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ORIGINAL ARTICLE

Epidemiologic Surveillance of Upper-Extremity Musculoskeletal Disorders in the Working Population

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Objective. **Since 2002, an epidemiologic surveillance system of work-related, upper-limb musculoskeletal disorders (MSDs) has been implemented in France's Pays de la Loire region to assess the prevalence of MSDs and their risk factors in the working population.**

Methods. **The surveillance was based on a network of occupational physicians (OPs) and used the recommendations of a group of European experts (criteria document consensus). In 2002–2003, 80 of 400 OPs volunteered to participate. All underwent a training program to standardize the physical examination. Health status was assessed by self-administered questionnaire and physical examination. Occupational risk factors were assessed by self-administered questionnaire. Exposure scores were computed for each anatomic zone by summing the risk factors taken into account by the criteria document.**

Results. **More than 50% of the 2,685 men and women randomly included in 2002–2003 experienced nonspecific musculoskeletal symptoms during the preceeding 12 months and ~30% experienced them in the preceeding week. The prevalence of clinically diagnosed MSDs was high: ~13% of workers experienced at least 1 of the MSDs. The most frequent disorder was rotator cuff syndrome followed by carpal tunnel syndrome and lateral epicondylitis. The prevalence of MSDs increased with age and varied widely across economic sectors and occupations. More than half of the workers were exposed to at least 2 risk factors of MSDs. Exposure varied according to industrial activity and occupation. According to the criteria document, a high percentage of MSD cases could be classified as probably work related (95% in men and 89% in women age <50, and 87% in men and 69% in women age >50).**

Conclusion. **Nonspecific upper-limb symptoms and specific upper-limb MSDs are common in the working population. These results show the need to implement prevention programs in most sectors to reduce the prevalence of MSDs.**

KEY WORDS. Musculoskeletal disorders; Epidemiologic surveillance; Sentinel network; Health assessment; Exposure assessment.

INTRODUCTION

Upper-limb musculoskeletal disorders (MSDs) include both peripheral nerve entrapments, mainly carpal tunnel syndrome (CTS) and ulnar tunnel syndrome, and peripheral enthesopathies, mainly shoulder tendinitis, lateral epicondylitis, and hand-wrist tendinitis (1). Numerous nonspecific musculoskeletal pain disorders can also be included under this umbrella term. In France, as in other industrialized countries, workers' compensation (WC) claims for work-related MSDs are increasing in a wide range of occupational groups. In 2003, work-related MSDs represented two-thirds of occupational diseases in France, with an incidence rate of more than 1 in 1,000 workers.

Although a large amount of epidemiologic data are available, it is difficult to compare various studies that investigated the prevalence of MSDs in the working population between countries and economic sectors. The data based

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on WC claims are difficult to compare because of the differences in social regulations and practices between countries, even in the European Union. The implementation of MSD surveillance systems using similar disorder and risk factor definitions in all countries and several definition criteria of MSDs has recently been proposed (2–6). In particular, in 2001 a group of European experts published a criteria document for evaluating the work relatedness of upper-extremity MSDs (referred to as a criteria document in the remainder of the article) (4), which included diagnostic criteria for the main MSDs of the upper extremities. This document presented a structured approach to the surveillance of MSDs to standardize the surveillance of the disorders in the workforce across countries and permit the implementation of surveillance systems in the European Union, allowing accurate comparisons of prevalence rates of MSDs between economic sectors and occupations. Such information will be useful to target preventive action in sectors and occupations with the highest risk of MSDs (1) and to evaluate ergonomic interventions at the level of the population.

The French National Institute for Public Health Surveillance implemented an experimental epidemiologic surveillance system for upper-extremity MSDs in the Pays de la Loire region (Loire Valley district, west-central France) in 2002. This region represents ~5% of the French working population and is characterized by a large industrial sector. The surveillance system relies upon a regional network of occupational physicians and was designed to assess prevalence rates of MSDs and their risk factors in the working population. To offer data comparable with other European countries, the surveillance protocol uses the recommendations of the criteria document (4).

The goal of the surveillance study was to assess prevalence rates of MSDs in the regional workforce according to sex, age, economic sector, and occupation. Only descriptive results according to the recommendations of the criteria document are presented.

