Hand Dominance in Upper Extremity Musculoskeletal Disorders

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ABSTRACT. ***Objective.*** To investigate the role of hand dominance in common upper extremity musculoskeletal disorders (UEMSD) in a population study.

Methods. The target population consisted of a representative sample of people aged 30 years or older residing in Finland during 2000-2001. Of the 7977 eligible subjects, 6254 (78.4%) were included in the study.

Results. The prevalence of UEMSD was as follows: rotator cuff tendinitis 3.8%, bicipital tendinitis 0.5%, lateral epicondylitis 1.1%, medial epicondylitis 0.3%, carpal tunnel syndrome (CTS) 3.8%, and surgery due to CTS 1.3%. CTS was 2.5 times as prevalent in women as men, whereas the other UEMSD were as common in both sexes. Rotator cuff and bicipital tendinitis and medial epicondylitis were more prevalent in the dominant arm only in women, whereas lateral epicondylitis was more prevalent in the dominant elbow in both sexes. The higher prevalence of rotator cuff and bicipital tendinitis in the dominant side persisted beyond working age. The prevalence of CTS did not differ by hand dominance. Dominant hand had been operated more frequently for CTS in women.

Conclusion. Our findings show that UEMSD are more prevalent in the dominant than nondominant arm mainly in women. For shoulder tendinitis, the difference persists throughout adult age. Physical load factors may have long-lasting effects on the shoulder and they may play a greater role in women than men. (First Release Mar 1 2007; J Rheumatol 2007;34:1076–82)

Key Indexing Terms:
CARPAL TUNNEL SYNDROME PREVALENCE ROTATOR CUFF
TENDINITIS TENNIS ELBOW

Upper extremity musculoskeletal disorders (UEMSD) are prevalent in both men and women and a common cause of functional and work disability, sickness absence, and healthcare costs[1-3]. They place a heavy burden on primary and secondary healthcare services.

Lateral and medial epicondylitis are common at working age[4-6]. The age distribution of carpal tunnel syndrome (CTS) is bimodal with a peak between ages 50 and 59 years and a second peak in those aged 70 or older[7,8]. The risk of shoulder pain increases with age in the working population[9]. Shoulder pain is also common in elderly people over the age of 70 years[10].

Female dominance in CTS is quite clear[7,8], and has also been reported with regard to other UEMSD by some studies[4,11], but not by all[1,5,12].

Most UEMSD are expected to occur more commonly in the dominant than in the nondominant arm owing to higher exposures of the dominant side to physical loads in various activities. However, studies have reported a higher prevalence of lateral epicondylitis in the dominant elbow[4,6], but contradictory findings on the role of hand dominance in medial epicondylitis and CTS[4,7,12-14]. We are not aware of studies on hand preference for shoulder disorders.

Most previous epidemiological studies on UEMSD have been conducted among small and selected occupational or clinical populations. Few studies have been carried out in the general population[1]. We estimated the prevalence of UEMSD in the Finnish general population aged 30 years or older according to sex, age, and hand dominance. We used hand dominance to test indirectly the effects of occupational and non-occupational physical exposures.

MATERIALS AND METHODS

Population. In this national health examination survey, the Health 2000 Survey, the target population comprised all men and women aged 30 years or over residing in Finland between fall 2000 and spring 2001. To obtain a representative sample of the whole Finnish population, a 2-stage stratified cluster sampling design was used and sample stratified according to the 5 university hospital regions, each containing roughly 1 million inhabitants[15]. From each university hospital region 16 healthcare districts were sampled as clusters (altogether, n = 80).

Information was gathered by means of interview and clinical health examination at the 5 field clinics. At the comprehensive health examination, specially trained nurses carried out a symptom interview on musculoskeletal complaints and physicians performed a standardized examination including the status of the shoulders, elbows, and wrists.

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The original sample consisted of 8028 subjects aged 30 years or over. Of them, 51 were deceased before interview, 6986 (87.6%) were interviewed, and 6354 (79.7%) participated in the health examination. Subjects with data on UEMSD (n = 6254, 78.4%) were included in this study.

The dominant hand was defined as the one used for writing. The following question was asked by a specially trained nurse before the examination: "Are you right or left handed?" Dominant hand was defined as either right or left hand.

