

The limitations of this study, in addition to the small number of cases, include the cross-sectional design, with assessment of exposure by questionnaire and the definition of outcome. Workers with elbow disorders may be more likely to describe their work as strenuous. However, misclassification should have been limited by the use of questions comprising a high level of detail. A recent review revealed that self-reported answers to questions concerning physical work demands showed good reproducibility when using the Borg scale and strenuous work [Stock et al., 2005]. The OPs were aware of the exposure of the study subjects, as they are responsible for general medical surveillance in the workplace according to the French occupational health surveillance system. However, misclassification (e.g. whether or not an individual has elbow disorders) can be expected to have been minimal: OPs were enrolled in a specific surveillance project focusing on major musculoskeletal disorders, with precise definitions and training in the whole range of diagnoses with standardized procedures [Sluiter et al., 2001; Roquelaure et al., 2006; Ha et al., 2009].

Workers with elbow pain in our study corresponded to various conditions: nonspecific elbow pain and other diagnoses such as medial epicondylitis, nerve entrapment at the elbow or osteoarthritis. However, the low prevalence of these disorders should not have had any impact on the results [Sluiter et al., 2001; van Rijn et al., 2009; Shiri and Viikari-Juntura, 2011].

Estimation of the prevalence of lateral epicondylitis in a representative sample of the working population constitutes one of the strengths of this study, with a high participation rate and a large range of exposure. Comparison of socio-economic status in the sample with the last available French census (1999 [INSEE des Pays-de-la-Loire, 2001]) showed no major differences for either gender. The distribution of occupations in the study sample was relatively similar, overall, to that of the regional workforce, except for certain occupations not monitored by OPs in France (e.g., shopkeepers and self-employed workers). The prevalence in the literature ranges from 0.3% to 12.2%, depending on the population characteristics and the definition used [Shiri and Viikari-Juntura, 2011]. For instance, the prevalence of 2.4% observed in our study is consistent with the prevalence of 1.6-3.5% estimated in another Finnish population-based study of the working population suffering from lateral epicondylitis [Shiri et al., 2006].

The observed associations were stronger for physical factors than for psychosocial factors. Among psychosocial factors, low social support remained significant after adjustment only for men and other factors became non-significant for both genders, whereas some authors have found a significant association between psychosocial factors and elbow disorders [Haahr and Andersen, 2003; Walker-Bone et al., 2011]. Further research is required to assess the links and the potential interactions between psychosocial and physical work factors [Macdonald et al., 2008; Macfarlane et al., 2009].

The risk of suffering from elbow pain and epicondylitis increased significantly with age. In a cross-sectional study, the effect of aging cannot be distinguished from the cumulative effect of present and previous deleterious exposure. However, among workers with more than 10 years of employment in the same job, age remained significant, reinforcing the idea of an aging effect associated with tissue degeneration [Hagberg, 2002]. As reported in a previous study on other elbow disorders [Descatha et al., 2003, 2004], elbow pain and epicondylitis were also associated with other musculoskeletal disorders, suggesting the complexity of movements and consequently pain in various parts of the body.

We also observed a strong association with a history of epicondylitis or, more generally, upper-extremity musculoskeletal disorders on current elbow pain or epicondylitis. These results seem to indicate the <u>recurrence</u> of symptoms over time, surprisingly with a strong link between past epicondylitis and current elbow pain, possibly due to the presence of common past risk factors of epicondylitis and elbow pain only. <u>However, we could not differentiate the possibility of relapse/recurrence and chronic epicondylitis, due to the cross-sectional design.</u>

The different proportions of exposed workers between men and women were consistent with the previous French study SUMER [Niedhammer et al., 2008]. It is considered as more cautious to stratify by gender, due to differences in types of jobs and exposure [Messing et al., 2009].