MATERIALS AND METHODS

Sentinel network of occupational physicians. In France, all salaried workers, including temporary and part-time workers, undergo a mandatory annual health examination by a qualified occupational physician (OP). The OPs are salaried by occupational health services in charge of the medical surveillance of the companies. Each OP works across multiple companies and economic sectors at a time and oversees the health of ~1,400–1,700 part-time workers and 2,800–3,200 full-time workers. All OPs working in the Pays de la Loire region (n = 460) were asked to include a sample of workers under their surveillance in the study, and 80 of them (17.4% of the region's OPs) volunteered to participate in the sentinel network in 2002 and/or 2003. The sentinel OPs were characteristic of the region's OPs in terms of medical practice, working time, geography, and economic sectors covered. The participation rate of the OPs ranged between 18% and 14% depending on the type of company surveyed (private company [18%], public services [17%], hospitals [15%], and agricultural sector [14%]). Each sentinel OP was, on average, in charge of the medical surveillance of 2,900–3,000 workers and 200–450 companies. This activity was similar to that of the region's OPs.

All sentinel physicians were trained by the investigators (YR assisted by a study coordinator) to perform a standardized physical examination based on the criteria document for the evaluation of work-related upper-limb MSDs (4). All physicians received a clinical notebook describing the French translation of the clinical protocol with diagnostic criteria charts and a clinical guide using photographs of clinical tests proposed by the criteria document (4). All OPs underwent a training program to standardize workers' physical examination and reduce the interoperators variability. This program consisted of a 3-hour session of clinical practice with small groups of OPs conducted by the investigators in the occupational health setting and 1 or 2 booster sessions lasting 1 hour conducted by groups of OPs themselves. No session was conducted to assess the within-rater and interrater reliability.

Population. Subjects were randomly selected from workers undergoing a regularly scheduled annual health examination in 2002 or 2003. Each physician working full time was asked to recruit 30 workers; those working part time were asked to recruit 15 workers. Subjects were selected at random, following a 2-stage sampling procedure: first, 15–30 half days of scheduled examinations for each physician were chosen for sampling by the investigators. Next, each physician was asked to randomly select from the schedule 1 of 10 workers on the selected half days of worker examinations. The selected workers were then recruited to the study by the examining physicians. The final study population comprised 2,685 workers (1,566 men [58%], 1,119 women [42%], mean ± SD age 38.2 ± 10.4 years, mean ± SD workers per physician 20.7 ± 8.7), working primarily in manufacturing industries (31%), the service industry (25%), or trade (13%), who were randomly included from April to September 2002 and May to October 2003. The sample of workers represented 24.1 workers for 10,000 workers of the Pays de la Loire region (26.3 for 10,000 men and 21.6 for 10,000 women). Less than 10% of selected workers failed to participate (no shows, refusals) and overall, almost all economic sectors and occupations of the salaried workforce in the Pays de la Loire region were represented.

The assessment of health and work exposure during the compulsory annual medical examination lasted for ~45–60 minutes. The assessment included a self-administered questionnaire about nonspecific musculoskeletal symptoms of the upper limbs and work exposure, followed by a standardized physical examination performed by the OP.

Health assessment. The presence of nonspecific regional musculoskeletal symptoms (NSRMS) of the upper limbs during the last 12 months and the last 7 days was identified using the Nordic questionnaire (1). The intensity of NSRMS symptoms during the preceding week was assessed on a visual analog scale ranging from 0 to 10. If symptoms occurred during the past 12 months, a physical examination was performed by the physician using a standardized clinical procedure. The physician strictly ap-

plied the methodology and clinical tests described in the criteria document for rotator cuff syndrome (International Statistical Classification of Diseases and Related Health Problems, Tenth Revision [ICD-10] M75.1), lateral epicondylitis (ICD-10 M77.1), ulnar tunnel syndrome (ICD-10 G56.2), CTS (ICD-10 G56.0), de Quervain's disease (ICD-10 M65.4), and flexor-extensor peritendinitis or tenosynovitis of the forearm-wrist region (ICD-10 M70.0). Disorder criteria and physical examination signs are described in Appendix A. All data were collected in observation notebooks that included diagnostic criteria in diagrams, which provided physicians with a standardized diagnostic tool. The diagnosis of MSD was considered to be positive when the following 3 conditions were fulfilled: symptoms were present on the date of the examination or for at least 4 days in the preceding week, the disorder met the symptom case definition, and the disorder met the sign case definition.