Case definition. The diagnosis of UEMSD was based on symptoms in the interview and clinical signs in the standardized examination. Diagnostic criteria for rotator cuff tendinitis were (1) history of pain in the shoulder during the preceding 30 days and (2) painful arc in 60° to 120° abduction or pain in the rotator cuff region induced by resisted active movement in at least one of abduction, external rotation, or internal rotation[16]. Criteria for bicipital tendinitis were (1) pain at the shoulder during the preceding 30 days and (2) pain occurring in the anterior shoulder region on resisted isometric flexion of the supinated forearm with the elbow in 90° of flexion.

Criteria for lateral epicondylitis were (1) pain at the elbow during the preceding 30 days and (2) pain in the lateral humeral epicondyle region on resisted extension of the wrist with the elbow in extension. Medial epicondylitis was defined similarly by (1) pain at the elbow during the preceding 30 days and (2) pain in the medial humeral epicondyle on resisted flexion of the wrist with the elbow in extension.

The diagnosis of possible or probable CTS was based on (1) pain or paresthesia or decreased sensitivity present in the thumb or index or middle finger on Katz hand diagram, plus (2) either positive Tinel's test, combined wrist flexion and carpal compression, decreased sensation in the median nerve distribution, or weakness of thumb abduction or wasting of the thenar eminence[16]. A probable case of CTS was defined as classic or probable Katz hand diagram, i.e., symptoms in 2 of the 3 radial fingers, and positive findings in at least 2 of the 4 clinical tests. The subjects (n = 79) who had undergone surgery due to CTS were questioned about the side of the operation. This information was available for 62 (78.5%) subjects.

Quality assessment. Two pilot studies were carried out 7 and 3 months before the field work started, in order to test and improve the methods. All staff members attended a 3-week training course. Quality assurance and quality control measures included training, written instructions, observation, video recording with feedback on examination technique, and repeated and parallel measurements.

To study the repeatability of the examination of the upper extremities, a subsample of 94 subjects underwent the standard clinical examination by 2 field physicians. Agreement was assessed by kappa coefficient and by the proportion of specific agreement when the prevalence of positive findings was low[17,18]. The agreement between the 2 examiners was good for a positive clinical sign of CTS ($\kappa = 0.68$). Proportion of specific agreement was 0.79 for pain in the rotator cuff region induced by resisted active movement of the shoulder, and 0.50 for pain in the lateral humeral epicondyle region induced by resisted extension of the wrist with the elbow in extension. Repeatability of the tests for the diagnosis of bicipital tendinitis and medial epicondylitis could not be assessed due to a very low prevalence of positive findings.

Statistical methods. Statistical significance (2-tailed $p < 0.05$) was assessed by a chi-square test for categorical variables and by a 2-sample t test for continuous variables. Within- and between-subject comparisons were performed between the dominant and nondominant as well as the right and left side. Population weighting was used in estimating the prevalence and confidence intervals (CI) to correct the age, sex, residential district, and language distributions of the study sample to correspond to those of the Finnish general population. Stata version 8.2 software was used to conduct survey analyses.

RESULTS

The subjects in the study group were younger than those who were not examined (mean age 52.6 vs 59.8 yrs), but there was no difference with respect to sex. No information was available on the handedness of subjects who did not participate in the health examination.

Men were on average about 2 years younger than women (mean age 51.5 vs 53.6 yrs). No difference was found between men and women regarding the level of education (mean 11.2 vs 11.3 yrs, respectively). Ninety-four percent of men and 96% of women were right-handed. Six percent of men and 4% of women were left-handed. There was a generation shift in handedness, older subjects being more often right-handed. This was more pronounced in women.

Overall prevalence. The prevalence of rotator cuff tendinitis was 3.8%, bicipital tendinitis 0.5%, lateral epicondylitis 1.1%, medial epicondylitis 0.3%, possible or probable CTS 3.8%, and surgery due to CTS 1.3% (Table 1). The prevalence of probable CTS was 1.0%. It was 1.3% in women and 0.6% in men.

Bilateral involvement. The prevalence of bilateral involvement was 0.5% for rotator cuff tendinitis, 0.1% for bicipital tendinitis, 0.1% for lateral epicondylitis, and 1.1% for CTS. There was only one case with bilateral medial epicondylitis. Bilateral bicipital tendinitis occurred more often in men than in women (0.2% vs 0; $p = 0.001$), whereas bilateral CTS was more prevalent among women (1.6%) than among men (0.4%).