This study compared elbow pain and lateral epicondylitis in order to test the difference of magnitude of association with elbow pain only and epicondylitis, i.e. according to the broader or stricter definition of elbow disorders. Results were similar for most exposures according to the broader (elbow pain) and stricter (epicondylitis) definition of elbow disorders, as previously observed [Viikari-Juntura et al., 1991; Chiang et al., 1993; Palmer et al., 2011; Walker-Bone et al., 2011]. However, perceived physical exertion was higher for workers with lateral epicondylitis than for workers with nonspecific elbow disorders. As detection of epicondylitis among workers with elbow pain is independent of the workers' perceptions, this result suggests that physical workforce is objectively higher for workers with lateral epicondylitis than with elbow pain only. Age also presented a higher association with lateral epicondylitis than with elbow pain only. These results are consistent with those of previous studies [Walker-Bone et al., 2011] and suggest that elbow pain occurs at a younger age than lateral epicondylitis. Risk factors may also possibly play different roles at various stages of the disorder, but further studies are needed in this area.

Our study highlighted the importance of associations between work-related factors, especially specific combination of high physical workload and elbow musculoskeletal pain and lateral epicondylitis, in addition to age, in a large working population of men and women. The differences observed between risk factors for lateral epicondylitis and other elbow pain suggest the need to more clearly elucidate the association of risk factors and the stage of the disorder involved, based on a longitudinal approach.

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Table 1 - Univariate analyses for elbow pain only and lateral epicondylitis among men

	N	N pain	N epi	Elbow pain only OR	Elbow pain only 95% CI	Elbow pain only p	Lateral epicondylitis OR	Lateral epicondylitis 95% CI	Lateral epicondylitis p	P eq[a]
Personal factors										
Age, in years						0.0005			<.0001	
< 30	492	37	3	1.00	.		1.00	.		
30-49	1271	132	25	1.45	0.99-2.12		3.38	1.02-11.25		0.1841
≥ 50	398	60	23	2.33	1.51-3.59		11.00	3.27-36.95		0.0166
BMI, kg/m^2						0.012			0.2503	
Underweight, Normal (<25)	1231	110	24	1.00	.		1.00	.		
Overweight (25-30)	755	98	21	1.54	1.15-2.05		1.51	0.83-2.73		0.9564
Obese (≥30)	175	21	6	1.42	0.86-2.33		1.85	0.75-4.61		0.6004
At least one prior experience of upper-extremity musculoskeletal disorders						<.0001			<.0001	
No	1782	124	27	1.00	.		1.00	.		
Yes	379	105	24	5.52	4.13-7.40		5.80	3.29-10.21		0.875
Physical work-related factors										
Doing repetitive tasks, more than 4 hours/day						0.0005			0.139	
No	1684	158	36	1.00	.		1.00	.		
Yes	477	71	15	1.71	1.27-2.31		1.59	0.86-2.93		0.8236
Physical exertion						<.0001			0.0022	
Light	993	76	13	1.00	.		1.00	.		
Hard	1168	153	38	1.86	1.39-2.49		2.70	1.43-5.11		0.1277
Elbow flexion/extension, more than 2 hours/day						<.0001			0.002	
No	1432	125	24	1.00	.		1.00	.		
Yes	729	104	27	1.79	1.35-2.36		2.41	1.38-4.22		0.331
Wrist bending, more than 2 hours/day						0.0025			0.004	
No	1412	130	24	1.00	.		1.00	.		
Yes	749	99	27	1.54	1.16-2.03		2.27	1.30-3.97		0.2091
Use of vibrating handtools, more than 2 hours/day						0.1159			0.8918	
No	1754	177	42	1.00	.		1.00	.		
Yes	407	52	9	1.30	0.94-1.81		0.95	0.46-1.97		0.4297
Specific elbow combined physical exposure						<.0001			<.0001	
Light physical exertion and no elbow movements[b]	436	46	5	1.00	.		1.00	.		
Light physical exertion and 1-2 elbow movements	299	23	2	0.70	0.47-1.07		1.34	0.46-3.90		0.2099
Hard physical exertion and no elbow movements	694	53	11	0.70	0.42-1.19		0.56	0.11-2.92		0.9986
Hard physical exertion and 1 elbow movement	382	38	15	0.97	0.61-1.52		3.51	1.26-9.76		0.0083
Hard physical exertion and 2 elbow movements	350	69	18	2.20	1.47-3.29		5.27	1.93-14.37		0.0429
Psychosocial exposures										
Social support						0.0623			0.0146	
High	1322	128	23	1.00	.		1.00	.		
Low	839	101	28	1.30	0.99-1.72		2.01	1.15-3.51		0.1636
Job strain						0.686			0.1827	
No	1726	181	37	1.00	.		1.00	.		
Yes	435	48	14	1.07	0.76-1.50		1.53	0.82-2.86		0.3144