Information was collected on participants' medical history; weight; height; hand dominance; hand surgery; arthritis and inflammatory rheumatism; tendinitis and nerve entrapment; and use of painkillers, steroids, and nonsteroidal antiinflammatory drugs. Information was also collected on obesity (defined as a body mass index >30 kg/m^2 [7]), diabetes mellitus, and thyroid disorders.

Occupational risk factors assessment. Work exposures were assessed by a self-administered questionnaire that included information on general job characteristics and tasks, work organization, and main risk factors of MSDs of the upper limbs and back. The questionnaire also included the full recommended scales of decision latitude (9 items), psychological demands (9 items), social support (8 items), and physical demands (5 items) from the validated French version of Karasek's Job Content Questionnaire (8,9). Response categories were presented on a 4-level Likert-type scale as follows: totally disagree (scored 1), disagree (scored 2), agree (scored 3), and totally agree (scored 4). Risk factors of MSDs were defined and quantified according to the criteria document for high repetitiveness, high force, too little recovery time, high psychological demand, low social support, and specific extreme posture for the neck, shoulder, elbow, and wrist regions (Appendix B). The questionnaires were completed by workers just before the medical visit and checked by the OPs at the beginning of the medical examination. The response rate to any question was >97%.

Statistical analysis. Information on sex, age, occupation, and occupational risk factors was available for all participants. Jobs were defined by 2 variables, namely, the Profession et Catégorie Sociale (PCS) code of the French classification of occupations (10) and the Nomenclature des Activités Françaises (NAF) code, based on the European Community Activities Nomenclature coding, which characterizes the sector of activity (11). The crudest codes comprise 1 digit for the PCS (6 codes) and 1 letter for the NAF (16 codes). The most detailed codes comprise 4 digits for the PCS (455 codes) and 3 digits for the NAF (494 codes). We compared the workers surveyed with the region's working population concerning sex, age, work contract, occupation, and economic sector using data from the national census of March 1999 (12).

Prevalence rates were computed by dividing the number of subjects with a unilateral or bilateral form of MSD by the total number of workers surveyed. Thus, bilateral cases of MSDs counted as 1 disorder, not 2. Separate analyses were performed for men and women (13).

According to the criteria document, 4 exposure scores were computed for the neck, shoulders and arms, elbows and forearms, and wrists and hands (see Appendix B for details). The scores took into account the general physical and nonphysical risk factors of MSDs (high repetitiveness, high force [except for the neck score], too little recovery time, high psychological demand, low social support) and specific extreme postures for the neck, shoulder, elbow, and wrist regions, respectively (Appendix B). The scores were computed by adding together the occurrence of the risk factors detailed in Appendix B according to the following rules: exposure score for neck region (total out of 8): sum of criteria numbers 1, 3, 4, 5, 61, 62, 63, 64; exposure score for shoulder and arm region (total out of 8): sum of criteria numbers 1, 2, 3, 4, 5, 71, 72, 73; exposure score for elbow and forearm region (total out of 7): sum of criteria numbers 1, 2, 3, 4, 5, 81, 82; exposure score for wrist and hand region (total out of 9): sum of criteria numbers 1, 2, 3, 4, 5, 91, 92, 93, 94.

In accordance with the criteria document, a traffic light model was used to categorize the work exposures (4). The level of exposure to risk factors of MSDs for each anatomic zone was classified as acceptable (green), moderate (yellow), or high (red), depending on whether the exposure score of the zone considered was 0, 1, or ≥ 2, respectively.

For descriptive purposes, workers with MSDs were classified according to a modified version of the decision process proposed by the criteria document to assess the disorders' work-relatedness. The first step of the decision process, ensuring that symptoms must have begun, recurred, or worsened after the start of the current job, was difficult to apply in the present study because of the lack of precision regarding the date of the appearance of symptoms in many subjects. To ensure that most of the symptoms began, recurred, or worsened since the start of the current job, the study was restricted to workers whose length of service was >1 year at the time of the diagnosis. The second step was to classify each worker with MSD according to the occupational risk factor score of the anatomic zone under consideration (e.g., shoulders for rotator cuff syndrome or elbow for lateral epicondylitis). The third step was to consider whether or not there was a presence of nonwork risk factors. Only medical conditions that could possibly increase the risk of MSDs, such as diabetes mellitus, thyroid disorders, and obesity, were considered because no data were available on housework, leisure, and sport activities. Finally, disorders were considered as probably work related if the exposure score was high (red) in the presence, or lack of presence, of at least 1 of the medical conditions taken into account, and if the exposure score was moderate (yellow) in the absence of any of these medical conditions.

