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Original Contribution

Prevalence and Determinants of Lateral and Medial Epicondylitis: A Population Study

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Epicondylitis is a common disorder of the arm, yet the role of individual- and work-related factors has not been addressed in a population study. The aims of this study were to estimate the prevalence of lateral and medial epicondylitis and to investigate their risk factors. The target population of this study comprised a representative sample of people aged 30–64 years residing in Finland during 2000–2001. Of the 5,871 subjects, 4,783 (81.5%) were included in this study. The prevalence of definite lateral epicondylitis was 1.3%, and that of medial epicondylitis was 0.4%. The prevalence did not differ between men and women and was highest in subjects aged 45–54 years. Current smoking (adjusted odds ratio (OR) = 3.4, 95% confidence interval (CI): 1.4, 8.3) and former smoking (OR = 3.0, 95% CI: 1.3, 6.6) were associated with definite lateral epicondylitis. An interaction ($p = 0.002$) was found between repetitive movements of the arms and forceful activities for the risk of possible or definite lateral epicondylitis (for both repetitive and forceful activities vs. no such activity: OR = 5.6, 95% CI: 1.9, 16.5). Smoking, obesity, repetitive movements, and forceful activities independently of each other showed significant associations with medial epicondylitis. Epicondylitis is relatively common among working-age individuals in the general population. Physical load factors, smoking, and obesity are strong determinants of epicondylitis.

diabetes mellitus; elbow; obesity; smoking; tennis elbow; vascular diseases

Abbreviations: CI, confidence interval; HDL, high density lipoprotein; LDL, low density lipoprotein; OR, odds ratio.

Soft-tissue disorders of the arm occur commonly among working populations and are a frequent cause of sickness absence worldwide (1). Epicondylitis is one of the most prevalent disorders of the arm. Lateral epicondylitis is commonly called tennis elbow, and medial epicondylitis is called golfer's elbow. Epicondylitis is clinically defined by pain in the region of the epicondyle, which is provoked by resisted use of either the extensor or flexor muscles of the wrist (2). Epicondylitis causes pain and functional impairment and reduces productivity. It produces a heavy economic burden as lost workdays and, in some patients, inability to work may last for several weeks (3, 4).

Contradictory findings have been reported on the associations between individual- and work-related physical factors and epicondylitis (5–7). There is evidence of an association of epicondylitis with forceful work tasks, a combination of forceful and repetitive activities of the upper extremity, and a combination of either forceful or repetitive activities and extreme nonneutral postures of the hands and arms (3, 8, 9). However, there is still insufficient evidence to support a relation between this disorder and exposure to repetitive work alone (5, 6, 8).

Epicondylitis occurs commonly in working populations (9, 10). An association between gender and epicondylitis is still controversial. A higher risk has been reported in women than in men by some studies (9, 11), but not by all (5, 10, 12). One study reported an association between obesity and upper extremity tendonitis (13), yet the role of other

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individual or lifestyle factors and systemic diseases is largely unknown.

Most of the previous studies of epicondylitis have been conducted among small and selected occupational populations. Few studies have reported the prevalence and determinants of lateral and medial epicondylitis in the general population (12).

The aims of this study were to estimate the prevalence of lateral and medial epicondylitis in the Finnish general population aged 30–64 years and to determine the association of sociodemographic factors, vascular diseases and their risk factors, and work-related physical factors with lateral and medial epicondylitis.

MATERIALS AND METHODS

Population

In this national health examination survey, the Health 2000 Survey, the main emphasis was to obtain up-to-date information on cardiovascular, respiratory, musculoskeletal, and mental diseases and disability in the country, their determinants, and treatments. The target population comprised all men and women aged 30 years or over residing in Finland between the fall of 2000 and the spring of 2001. A two-stage stratified cluster sampling design was used and sample stratified according to the five university hospital regions, each containing roughly one million inhabitants (14). From each university hospital region, 16 health-care districts were sampled as clusters (altogether, $n = 80$). The 15 largest health center districts in the country were selected with probability 1 and the remaining 65 by systematic probability proportional to population size. From each of these 80 areas, a random sample of individuals was drawn from the national population register. Persons aged 80 years or over were oversampled by a 2:1 ratio in relation to their proportion in the population.

The study population is presented in figure 1. Of the original sample ($n = 8{,}028$), subjects aged 30–64 years ($n = 5{,}871$) were included in this study. The analysis of the prevalence of epicondylitis was restricted to the subjects ($n = 4{,}783$) with complete data on epicondylitis. The determinants of epicondylitis were analyzed for those who were free from rheumatoid arthritis ($n = 4{,}698$).