Hand dominance. Rotator cuff and bicipital tendinitis occurred more commonly in the dominant than in the nondominant shoulder only in women, whereas lateral epicondylitis was more prevalent in the dominant compared to the nondominant elbow in both sexes (Table 2 and Figures 1-3). The prevalence of medial epicondylitis was higher in the dominant than the nondominant elbow in women aged 40–59 years (0.4% vs 0.1%; $p = 0.03$), but did not differ in men (Figure 4). CTS was 2.5 times as prevalent in women as in men ($p < 0.001$), and its prevalence did not differ by hand dominance in either sex (Figure 5). There was also no significant difference in the prevalence of probable CTS between the dominant and nondominant hand. However, in women, surgery due to CTS was more frequent on the dominant compared with the nondominant side ($p = 0.01$; Figure 6).

Side. Rotator cuff and bicipital tendinitis were significantly more frequent in the right than in the left arm in women, but not in men. Bicipital tendinitis was more prevalent in men (0.5%) than in women (0.1%) in the nondominant left arm ($p < 0.001$). Overall, lateral epicondylitis was significantly more frequent in the left dominant (2.5%) than in the right dominant (0.7%) or left nondominant elbow (0.4%). The difference in the prevalence of lateral epicondylitis between the left and right dominant elbow reached statistical significance only in men ($p = 0.001$). The prevalence of medial epicondylitis and CTS did not differ significantly between the right and left side.

Age. The prevalence of rotator cuff tendinitis increased with age in the dominant and nondominant side until the 60s in

Table 1. Prevalence of musculoskeletal disorders of the upper extremity by sex, Health 2000 Survey, 2000–2001.

Disorder	Men				Women				All			
	Sample	n	%	95% CI	Sample	n	%	95% CI	Sample	n	%	95% CI
Rotator cuff tendinitis	2824	99	3.5	2.8–4.3	3398	133	4.0	3.4–4.7	6222	232	3.8	3.3–4.3
Bicipital tendinitis	2824	16	0.6	0.4–0.9	3398	12	0.4	0.2–0.7	6222	28	0.5	0.3–0.7
Lateral epicondylitis	2800	28	1.0	0.7–1.5	3352	39	1.2	0.9–1.6	6152	67	1.1	0.9–1.4
Medial epicondylitis	2800	9	0.3	0.2–0.6	3352	8	0.3	0.1–0.6	6152	17	0.3	0.2–0.5
Carpal tunnel syndrome (CTS)	2844	61	2.1	1.7–2.8	3410	182	5.3	4.5–6.2	6254	243	3.8	3.3–4.3
Surgery due to CTS	2844	20	0.7	0.5–1.1	3410	59	1.8	1.4–2.3	6254	79	1.3	1.1–1.6

n: number of prevalent cases

Table 2. Prevalence of musculoskeletal disorders of the upper extremity by sex, side, and hand dominance, Health 2000 Survey, 2000–2001.

Disorder	Men							Women						
	Dominant			Nondominant			p	Dominant			Nondominant			p
	Sample	n	%	Sample	n	%		Sample	n	%	Sample	n	%	
Right arm														
Rotator cuff tendinitis	2646	59	2.2	168	1	0.6	0.14	3248	96	3.0	135	0	0	0.04
Bicipital tendinitis	2646	10	0.4	168	0	0	0.41	3248	11	0.4	135	0	0	0.53
Lateral epicondylitis	2628	16	0.6	166	1	0.6	0.97	3212	25	0.8	131	1	0.8	0.98
Medial epicondylitis	2628	4	0.2	166	0	0	0.61	3212	6	0.2	131	0	0	0.68
Carpal tunnel syndrome (CTS)	2667	31	1.2	171	2	1.2	0.96	3261	119	3.6	135	2	1.1	0.07
Surgery due to CTS	2667	11	0.4	171	0	0	0.38	3261	37	1.2	135	2	1.6	0.72
Left arm														
Rotator cuff tendinitis	168	5	3.1	2646	49	1.8	0.23	135	2	1.5	3248	48	1.5	0.98
Bicipital tendinitis	168	0	0	2646	12	0.5	0.34	135	0	0	3248	2	0.1	0.78
Lateral epicondylitis	166	5	3.2	2628	9	0.4	< 0.001	131	2	1.5	3211	15	0.5	0.09
Medial epicondylitis	166	0	0	2628	5	0.2	0.55	131	1	0.8	3211	2	0.1	0.008
Carpal tunnel syndrome	171	1	0.6	2667	39	1.5	0.34	135	4	2.9	3261	113	3.5	0.69
Surgery due to CTS	171	0	0	2667	11	0.4	0.38	135	2	1.6	3261	22	0.7	0.25
Overall														
Rotator cuff tendinitis	2814	64	2.3	2814	50	1.7	0.07	3383	98	3.0	3383	48	1.4	< 0.001
Bicipital tendinitis	2814	10	0.4	2814	12	0.4	0.58	3383	11	0.3	3383	2	0.1	0.004
Lateral epicondylitis	2794	21	0.7	2794	10	0.4	0.03	3343	27	0.8	3342	16	0.5	0.05
Medial epicondylitis	2794	4	0.1	2794	5	0.2	0.71	3343	7	0.2	3342	2	0.1	0.06
Carpal tunnel syndrome	2838	32	1.1	2838	41	1.4	0.20	3396	123	3.5	3396	115	3.4	0.66
Surgery due to CTS	2838	11	0.4	2838	11	0.4	0.96	3396	39	1.2	3396	24	0.8	0.01