Pairwise associations between different disorders in the same person were summarized by odds ratios (ORs) ad-

Table 1. Characteristics of workers participating in the Pays de la Loire surveillance network*

Characteristic	Sample	Region†
Sex‡		
Male	1,566 (58.3)	576,469 (53.1)
Female	1,119 (41.7)	508,186 (46.9)
Age, years§		
20–29	637 (24.0)	245,280 (22.6)
30–39	780 (29.4)	326,152 (30.1)
40–49	790 (29.7)	324,401 (29.9)
50–59	450 (16.9)	188,822 (17.4)
Economic sector¶		
Agriculture	56 (2.1)	29,141 (2.6)
Industry	897 (33.4)	268,754 (23.8)
Construction	164 (6.1)	68,437 (6.1)
Services	1,568 (58.4)	461,038 (67.5)¶
Occupation¶		
Farmers	0 (0)	55,986 (4.5)#
Craftsmen	14 (0.5)	78,081 (6.2)¶
Managers and professionals	206 (7.7)	116,772 (9.3)
Associate professionals and technicians	584 (21.8)	268,656 (21.4)
Employees	709 (26.4)	342,876 (27.4)
Skilled and unskilled workers	1,171 (43.6)	390,598 (31.2)¶

* Values are the number (percentage).
† Workers ages 20–59 years (National census, 3/9/1999).
‡ $P < 0.01$.
§ $P \geq 0.05$, not significant.
¶ $P < 0.001$.
# $P < 0.05$.

justed for age (in 10-year strata) and sex. Variations of prevalence rates of MSDs between the OPs were analyzed using the Kruskal-Wallis test. Year-to-year variations of prevalence of MSDs diagnosed by the 49 OPs who participated in the study both years were analyzed using paired *t*-tests. Because the objective was mainly to present descriptive results, we did not model the relationships between MSDs, individual characteristics, and work exposures. Statistical analyses were performed using SPSS software, version 12.0 (SPSS, Chicago, IL).

RESULTS

Representativeness of the sample of workers surveyed. The comparison of socioeconomic status among workers surveyed and the 1999 French census (12) showed no major differences for either sex. However, women were slightly underrepresented in the sample (42% versus 47%).

Overall, the distribution of occupations in the study sample was relatively close to that of the regional workforce. Similar to the region's working population, participants worked mainly in the private sector (84%) and only rarely in the public sector (16%). Length of service in the current job was high for the majority of workers: >10 years in 56% of workers with MSDs, >2 years in 81%, and >1 year in 91%, with no differences between men and women. Almost all occupations were represented in the sample, except for the rare occupations not surveyed by OPs such as farmers, craftsmen, shopkeepers, and independent workers (Table 1). No significant differences from the regional workforce were observed for managers and professionals, associate professionals and technicians, and clerks, but skilled and unskilled manual workers were overrepresented. The proportion of temporary workers was close to that of the region's working population (13%), and almost all economic sectors were represented. The main regional economic sectors (agriculture, construction, automobile and food industries, commerce, energy, transport and communication, financial activities, public administration, domestic services) were appropriately represented. However, education, health, and social work were underrepresented, whereas the electronics industry and services to enterprises were overrepresented. No major difference was observed between the workers surveyed in 2002 and in 2003.