Information was gathered by means of home interview, clinical health examination, and laboratory tests. The first phase of the survey was the health interview to obtain information on sociodemographic status, lifestyle factors, work, health, and illnesses. At the comprehensive health examination a few weeks later, specially trained nurses carried out a symptom interview on musculoskeletal complaints, and physicians performed a standardized physical examination including the status of the elbows, palpation of epicondyles, and resisted movements of the wrists.

Case definition

The diagnosis of epicondylitis was based on self-reported symptoms in the interview and clinical signs in the standardized health examination. Diagnostic criteria for definite lateral epicondylitis were 1) pain at the elbow during the preceding 30 days and 2) pain at the lateral humeral epicondyle region on resisted extension of the wrist with the elbow extended (15). Diagnostic criteria for possible lateral epicondylitis were 1) pain at the elbow during the preceding 30 days and 2) tenderness at the lateral humeral epicondyle on physical examination. Definite medial epicondylitis was defined accordingly by 1) self-reported pain at the elbow during the preceding 30 days and 2) pain at the medial humeral epicondyle on resisted flexion of the wrist with the elbow extended. Possible medial epicondylitis was defined by 1) pain at the elbow during the preceding 30 days

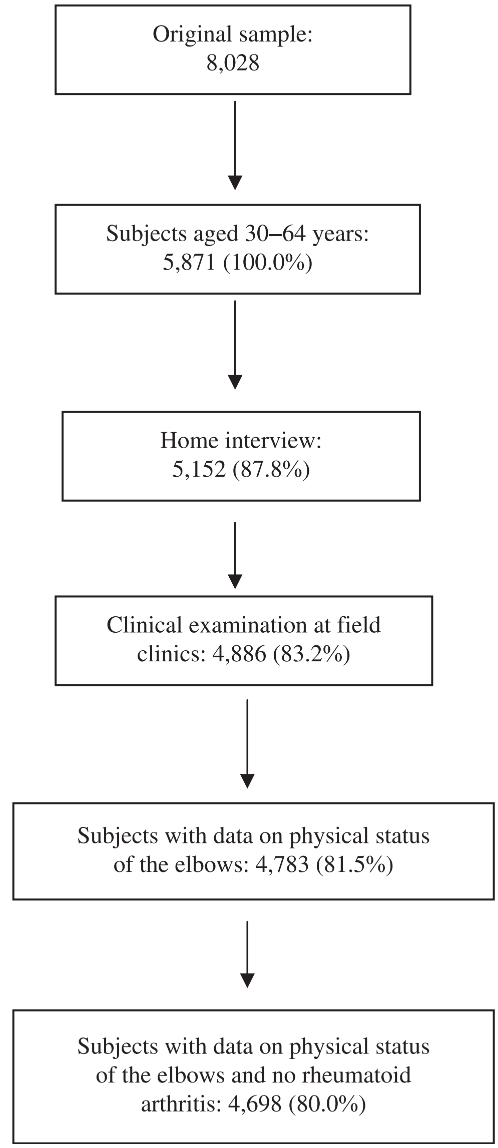

FIGURE 1. Flow chart of the study population, Health 2000 Survey, Finland, 2000–2001.

TABLE 1. Background characteristics of the individuals who were clinically examined and those who were not, Health 2000 Survey, Finland, 2000–2001

Characteristic	Subjects clinically examined	Subjects not examined*
No. of subjects	4,783	1,088
Age, years (mean (standard deviation))	46.3 (9.6)	44.9 (9.4)
Gender (%)		
Male	47.5	57.1
Female	52.5	42.9
Years of education (mean (standard deviation))	12.3 (3.7)	11.4 (4.2)
Body mass index, kg/m^2 (mean (standard deviation))	26.1 (4.4)	25.9 (5.1)
Smoking status (%)		
Former smoker	30.3	40.4
Current smoker	29.7	38.6
Forceful activities (%)	35.7	43.3
Repetitive movements of the hands or wrists (%)	46.3	47.9
Work with vibrating tools (%)	8.7	9.1

* Information was available for 161–1,088 subjects.

and 2) tenderness at the medial humeral epicondyle on physical examination.

Quality assessment

Two pilot studies were carried out 7 and 3 months before the fieldwork 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.

Determinants

Individual factors. The home interview elicited information on age, gender, education, smoking history, and leisure time physical activity. Fasting serum samples were drawn for the assessment of low density lipoprotein (LDL) and high density lipoprotein (HDL) cholesterol and sensitized C-reactive protein.

The subjects were defined as 1) current smokers if they smoked cigarettes, cigars, or a pipe at the time of interview; 2) former smokers if they had smoked at least 1 year in the past and were not current smokers; and 3) never smokers.