n: number of prevalent cases.

men and the 70s in women. The prevalence of bicipital tendinitis also increased with age (p for trend = 0.03), with a peak in those aged 50 to 59 years. Lateral and medial epicondylitis were prevalent at working age in both men and women, but were rare after the age of 70. The prevalence of lateral epicondylitis peaked in women aged 40–49 years and in men aged 40–59. The highest prevalence of medial epicondylitis was found in women aged 50–59 years and in men aged 40–49. The age distribution of CTS was bimodal, with a peak in subjects aged 50 to 59 years and a second peak in those aged 80 years or older in both sexes and in both dominant and nondominant arm. Surgery due to CTS also showed a bimodal age distribution, with a peak in subjects aged 50 to 59 years and a second peak in those aged 70–79 in both sexes.

Among those in working age (30 to 64 yrs) rotator cuff tendinitis and lateral epicondylitis were found more often in the dominant arm (2.1% and 1.0%, respectively) compared with the nondominant (1.2% and 0.5%), whereas after working age (≥ 65 yrs) only rotator cuff tendinitis was significantly more prevalent in the dominant (4.5%) relative to the nondominant shoulder (2.8%).

DISCUSSION

Our findings in a large representative sample of the general population indicate that UEMSD are common in both men and women. Only CTS was more common in women than in men. Shoulder tendinitis, epicondylitis, and surgery due to CTS were more prevalent in the dominant arm in women, whereas only lateral epicondylitis was more prevalent in the dominant elbow in men. Among those with left-hand dominance, left-side lateral epicondylitis showed conspicuously

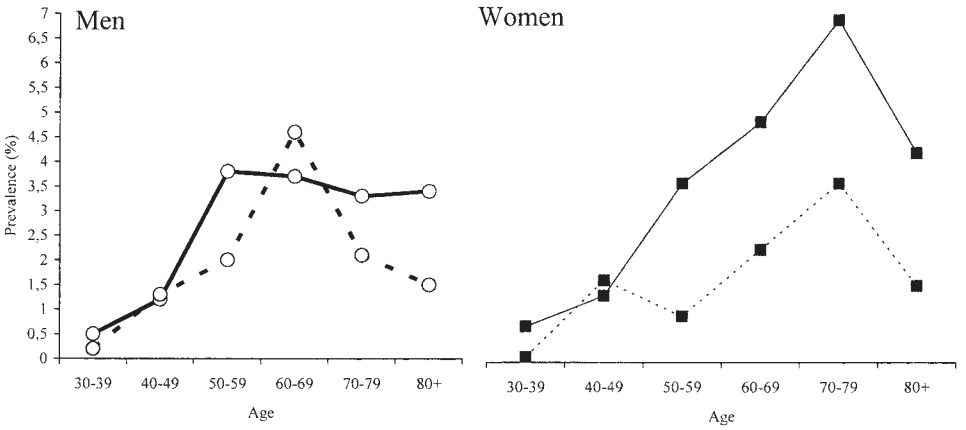

Figure 1. Prevalence of rotator cuff tendinitis according to hand dominance by sex and age. Dominant shoulder: solid line; nondominant shoulder: broken line. p = 0.07 for men and p < 0.001 for women for the difference between dominant and nondominant shoulder.