[a] P eq = Wald equality test for the association with elbow pain only and with lateral epicondylitis

[b] elbow movements = elbow flexion/extension more than 2 hours/day and wrist bending more than 2 hours/day

Table 2 - Univariate analyses for elbow pain only and lateral epicondylitis among women

	N	N pain	N epi	Elbow pain only			Lateral epicondylitis			P eq[a]
				OR	95% CI	p	OR	95% CI	p	
Personal factors										
Age, in years						0.0079			0.0137	
< 30	348	21	2	1.00	.		1.00	.		
30-49	909	103	24	2.04	1.25-3.32		4.99	1.17-21.22		0.2477
≥ 50	292	36	13	2.29	1.31-4.03		8.69	1.94-38.87		0.0989
BMI, kg/m²						0.1023			0.4915	
Underweight, Normal (<25)	1101	102	29	1.00	.		1.00	.		
Overweight (25-30)	323	41	9	1.43	0.97-2.10		1.10	0.52-2.36		0.5418
Obese (≥30)	125	17	1	1.51	0.87-2.62		0.31	0.04-2.32		0.1336
At least one prior experience of upper-extremity musculoskeletal disorders						<0.0001			<.0001	
No	1215	85	14	1.00	.		1.00	.		
Yes	334	75	25	4.21	2.99-5.92		8.52	4.36-16.63		0.0564
Physical work-related factors										
Doing repetitive tasks, more than 4 hours/day						0.1948			0.0058	
No	1068	104	19	1.00	.		1.00	.		
Yes	481	56	20	1.26	0.89-1.77		2.46	1.30-4.65		0.0631
Physical exertion						0.3155			0.0021	
Light	861	84	12	1.00	.		1.00	.		
Hard	688	76	27	1.18	0.85-1.64		2.94	1.48-5.86		0.0084
Elbow flexion/extension, more than 2 hours/day						0.7396			0.0029	
No	1064	109	18	1.00	.		1.00	.		
Yes	485	51	21	1.06	0.75-1.51		2.65	1.40-5.02		0.0119
Wrist bending, more than 2 hours/day						0.0419			0.0366	
No	1062	99	21	1.00	.		1.00	.		
Yes	487	61	18	1.42	1.01-2.00		1.98	1.04-3.75		0.3593
Use of vibrating handtools, more than 2 hours/day						0.7469			0.2351	
No	1487	153	36	1.00	.		1.00	.		
Yes	62	7	3	1.14	0.51-2.56		2.08	0.62-6.98		0.401
Specific elbow combined physical exposure						0.6437			0.0586	
Light physical exertion and no elbow movements[a]	597	61	7	1.00	.		1.00	.		
Light physical exertion and 1-2 elbow movements	262	24	6	1.11	0.68-1.83		0.51	0.17-1.54		0.2047
Hard physical exertion and no elbow movements	264	23	5	0.94	0.52-1.72		0.82	0.25-2.72		0.8115
Hard physical exertion and 1 elbow movement	597	61	7	1.26	0.69-2.29		2.10	0.75-5.89		0.4671
Hard physical exertion and 2 elbow movements	218	24	10	1.60	0.90-2.86		2.52	0.91-6.94		0.5692
Psychosocial exposures										
Social support						0.2834			0.9593	
High	980	95	25	1.00	.		1.00	.		
Low	569	65	14	1.20	0.86-1.68		0.98	0.51-1.91		0.5888
Job strain						0.3263			0.0558	
No	1120	111	23	1.00	.		1.00	.		
Yes	429	49	16	1.20	0.84-1.71		1.88	0.98-3.61		0.2164

[a] P eq = Wald equality test for the association with elbow pain only and with lateral epicondylitis

[b] elbow movements = elbow flexion/extension more than 2 hours/day and wrist bending more than 2 hours/day