Prevalence of MSDs. Prevalence rates of upper-extremity NSRMS were high for both sexes (Table 2). Approximately 58% (95% confidence interval [95% CI] 55–61) of women and 53% (95% CI 51–55) of men had experienced upper-extremity NSRMS during the preceding 12 months, and 35% (95% CI 32–38) of women and 27% (95% CI 25–29) of men experienced these symptoms during the preceding week. Symptoms predominantly involved the neck, shoulders, and wrists. Symptoms often overlapped between ≥2 anatomic regions within the same individual, particularly the neck and shoulder regions. Many workers reported symptoms over a period longer than 30 days (19% [95% CI 17–21] of women and 16% [95% CI 14–18]

Table 2. Prevalence rates of nonspecific regional symptoms of musculoskeletal disorders (1,566 men and 1,119 women)*

Symptoms	Neck	Shoulder/arm	Elbow/forearm	Wrist/hand	Upper extremity
During the preceding 12 months					
Men	34.2 (31.8–36.6)	34.4 (32.0–36.7)	17.4 (15.5–19.3)	21.2 (19.2–23.2)	52.6 (50.1–55.1)
Women	48.9 (45.9–51.2)	39.8 (36.9–42.7)	16.5 (14.3–18.7)	29.9 (27.1–32.6)	58.1 (55.2–61.0)
Lasting >1 month					
Men	6.7 (5.4–8.0)	8.7 (7.3–10.1)	5.9 (4.7–7.1)	5.8 (4.6–7.0)	16.3 (14.5–18.1)
Women	11.6 (9.7–13.5)	12.2 (10.2–14.1)	6.9 (5.4–8.4)	9.0 (7.3–10.7)	18.8 (16.5–21.1)
Daily symptoms					
Men	2.6 (1.8–3.4)	4.1 (3.1–5.1)	2.4 (1.6–3.2)	2.4 (1.6–3.2)	7.7 (6.4–9.0)
Women	4.6 (3.4–5.8)	5.2 (3.9–6.5)	2.6 (1.7–3.5)	3.4 (2.3–4.5)	8.1 (6.5–9.7)
During the preceding week					
Men	14.1 (12.4–15.8)	16.2 (14.4–18.1)	8.1 (6.7–9.5)	9.9 (8.4–11.4)	27.1 (24.9–29.8)
Women	25.6 (23.0–28.2)	21.3 (18.9–23.7)	9.0 (7.3–10.7)	15.3 (13.2–17.4)	34.9 (32.1–37.7)

* Values are the percentage (95% confidence interval).

of men) or daily (8% [95% CI 6–10] of women and 8% [95% CI 7–9] of men) during the preceding year. The mean ± SD intensity of NSRMS during the preceding week (visual analog scale score ranging between 0 and 10) for both sexes was high: 4.2 ± 0.1, 4.7 ± 0.1, 4.7 ± 0.1, and 4.7 ± 0.1 for the neck, shoulder, elbow, and wrist regions, respectively.

Prevalence rates of clinically diagnosed MSDs were high for both sexes: 470 cases were diagnosed in 383 different workers. The estimated age- and sex-specific prevalence rates of the 6 MSDs are illustrated in Table 3. A total of 11% (95% CI 10–13) of men and 15% (95% CI 13–17) of women experienced at least 1 of the 6 main disorders. The leading MSD for both sexes was rotator cuff syndrome, followed by CTS and lateral epicondylitis. Prevalence rates of clinically diagnosed MSDs (range 0–30%) varied significantly ($P < 0.05$) among the 80 OPs of the sentinel network, but the workers' age, economic sectors, occupations, and exposure to risk factors of MSDs also varied among OPs. No significant year-to-year variation in prevalence rates of MSDs was observed among the 49 OPs who participated in the study both in 2002 and in 2003.

The prevalence rate of rotator cuff syndrome was 6.8% (95% CI 5.5–8.1) in men and 9.0% (95% CI 7.3–10.7) in women. Of the 105 clinically diagnosed men, 27 had previously been diagnosed (recurrent cases), whereas 78 were newly diagnosed. The corresponding figures for women were 38 recurrent cases and 59 new cases out of a total of 97 cases. Therefore, the prevalence rate of rotator cuff syndrome without a previous history of the same disorder was 5.0% (95% CI 3.9–6.1) for men and 5.4% (95% CI 4.1–6.7) for women. Pain predominantly involved the right shoulder (52%) and less often both shoulders (16%). Many workers reported experiencing shoulder pain daily (30%) or for >1 month in the preceding year (49%). The mean pain intensity was high on the day of the physical examination (4.8 out of 10). The positive signs most often checked by the physician were pain during active shoulder elevation (50%) and pain provoked by resisted abduction, internal and external rotation (15%) or both (26%),