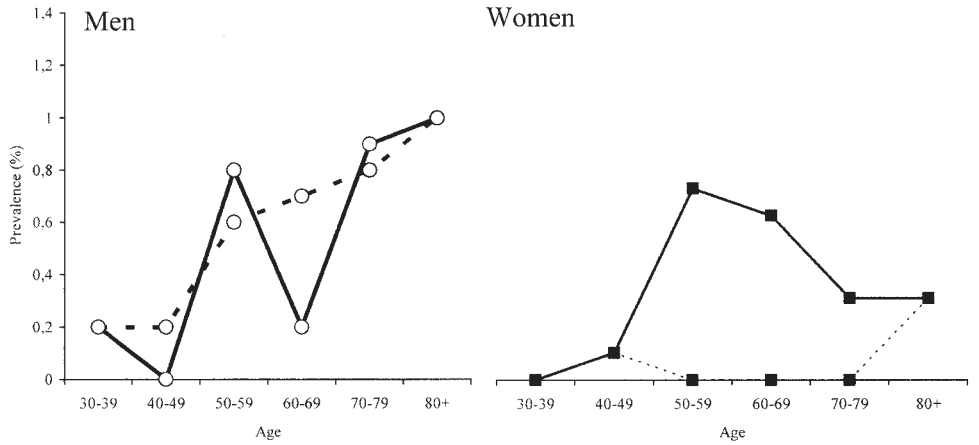

Figure 2. Prevalence of bicipital tendinitis according to hand dominance by sex and age. Dominant shoulder: solid line; nondominant shoulder: broken line. p = 0.58 for men and p = 0.004 for women for the difference between dominant and nondominant shoulder.

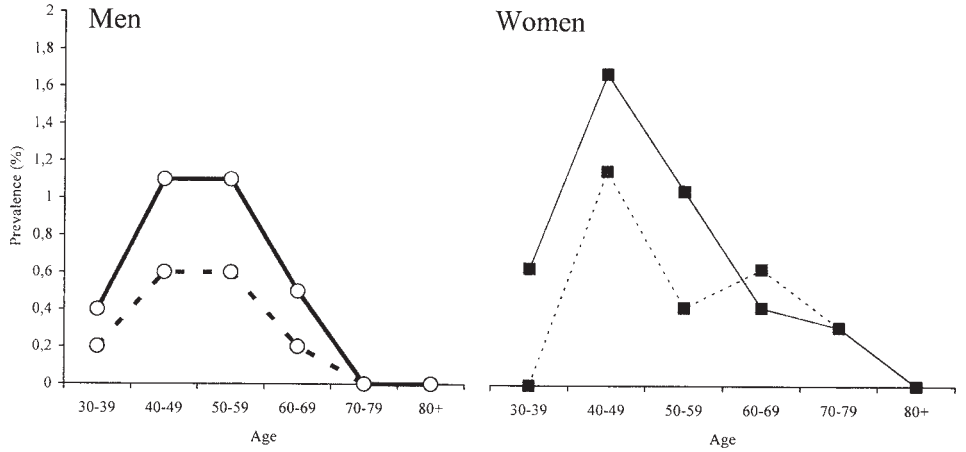

Figure 3. Prevalence of lateral epicondylitis according to hand dominance by sex and age. Dominant elbow: solid line; nondominant elbow: broken line. p = 0.03 for men and p = 0.05 for women for the difference between dominant and nondominant elbow.

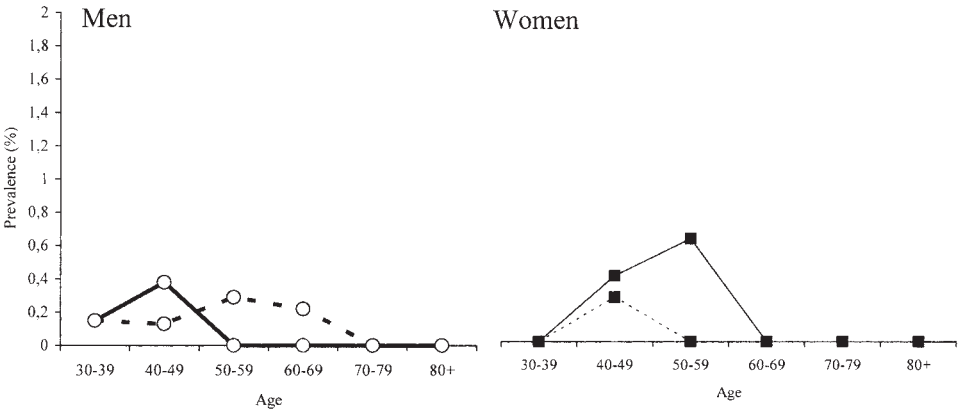

Figure 4. Prevalence of medial epicondylitis according to hand dominance by sex and age. Dominant elbow: solid line; nondominant elbow: broken line. p = 0.71 for men and p = 0.06 for women for the difference between dominant and nondominant elbow.