Table 3 - Multivariate analysis for elbow pain only and lateral epicondylitis among men and women

Men	Model 1				Model 2			
	Elbow pain only		Lateral epicondylitis		Elbow pain only		Lateral epicondylitis	
	OR	95% CI	OR	95% CI	OR	95% CI	OR	95% CI
Age, in years								
< 30	1.00	.	1.00	.	1.00	.	1.00	.
30-49	1.40	0.95-2.07	3.44	1.02-11.56	1.42	0.96-2.11	3.63	1.08-12.24
≥ 50	2.17	1.38-3.41	11.38	3.30-39.25	2.28	1.44-3.61	13.55	3.90-47.03
BMI, kg/m^2								
Underweight, normal	1.00	.	1.00	.	1.00	.	1.00	.
Overweight, Obese	1.36	1.02-1.81	1.10	0.61-1.96	1.35	1.01-1.80	1.12	0.63-2.02
Doing repetitive tasks								
No	1.00	.	1.00	.	1.00	.	1.00	.
Yes	1.57	1.15-2.13	1.39	0.74-2.59	1.36	0.99-1.88	1.05	0.54-2.02
Physical exertion								
Light	1.00	.	1.00	.				
Hard	1.75	1.30-2.36	2.57	1.34-4.90				
Combined physical exposure								
Light physical exertion and no elbow movements[b]					1.00	.	1.00	.
Light physical exertion and 1-2 elbow movements					0.73	0.48-1.11	1.52	0.52-4.44
Hard physical exertion and no elbow movements					0.76	0.45-1.29	0.76	0.14-3.98
Hard physical exertion and 1 elbow movement					1.01	0.64-1.61	4.55	1.60-12.88
Hard physical exertion and 2 elbows movements					2.18	1.43-3.32	6.71	2.38-18.96
Social support								
High	1.00	.	1.00	.	1.00	.	1.00	.
Low	1.20	0.91-1.60	1.86	1.05-3.28	1.20	0.91-1.60	1.98	1.11-3.52

Women	Model 1				Model 2			
	Elbow pain only		Lateral epicondylitis		Elbow pain only		Lateral epicondylitis	
	OR	95% CI	OR	95% CI	OR	95% CI	OR	95% CI
Age, in years								
< 30	1.00	.	1.00	.	1.00	.	1.00	.
30-49	1.98	1.21-3.23	5.13	1.20-21.89	1.97	1.21-3.22	5.16	1.21-22.03
≥ 50	2.15	1.21-3.79	9.04	2.00-40.78	2.12	1.20-3.76	9.19	2.03-41.53
BMI, kg/m2								
Underweight, normal	1.00	.	1.00	.	1.00	.	1.00	.
Overweight, Obese	1.35	0.96-1.92	0.69	0.33-1.46	1.34	0.95-1.91	0.67	0.32-1.41
Doing repetitive tasks								
No	1.00	.	1.00	.	1.00	.	1.00	.
Yes	1.21	0.85-1.73	2.14	1.11-4.12	1.17	0.81-1.71	1.80	0.91-3.59
Physical exertion								
Light	1.00	.	1.00	.				
Hard	1.10	0.78-1.54	2.51	1.24-5.08				
Combined physical exposure								
Light physical exertion and no elbow movements[b]					1.00	.	1.00	.
Light physical exertion and 1-2 elbow movements					1.14	0.69-1.88	0.53	0.17-1.60
Hard physical exertion and no elbow movements					0.94	0.51-1.73	0.80	0.24-2.71
Hard physical exertion and 1 elbow movement					1.17	0.63-2.15	1.81	0.63-5.23
Hard physical exertion and 2 elbows movements					1.47	0.80-2.68	2.06	0.72-5.93
Social support								
High	1.00	.	1.00	.	1.00	.	1.00	.
Low	1.16	0.83-1.63	0.85	0.44-1.67	1.17	0.83-1.63	0.86	0.44-1.69

[a] P eq = Wald equality test between association with elbow only and with lateral epicondylitis in model 3
[b] elbow movements = elbows flexion/extension more than 2 hours/day and wrist bending more than 2 hours/days