Table 3. Sex- and age-specific prevalence rates of clinically diagnosed MSDs of the upper extremities*

Prevalence rate	20–29 years	30–39 years	40–49 years	50–59 years	Total
Men					
Rotator cuff syndrome	6/1.6 (0.3–2.9)	22/4.7 (2.7–6.6)	44/10.2 (7.3–13.0)	33/12.2 (8.3–16.1)	105/6.8 (5.5–8.1)
Lateral epicondylitis	3/0.8 (0–1.7)	3/0.6 (0–1.4)	13/3.0 (1.4–4.6)	15/5.6 (2.8–8.3)	34/2.2 (1.5–2.9)
Ulnar cubital syndrome	1/0.3 (0–0.8)	1/0.2 (0–0.6)	7/1.6 (0.4–2.8)	0/0 (0–0)	9/0.6 (0.2–1.0)
Carpal tunnel syndrome	2/0.5 (0–1.3)	9/1.9 (0.7–3.2)	11/2.5 (1.1–4.0)	13/4.8 (2.3–7.4)	37/2.3 (1.5–3.0)
Wrist tendinitis	3/0.8 (0–1.7)	2/0.4 (0–1.0)	4/0.9 (0.1–1.8)	3/1.1 (0–2.4)	12/0.8 (0.3–1.2)
De Quervain' disease	2/0.5 (0–1.3)	2/0.4 (0–1.0)	2/0.5 (0–1.1)	5/1.9 (2.4–3.5)	11/0.7 (0.3–1.1)
At least 1 MSD	17/4.6 (2.4–6.7)	32/6.8 (4.5–9.1)	67/15.5 (12.1–18.9)	58/21.5 (16.6–26.4)	174/11.3 (9.8–12.8)
Women					
Rotator cuff syndrome	7/2.7 (0.7–4.6)	20/6.5 (3.7–9.3)	45/2.7 (9.2–16.2)	27/15.1 (9.8–20.3)	99/9.0 (7.3–10.7)
Lateral epicondylitis	2/0.8 (0–1.8)	7/2.2 (0.6–4.0)	12/3.4 (0.2–2.6)	9/5.0 (1.8–9.2)	30/2.7 (1.8–3.7)
Ulnar cubital syndrome	2/0.8 (0–1.8)	1/0.3 (0–1.0)	5/1.4 (0.2–2.6)	1/0.6 (0–1.6)	9/0.8 (0.3–1.3)
Carpal tunnel syndrome	2/0.8 (0–1.8)	13/4.2 (2.0–6.5)	15/4.2 (2.1–6.3)	14/7.8 (3.9–11.6)	44/4.0 (2.8–5.1)
Wrist tendinitis	1/0.4 (0–1.1)	4/1.3 (0.1–2.6)	1/0.3 (0–0.8)	0/0 (0–0)	6/0.5 (0.1–2.9)
De Quervain' disease	3/1.1 (0–2.4)	6/2.0 (0.4–3.5)	6/1.7 (0.4–3.5)	8/4.5 (1.4–7.5)	23/2.1 (1.2–2.9)
At least 1 MSD	14/5.3 (2.6–8.0)	38/12.4 (8.7–16.1)	69/19.5 (15.4–23.6)	46/25.7 (19.3–32.1)	167/15.1 (13.0–17.3)

* Values are the number of musculoskeletal disorder (MSD) cases/percentage prevalence rate (95% confidence interval).

sometimes associated with pain during the resisted elbow flexion test.

The prevalence rate of lateral epicondylitis was 2.2% (95% CI 1.5–2.9) in men and 2.7% (95% CI 1.8–3.7) in women. Of the 34 men, 23 were newly diagnosed and 11 had previously been diagnosed. The corresponding figures for women were 13 new cases and 16 recurrent cases of a total of 29 cases. The prevalence rate of workers with lateral epicondylitis without a previous history of the same disorder was therefore 1.5% (95% CI 0.9–2.1) in men and 1.2% (95% CI 0.6–1.8) in women. Pain often involved the right side (63%) and rarely both sides (6%). Many workers reported daily pain in the elbow (35%) or pain for >1 month during the last year (60%). The mean level of pain was high for both sexes (5.7 out of 10).