Leisure time physical exercise was assessed by a single global question and classified into one of three groups: $\leq$1, 2–3, and $\geq$4 times per week.

As part of the health examination, body weight and height and waist and hip circumferences were measured. Body mass index was calculated for all subjects, and overweight was defined as a body mass index value between 25.0 and 29.9 kg/m^2 and obesity as a value greater than or equal to 30.0 kg/m^2. Waist circumference was classified into one of three groups: <85, 85–100, and >100 cm. In addition, the waist:hip ratio was computed and classified into one of three levels: <0.85, 0.85–0.95, and >0.95.

Hypertension was defined on the basis of medical history and antihypertensive drug use. Ischemic vascular disease was defined as myocardial infarction, angina pectoris, history of balloon distension or coronary bypass surgery, transient ischemic attack, or intracranial cerebral infarction. Other heart disease was defined as heart failure, cardiac arrhythmia, or valvular disease. Field physicians diagnosed all the conditions by applying preset criteria.

Direct enzymatic methods were used for LDL and HDL cholesterol determinations. LDL cholesterol was classified into three levels: $\leq$129, 130–189, and $\geq$190 mg/dl. HDL cholesterol was also grouped into three levels: <40, 40–59, and $\geq$60 mg/dl. Sensitized C-reactive protein was divided into four equally sized groups by use of a quartile method.

Occupational physical factors. Physical load factors were assessed by the home interview. The current and five most long-lasting former jobs were scrutinized, and the respondents were asked whether they had been exposed (no/yes) to

TABLE 2. Prevalence of lateral and medial epicondylitis, Health 2000 Survey, Finland, 2000–2001*

Characteristic	Sample	Lateral				Medial				Total			
		All		Definite		All		Definite		All		Definite	
		No.	%	No.	%	No.	%	No.	%	No.	%	No.	%
Age (years)													
30–44	2,104	34	1.6	18	0.9	22	1.0	6	0.3	42	2.0	22	1.1
45–54	1,597	59	3.7	32	2.0	38	2.4	8	0.5	74	4.6	36	2.2
55–64	1,082	42	3.8	13	1.2	30	2.7	3	0.3	52	4.8	16	1.5
Gender													
Male	2,270	47	2.1	27	1.2	26	1.1	9	0.4	61	2.7	34	1.5
Female	2,513	88	3.6	36	1.4	64	2.6	8	0.3	107	4.3	40	1.6
Overall	4,783	135	2.8	63	1.3	90	1.9	17	0.4	168	3.5	74	1.6

* No. = prevalent cases; weighted number of observations = 4,993.

TABLE 3. Age- and gender-adjusted odds ratios for the association of individual and physical workload factors with lateral or medial epicondylitis, Health 2000 Survey, Finland, 2000–2001