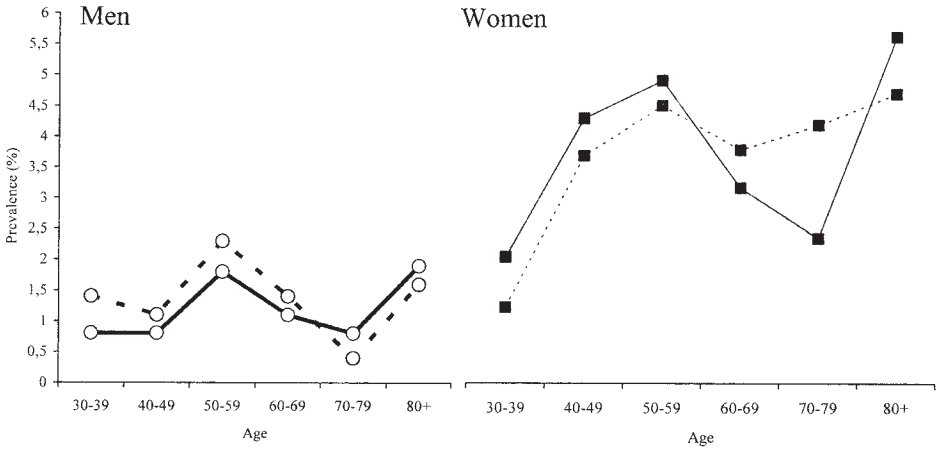

Figure 5. Prevalence of carpal tunnel syndrome according to hand dominance by sex and age. Dominant wrist: solid line; nondominant wrist: broken line. p = 0.20 for men and p = 0.66 for women for the difference between dominant and nondominant wrist.

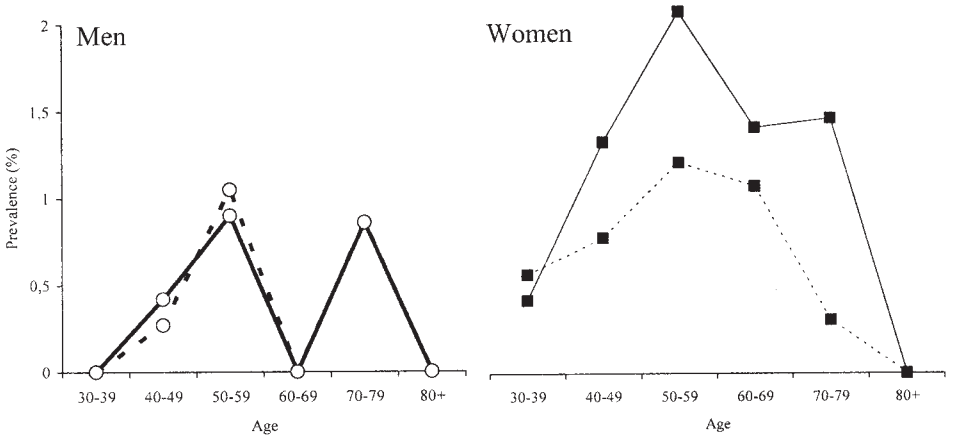

Figure 6. Prevalence of surgery due to carpal tunnel syndrome according to hand dominance by sex and age. Dominant wrist:solid line; nondominant wrist:broken line. p = 0.96 for men and p = 0.01 for women for the difference between dominant and nondominant wrist.

high prevalence. The prevalence of CTS did not differ by hand dominance in either sex.

We studied the role of hand dominance in UEMSD to test whether physical loads play a role in UEMSD. We assumed that the cumulative physical exposure in various activities would be higher for the dominant compared to the nondominant hand. We gathered information of exposure to work-related physical load factors in current and former jobs. However, this information was not side-specific. We therefore used hand dominance as a surrogate measure for assumed exposure differential between the hands.