Characteristic	Sample	Lateral (definite or possible)			Lateral (definite)			Medial (definite or possible)		
		No.	Odds ratio	95% confidence interval	No.	Odds ratio	95% confidence interval	No.	Odds ratio	95% confidence interval
Individual factors										
Age (years)*										
30–44	2,080	33	1		18	1		22	1	
45–54	1,574	58	2.4	1.5, 3.7	32	2.4	1.4, 4.1	37	2.3	1.3, 3.9
55–64	1,044	40	2.4	1.5, 3.9	13	1.4	0.7, 3.1	27	2.5	1.4, 4.3
Gender†										
Male	2,245	47	1		27	1		25	1	
Female	2,453	84	1.7	1.2, 2.4	36	1.2	0.7, 2.1	61	2.4	1.5, 3.6
Education										
Basic	1,371	56	1		29	1		33	1	
Secondary	1,701	46	0.8	0.5, 1.2	19	0.6	0.3, 1.0	37	1.2	0.7, 2.0
Higher	1,608	28	0.5	0.3, 0.9	15	0.5	0.2, 0.9	15	0.5	0.2, 0.9
Smoking status										
Never smoker	1,291	27	1		8	1		19	1	
Former smoker	1,211	42	2.1	1.3, 3.5	20	3.1	1.4, 6.8	24	2.0	1.1, 3.6
Current smoker	1,194	40	2.3	1.4, 3.7	22	3.6	1.5, 8.3	27	2.5	1.3, 4.7
Exercise (times/week)										
≤1	1,939	47	1		27	1		30	1	
2–3	1,597	46	1.3	0.8, 2.1	18	0.8	0.4, 1.5	26	1.2	0.6, 2.2
≥4	1,111	34	1.5	0.9, 2.4	16	1.0	0.5, 1.9	29	1.7	0.9, 3.2
Body mass index (kg/m^2)										
Normal	1,976	49	1		25	1		27	1	
Overweight	1,718	50	1.2	0.8, 1.8	22	1.0	0.5, 1.7	35	1.6	0.9, 2.8
Obese	764	27	1.3	0.8, 2.2	13	1.3	0.6, 2.5	21	1.9	1.0, 3.7
Waist circumference (cm)										
<85	1,502	38	1		20	1		21	1	
85–100	2,003	56	1.3	0.8, 1.9	25	1.0	0.5, 1.9	38	1.8	1.0, 3.0
>100	1,167	37	1.4	0.8, 2.4	18	1.2	0.5, 2.6	27	2.3	1.1, 4.7
Waist:hip ratio										
<0.85	1,328	36	1		16	1		20	1	
0.85–0.95	1,789	60	1.4	0.9, 2.2	28	1.4	0.7, 2.7	39	2.0	1.2, 3.4
>0.95	1,555	35	1.2	0.7, 2.1	19	1.2	0.5, 3.0	27	3.5	1.6, 7.5
LDL‡ cholesterol (mg/dl)										
≤129	1,638	46	1		21	1		31	1	
130–189	2,333	63	0.9	0.6, 1.3	28	0.9	0.5, 1.7	43	0.9	0.6, 1.5
≥190	713	22	0.9	0.6, 1.6	14	1.4	0.7, 2.8	12	0.8	0.4, 1.6
HDL‡ cholesterol (mg/dl)										
≥60	1,300	34	1		15	1		26	1	
40–59	2,446	71	1.3	0.8, 1.9	34	1.3	0.7, 2.6	42	1.0	0.6, 1.6
<40	938	26	1.3	0.8, 2.3	14	1.4	0.6, 3.2	18	1.3	0.7, 2.5
Sensitized C-reactive protein										
Quartile 1	1,137	30	1		13	1		16	1	
Quartile 2	1,177	33	1.1	0.7, 1.6	19	1.5	0.7, 3.0	25	1.5	0.8, 2.9
Quartile 3	1,171	28	0.8	0.5, 1.4	14	1.0	0.5, 2.1	15	0.8	0.4, 1.8
Quartile 4	1,159	39	1.2	0.7, 1.9	17	1.3	0.6, 2.7	29	1.5	0.8, 1.3

Table continues

TABLE 3. Continued

Characteristic	Sample	Lateral (definite or possible)			Lateral (definite)			Medial (definite or possible)		
		No.	Odds ratio	95% confidence interval	No.	Odds ratio	95% confidence interval	No.	Odds ratio	95% confidence interval
Medical history										
Diabetes										
No	4,553	123	1		60	1		79	1	
Type 1	24	1	1.7	0.2, 13.4	0			1	2.9	0.4, 23.1
Type 2	100	7	2.4	1.1, 5.3	3	2.1	0.6, 6.7	6	3.3	1.4, 7.9
Unknown type	5	0			0			0		
Vascular disease										
No	4,386	119	1		61			75	1	
Ischemic vascular disease	131	6	1.2	0.5, 3.4	1			5	1.8	0.7, 4.9
Other heart disease	157	6	1.1	0.4, 2.8	1			6	1.8	0.8, 4.3
Hypertension										
No	4,012	105	1		52	1		65	1	
Yes	686	26	1.2	0.7, 1.9	11	1.1	0.5, 2.3	21	1.6	0.9, 2.6
Occupational physical factors										
Handling of loads >5 kg ≥2 times/minute ≥2 hours/day (years)										
None	3,220	75	1		35	1		51	1	
1–8	464	16	1.8	1.0, 3.0	9	2.0	0.9, 4.2	14	2.4	1.3, 4.5
9–19	419	13	1.5	0.8, 2.6	7	1.6	0.7, 3.6	7	1.1	0.5, 2.5
≥20	548	25	1.9	1.1, 3.2	11	1.8	0.8, 4.0	13	1.4	0.7, 2.6
Handling of loads >20 kg ≥10 times/day (years)										
None	3,148	72	1		35	1		48	1	
1–8	516	13	1.3	0.7, 2.6	4	0.8	0.3, 2.3	15	2.5	1.4, 4.6
9–19	419	11	1.4	0.7, 3.0	8	1.9	0.8, 4.3	4	0.8	0.3, 2.2
≥20	568	33	2.7	1.7, 4.2	15	2.6	1.3, 5.1	18	2.3	1.2, 4.2
High handgrip forces ≥1 hour/day (years)										
None	2,992	71	1		38			43	1	
1–8	481	11	1.2	0.6, 2.3	6	1		11	2.2	1.1, 4.3
9–19	446	14	1.7	0.9, 3.3	7	1.1	0.4, 2.6	7	1.5	0.6, 3.8
≥20	731	33	1.9	1.2, 2.9	11	1.4	0.6, 3.1	24	2.5	1.4, 4.5
Repetitive movements of the hand or wrist ≥2 hours/day (years)										
None	2,010	30	1		15	1		18	1	
1–8	649	13	1.4	0.7, 2.8	8	1.7	0.7, 4.2	10	1.8	0.8, 4.0
9–19	820	23	2.1	1.2, 3.6	14	2.4	1.2, 4.9	15	2.2	1.1, 4.4
≥20	1,171	63	3.3	2.1, 5.2	25	2.8	1.4, 5.8	42	3.6	2.1, 6.2
Keying ≥4 hours/day										
No	3,400	102	1		51	1		70	1	
Yes	1,250	27	0.7	0.5, 1.1	11	0.6	0.3, 1.1	15	0.5	0.3, 0.9
Work with vibrating tools ≥2 hours/day										
No	4,249	110	1		58	1		74	1	
Yes	401	19	2.3	1.3, 4.1	4	0.7	0.2, 2.1	11	2.2	1.1, 4.4

* Adjusted for gender.
† Adjusted for age.
‡ LDL, low density lipoprotein; HDL, high density lipoprotein.

TABLE 4. Multivariable odds ratios mutually adjusted for the determinants of lateral epicondylitis, Health 2000 Survey, Finland, 2000–2001

Characteristic	Definite or possible		Definite	
	Odds ratio	95% confidence interval	Odds ratio	95% confidence interval
Age (years)				
30–44	1		1	
45–54	2.3	1.5, 3.6	2.2	1.3, 3.9
55–64	2.2	1.3, 3.7	1.4	0.6, 3.2
Gender				
Male	1		1	
Female	2.2	1.5, 3.2	1.6	0.9, 2.7
Smoking status				
Never smoker	1		1	
Former smoker	2.0	1.2, 3.4	3.0	1.3, 6.6
Current smoker	2.0	1.2, 3.3	3.4	1.4, 8.3
Forceful activities	0.5	0.2, 1.3	0.6	0.2, 2.0
Repetitive movements of the hands or wrists	1.0	0.6, 1.8	1.1	0.6, 2.4
Interaction between repetitive and forceful activities	5.6	1.9, 16.5	3.6	0.9, 14.6
Work with vibrating tools	1.3	0.7, 2.4		

workload factors of interest. The workload factors were the following:

- Manual handling of loads (manually lifting, carrying, pushing, or pulling items) heavier than 5 kg at least two times per minute at a minimum of 2 hours daily;
- Manual handling of loads heavier than 20 kg at least 10 times every day;
- Work demanding high handgrip forces (e.g., squeezing, twisting, or holding burdens or tools) at least 1 hour per day on average;
- Repetitive movements of the hands or wrists (e.g., packing and sorting out) at least 2 hours a day on average;
- A keying job (e.g., typewriting, cash register work, computer display work) with a duration of at least 4 hours per day; and
- Work with a vibrating tool at least 2 hours per day on average.

Furthermore, information on the duration (in years) of current and previous employments was also gathered by the interview. The number of years of exposure to each workload factor was summed up, and a cumulative index was estimated for each factor. The indices were categorized into four groups: 0, 1–8, 9–19, and ≥20 years, to allow a sufficient number of subjects in each group.

Statistical methods

Statistical significance (two-tailed $p < 0.05$) was assessed by a chi-squared test for categorical variables and by a two-sample t test for continuous variables. Logistic regression models were run to study the determinants of lateral and medial epicondylitis. To find out whether the determinants of possible lateral epicondylitis differed from those of definite cases, we ran the analyses separately for combined possible or definite cases and only definite cases. No analysis was run for definite medial epicondylitis because of the small number of prevalent cases. Population weighting was used in estimating the prevalences, odds ratios, and confidence intervals to correct the age, gender, residential district, and language distributions of the study sample to correspond to those of the Finnish general population. Multivariable logistic regression models were limited to age, gender, and the variables associated with lateral or medial epicondylitis at $p \leq 0.10$ in the age- and gender-adjusted analyses. Backward elimination was used in the multivariable models to remove those factors that were not associated with lateral or medial epicondylitis. Logistic regression models were initially run separately for men and women. In the analysis of lateral epicondylitis, men and women were combined because the results were largely similar. High handgrip forces and manual handling of loads heavier than 5 or 20 kg were highly correlated with each other (Pearson's correlation coefficient = 0.52–0.54) and were grouped into a single variable of forceful activities. The correlation between forceful activities and repetitive movements of the arm was 0.33. The presence of multiplicative interaction for the risk of lateral or medial epicondylitis was assessed for the following combinations: gender × physical load factors, smoking × physical load factors, obesity × physical load factors, repetitive activities × forceful activities, and smoking × obesity. STATA, version 8.2, software (StataCorp LP, College Station, Texas) was used for the analyses.