The prevalences of UEMSD in general populations have been estimated to date as follows: rotator cuff tendinitis 3.0–6.1%, bicipital tendinitis 0.7%, lateral epicondylitis 0.7–3.0%, medial epicondylitis 0.6–1.1%, and CTS 1–5%[1,19-21]. Different case definitions and different diagnostic methods have been used.

Previous reports give controversial findings regarding sex differences in UEMSD, possibly because small and selected populations have been studied[1,4,5,7,8,11-13]. In line with many previous studies[7,8,19], we found a higher prevalence of CTS in women than men. However, this finding differs from those of a recent study in the British general population aged 25 to 64 years, in which a similar prevalence of CTS was reported among men and women[1]. The results have been discussed and are likely due to the use of different diagnostic criteria from those of the other studies[22]. In addition to biological factors such as hormonal factors and differences in tolerance to biomechanical loads, sex difference in UEMSD can be attributed to other exposures for which sex is a surrogate.

There is also controversy over the role of handedness in UEMSD. In general, upper limb pain tends to be commonly bilateral or in the dominant arm[23]. Rotator cuff tendinitis is a common disorder of the upper extremity[10,24], yet little is known of the role of hand dominance. Pain, stiffness, or tendinitis has been reported frequently in both shoulders or only on the right side[25,26]. Tears of the rotator cuff tendon were found more often in the dominant than the nondominant shoulder in a study among tennis-playing veterans[27], but showed an equal side distribution in a study on an asymptomatic population[28]. Tears of the biceps tendon were reported more commonly in the dominant than in the nondominant shoulder[27]. Rotator cuff and biceps tears represent probably a natural degenerative attrition as a result of aging and are often present without clinical symptoms.

Our finding of a similar prevalence of CTS in the dominant and nondominant wrist is inconsistent with many previous studies[7,13,14]. None of those studies was population-based, so selection mechanisms may explain the different results. In addition, different case definitions have been used. However, we found a higher rate of wrist surgery due to CTS in the dominant hand in women. A higher rate of surgery for CTS in the dominant hand may not be related to a higher prevalence. CTS may be more symptomatic and associated with more severe disability in the dominant than nondominant wrist.

Consistently with earlier studies[4,6], we found lateral epicondylitis to be more common in the dominant and right elbow. In our study, lateral epicondylitis was 6 times more common in the left dominant than in the left nondominant elbow. It was 3.6 times more prevalent in the left dominant relative to right dominant elbow, whereas its prevalence did not differ between the right dominant and nondominant elbow. Many work tasks and tools are mainly designed for the right hand and may be poorly fitted to the left hand. It has been suggested that subjects with left-hand dominance are more prone to accidental injury[29], yet no significant difference in injury involvement between left- and right-handed was found in a Finnish population-based study[30].

The advantages of our study include a large population-based sample with a high response rate, face to face interview, and comprehensive examination. The limitation of the study is its cross-sectional design. Subjects who were not included in our study did not differ with respect to sex, but were on average older than those included. Therefore, the prevalence of shoulder tendinitis and CTS may have been underestimated.

We used writing hand as a measure of hand dominance. Writing hand is a relatively good measure of hand preference[31]. However, people with left-hand dominance may have been educated during childhood to use their right nondominant hand for writing[32]. Therefore, left-handers may not use their dominant hand for all tasks[33]. Our estimated prevalence of left-handers was similar to that reported elsewhere[34]. Further, our prevalence estimates suggest that ambidextrous individuals, i.e., those who are able to use both hands equally, may have been classified as right-handers. Therefore, we may have underestimated the differences in the prevalence of UEMSD between dominant and nondominant hand.

The differences in prevalence between the dominant and nondominant side suggest a role of physical load factors in shoulder tendinitis and epicondylitis. Since each subject served as his or her own control, these differences are independent of the most important confounders.

In summary, shoulder tendinitis, epicondylitis, and surgery due to CTS are more common in the dominant than nondominant arm in women. Only lateral epicondylitis is more prevalent in the dominant than nondominant arm in men. For shoulder tendinitis the difference appears during wage-earning age and persists until retirement. Exposure to physical loads may therefore cause persistent damage to the shoulder. Our findings indicate that physical load factors, either at work or leisure, may play a greater role in UEMSD in women than in men. Therefore, modification of physical load factors could substantially reduce the risk of UEMSD. Regarding shoulder disorders, such measures may have a potential for sustainable effects.

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