RESULTS

Information on age and gender was available for all subjects who were not clinically examined (table 1). Data on other characteristics existed for only 161–599 subjects. On the basis of available information, there were no significant differences between subjects who were and those who were not examined with respect to body mass index, exposure to repetitive movements of the hand or wrists, or working with vibrating tools. However, subjects not examined had less education and were more often former or current smokers and exposed to forceful activities than those examined.

Prevalence

Lateral epicondylitis. The prevalence of lateral epicondylitis (definite or possible) was 2.8 percent (95 percent confidence interval (CI): 2.4, 3.3) (table 2). It was highest in subjects aged 45–54 and 55–64 years and higher in women compared with men. The prevalence of definite lateral epicondylitis was 1.3 percent (95 percent CI: 1.0, 1.7). It was highest in subjects aged 45–54 years. There was no gender difference in the prevalence of definite lateral epicondylitis.

TABLE 5. Multivariable odds ratios mutually adjusted for the determinants of medial (definite or possible) epicondylitis by gender, Health 2000 Survey, Finland, 2000–2001

Characteristic	Men		Women		All	
	Odds ratio	95% confidence interval	Odds ratio	95% confidence interval	Odds ratio	95% confidence interval
Age (years)						
30–44	1		1		1	
45–54	2.4	0.9, 6.5	2.0	1.1, 3.8	2.1	1.2, 3.6
55–64	2.6	0.9, 7.2	1.9	0.9, 4.1	2.1	1.1, 3.8
Gender						
Male					1	
Female					4.9	2.5, 9.6
Smoking status						
Never smoker	1		1		1	
Former smoker	2.0	0.4, 10.1	1.9	1.0, 3.6	1.8	1.0, 3.4
Current smoker	2.4	0.5, 10.8	2.1	1.0, 4.5	2.1	1.1, 4.1
Waist:hip ratio						
<0.85			1		1	
0.85–0.95			1.6	0.9, 2.8	1.7	0.9, 2.8
>0.95			2.9	1.1, 7.2	2.7	1.2, 6.0
Forceful activities	2.2	1.0, 4.7	1.5	0.8, 2.5	1.6	1.0, 2.6
Repetitive movements of the hands or wrists	1.4	0.6, 3.0	1.7	1.0, 2.9	1.6	1.1, 2.5
Work with vibrating tools			2.1	0.8, 5.8	1.3	0.6, 2.8

Medial epicondylitis. The prevalence of medial epicondylitis (definite or possible) was 1.9 percent (95 percent CI: 1.6, 2.2). It was highest in subjects aged 45–54 and 55–64 years and more common in women compared with men. However, no difference was found in the prevalence of definite medial epicondylitis between men and women.

Concurrent lateral and medial epicondylitis. Fifty-seven subjects had both medial and lateral epicondylitis (possible or definite), with a prevalence of 1.2 percent (95 percent CI: 0.9, 1.5). The prevalence of this comorbidity was 1.8 percent in women and 0.5 percent in men. It was highest in subjects aged 55–64 (1.8 percent) and 45–54 (1.4 percent) years. Only six subjects (0.1 percent) had both definite lateral and medial epicondylitis.

Determinants

Individual factors. In the gender-adjusted analyses, the prevalence of lateral and medial epicondylitis was higher in subjects aged 45–64 years compared with those aged 30–44 years (table 3). However, an increased prevalence of definite lateral epicondylitis was found only in subjects aged 45–54 years. In the age-adjusted analyses, lateral epicondylitis and medial epicondylitis were more common among women than among men, but no difference was found for the definite lateral cases. After controlling for age and gender, we found both conditions to be significantly less common in subjects with high education compared with those with low education, while the disorders were not related to leisure-time physical activity.

Current smoking and former smoking were associated with both lateral and medial epicondylitis. Among current smokers, no clear dose-response relation was found between the numbers of pack-years smoked and the risk of lateral or medial epicondylitis. Body mass index, waist circumference, and waist:hip ratio were strongly associated with medial epicondylitis but not with lateral epicondylitis. The associations were statistically significant only for women and not for men.

Type 2 diabetes was associated with both lateral (odds ratio (OR) = 2.4, 95 percent CI: 1.1, 5.3) and medial (OR = 3.3, 95 percent CI: 1.4, 7.9) epicondylitis. The risk of medial epicondylitis was nonsignificantly higher in subjects who suffered from vascular disease. The risk of the disorders did not differ according to the level of blood pressure. Sensitized C-reactive protein, LDL cholesterol, and HDL cholesterol levels were not associated with lateral or medial epicondylitis.

In the multivariable analyses after controlling for the effects of other covariates, we found that possible or definite lateral epicondylitis was still associated with age, gender, and smoking (table 4). Possible or definite medial epicondylitis was also associated with age, gender, and smoking (table 5). It was associated with the waist:hip ratio only in women.

Occupational physical factors. In the age- and gender-adjusted analyses, work tasks requiring repetitive movements of the hands or wrists, manual handling of loads heavier than 5 or 20 kg, and activities demanding high handgrip forces or the use of a vibrating tool were associated with both lateral and medial epicondylitis (table 3). However, the association was statistically significant regarding definite diagnosis of lateral epicondylitis for work tasks demanding manual handling of loads heavier than 20 kg and repetitive movements of the arms. A dose-response relation was found between repetitive movements of the hands or wrists and manual handling of loads heavier than 20 kg and both disorders, the risk being higher for longer duration of exposure. A keying job was associated with lower risk of lateral and medial epicondylitis, although the odds ratio was not significant for lateral epicondylitis.

In the multivariable model after controlling for other covariates, we found that there was an interaction ($p = 0.002$) between repetitive movements of the arms and forceful activities for the risk of possible or definite lateral epicondylitis (table 4). Work tasks demanding only forceful activities or only repetitive movements of the hands or wrists were not associated with lateral epicondylitis. Subjects exposed to a combination of forceful and repetitive activities were at 5.6 times (95 percent CI: 1.9, 16.5) higher risk of lateral epicondylitis than were those exposed to neither of these activities. The interaction was not statistically significant for the definite cases ($p = 0.069$). Work tasks requiring vibrating tools were not significantly related to a higher risk of lateral epicondylitis.

Medial epicondylitis was significantly associated with forceful activities among men (OR = 2.2) and with repetitive movements of the arms among women (OR = 1.7) (table 5). Work tasks demanding vibrating tools were nonsignificantly related to a higher risk of medial epicondylitis in women. No interaction was found between forceful and repetitive activities for the risk of medial epicondylitis.

DISCUSSION

Our findings from a representative sample of the general population demonstrate that epicondylitis is a relatively common disorder with a prevalence of 1.3 percent for definite lateral and 0.4 percent for definite medial epicondylitis at the wage-earning age. The prevalence peaked at the age of 45–54 years. Definite lateral epicondylitis and medial epicondylitis were as common in the men as women, but combined definite or possible lateral and medial epicondylitis affected women more frequently than it did men. Smoking was associated with both lateral and medial epicondylitis, and obesity was associated with medial epicondylitis in women. Work tasks demanding forceful activities were associated with a higher risk of medial epicondylitis among men and with repetitive movements of the hands or wrists among women. The presence of both forceful and repetitive movements of the arm was strongly associated with lateral epicondylitis but not the presence of repetitive or forceful movement alone. These imply a positive interaction (synergism) between these factors on the risk of lateral epicondylitis.

We examined subjects aged 30–64 years, because epicondylitis is a common disorder at working age and is associated with work-related physical load factors (8, 9). No subject aged less than 30 years was recruited to the study, and there were only 18 subjects aged 65 years or over who held a job during the preceding 12 months.

The prevalence of lateral epicondylitis or tennis elbow has varied between 1 percent and 3 percent in the general population (12, 16) and between 2 percent and 23 percent among occupational populations (7, 10, 16). The highest prevalence has been reported among subjects aged 40–60 years (4, 9, 10, 17). In previous studies, the prevalence of medial epicondylitis or golfer's elbow has ranged between 0.2 percent and 5.0 percent (5, 9, 11). Our prevalence estimates of the dominance of lateral epicondylitis and a higher occurrence in subjects aged 45–54 years and in women are consistent with those of other studies (4, 7, 9–11, 17).

The diagnosis of lateral epicondylitis and medial epicondylitis has usually been based on local pain at the elbow, tenderness at the epicondyle on palpation, and pain at the epicondyle on resisted isometric extension or flexion of the wrist. In some studies (9, 11, 12), both positive palpation and isometric test finding have been required for the diagnosis, whereas other studies (5, 10) have required only one of them. The interexaminer repeatability of isometric and palpation tests has been moderate in the general population, with a k coefficient of 0.52–0.64 (18). We used the isometric test in the criteria for definite diagnosis and the palpation test for possible diagnosis. In the present study, 65 percent of definite lateral cases and 59 percent of definite medial cases also had tenderness at the humeral epicondyle on physical examination. Differences in the prevalence of lateral and medial epicondylitis between studies may be partly related to different case definitions.

Previous epidemiologic studies have shown that lateral epicondylitis is related to forceful movements of the elbow (3, 8, 10, 19–21). However, inconsistent results have been reported on the relation between lateral epicondylitis and repetitive movements of the arms (6, 8). An association between medial epicondylitis and forceful activities has also been reported (5, 22) but not with repetitive activities (5). A dose-response relation has been found between lateral or medial epicondylitis and the duration of employment in jobs requiring forceful movements of the elbow (6, 8–10, 21). The relation between work loading factors and epicondylitis has been strongest when workers have been exposed to a combination of risk factors, such as force and repetition, or either force or repetition and extreme nonneutral postures of the arms (3, 8, 9). Our study showed that lateral epicondylitis is strongly associated with work tasks demanding a combination of repetitive and forceful activities and with a longer exposure to these activities. We found that work tasks demanding forceful or repetitive activities alone are risk factors for only medial epicondylitis.

Tennis and golf players often develop lateral or medial epicondylitis (23). In the current population-based study, it is very unlikely that workers exposed to repetitive or forceful activities of the arms were more frequently golfers or tennis players than were those not exposed to these activities. A limitation of our study was that we had no information on practicing tennis, golf, or other sports.

In epidemiologic studies, exposure to work-related physical loads is often assessed by a self-report. An advantage of this method is the possibility of studying cumulative exposure over time, but it may have limited validity (24). The assessment of the weights of handled loads and exerted forces is usually the most difficult. Everyday loads, for example, five 1-liter milk or juice cans corresponding to 5 kg, can be used as an aid in the estimation. In the multivariable analyses, we used dichotomous variables of exposure to physical load factors in the participants' current jobs, which method has good sensitivity and specificity (25).

We saw an association between smoking and lateral and medial epicondylitis, a finding not reported earlier (5, 9, 10). Smoking may interfere with the circulation to tendons, which not only places these tissues at risk for injury but also slows or prevents their healing during a recovery period. That former smokers are also at higher risk of epicondylitis suggests that previous exposure to tobacco may have persistent effects on the vascular system. Increased risk of epicondylitis among smokers may also be due to other lifestyle factors associated with smoking.

A higher incidence of upper extremity tendinitis has been found in subjects with obesity (13). In the current study, obesity was associated with medial epicondylitis. Obesity causes insulin resistance, a component of metabolic syndrome, which may lead to type 2 diabetes mellitus. In the age- and gender-adjusted analyses, we saw an increased risk of lateral and medial epicondylitis in subjects with type 2 diabetes. However, the estimates were not statistically significant after controlling for other confounders, probably because of the small numbers of diabetic subjects. Further longitudinal studies are needed to clarify the roles of smoking and obesity in the etiology of epicondylitis.

The pathogenesis of epicondylitis is still unclear. Repeated microtrauma at the origin of the common extensor or flexor tendon may initiate the disease. Common pathologic findings in lateral epicondylitis are chronic tears with formation of granulation tissue in the origin of the extensor carpi radialis brevis (26, 27). Two possible mechanisms have been proposed: the role of eccentric exertions and contact pressure from the radial head. Repetitive dorsiflexions of the wrist and supination of the forearm may contribute to this process, given the asymmetric axis of rotation of the radial head on the end of the radius. The injury initiates a natural repair response, and accumulated connective tissue may account for the clinical and pathologic manifestations.

The results of our study and earlier studies suggest that modification of physical load factors could substantially reduce the risk of epicondylitis. Thus far, it is premature to speculate whether effective population-level health promotion activities against smoking and obesity could reduce the risk of epicondylitis.

Our study population was sufficiently large to estimate accurately the prevalence of lateral and medial epicondylitis in the general population. The interview and clinical examination having been carried out on separate occasions reduces the likelihood of information bias. A limitation of this study is its cross-sectional nature. Risk factors should be defined in terms of incidence rather than prevalence.

To the extent that we were able to obtain information, subjects who were not included in the study had a lower level of education, were more frequently smokers, and were more frequently exposed to forceful activities than were those included in the study. Therefore, the more heavily exposed population did not participate, although the participation rate was high. We may have therefore underestimated the prevalence of lateral and medial epicondylitis, and the estimated odds ratios of lateral and medial epicondylitis may have been attenuated. We used weighted survey analyses to reduce biased estimates of the prevalence and associations. In a multistage sampling design, when certain subgroups of the population are oversampled, the estimated association may be biased in one direction or another (28). In the present study, the results of the weighted logistic regression analyses differed from those of the unweighted in both directions, but there were no major differences. However, the population weighting techniques cannot effectively control for nonresponse bias.

In summary, epicondylitis is relatively common at the working age in the general population. Physical load factors and smoking are associated with both lateral and medial epicondylitis, as is obesity with medial epicondylitis.

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