The prevalence rate of CTS was 2.3% (95% CI 1.5–3.0) in men and 4.0% (95% CI 2.8–5.1) in women. Of the 37 cases diagnosed in men, 27 were newly diagnosed and 9 had been previously diagnosed. The corresponding figures for women were 22 new cases and 22 recurrent cases out of a total of 44 cases. The prevalence rate of newly diagnosed CTS was therefore 2% (95% CI 1.1–2.3) in men and 2.0% (95% CI 1.2–2.8) in women. Pain mostly affected the right side (43%) or both sides (32%). Many workers reported daily nonspecific symptoms (22%) or pain in the hand for >1 month during the last year (46%). The mean hand/wrist pain intensity was high for both sexes (5.5 out of 10). The positive sign criteria checked by the physician were mainly pain during the flexion compression test (37%) and the carpal compression test (8%) or both (15%), and rarely the Tinel test (3%) or the Phalen test alone (6%).

Prevalence rates of the other MSDs were lower. The prevalence rate of de Quervain's disease was 0.7% (95% CI 0.3–1.1) in men and 2.1% (95% CI 1.2–2.9) in women, whereas the prevalence of ulnar tunnel syndrome was 0.6% (95% CI 0.2–1.0) in men and 0.8% (95% CI 0.3–1.3) in women and that of flexor-extensor wrist tenosynovitis was 0.8% (95% CI 0.3–1.2) in men and 0.5% (95% CI 0.1–2.9) in women.

Many of the 383 workers who experienced unilateral or bilateral clinically diagnosed MSDs were affected by ≥2 disorders at different anatomic sites of the upper limbs: 32 men (2.0%) and 25 women (2.2%) had 2 disorders, 4 men (0.3%) had 3–4 disorders, and 8 women (0.7%) had 3–6 disorders. The most frequent associations between specific diagnoses in the same individual were rotator cuff syndrome and lateral epicondylitis in men (OR 3.5 [95% CI 1.6–7.7]) and women (OR 4.3 [95% CI 1.9–9.6]), rotator cuff syndrome and CTS in men (OR 3.1 [95% CI 1.3–7.0]) and women (OR 2.1 [95% CI 1.0–4.7]), and CTS and lateral epicondylitis in women (OR 5.3 [95% CI 2.0–4.0]). Of the other MSDs, de Quervain's disease and flexor-extensor wrist tenosynovitis were often associated with CTS or a more proximal-specific disorder, and ulnar tunnel syndrome was associated with CTS and lateral epicondylitis.

The prevalence rates of the 6 MSDs increased with length of service, ranging between 6%, 7%, 9%, and 17% in men and 12%, 9%, 12%, and 22% in women with <1 year, 1–2 years, 3–10 years, and >10 years of service, respectively. However, the differences were not statistically significant after adjustment for age. The prevalence rate of the 6 MSDs increased significantly with age for both sexes, even after adjustment for job seniority ($P < 0.05$). As shown in Table 3, disorder prevalence increased with age for both sexes, except for ulnar tunnel syndrome and finger flexor-extensor tendinitis. The age-related increase in prevalence was particularly evident for rotator cuff syndrome (prevalence rate of 2% in men and 3% in women between ages 20 and 29 years, and 12% in men and 15% in women between ages 50 and 59 years). After age 50, 22% of men and 26% of women had at least 1 disorder and 4% of men and 6% of women had at least 2 disorders.

Prevalence rates of MSDs varied widely across economic sectors (Table 4) and occupations (Table 5). The 5 economic sectors with the highest prevalence for women were the rubber and plastic industries, the steel industry, agriculture, machine and equipment industries, and paper and printing industries. For men, prevalence was highest in the automotive and transport industries, public administration, steel industry, construction and transport, and communications. For women, skilled and unskilled workers (particularly in industry and agriculture) and personal care employees had the highest prevalence. In men, the prevalence was highest in public sector employees and skilled and unskilled workers, particularly industrial skilled workers, drivers, material handlers, and industrial unskilled workers.

Individual medical conditions. The prevalence of obesity was 8% in men and women. Approximately 2% of workers reported having inflammatory rheumatism or arthritis of the upper limbs or back, whether they experienced MSDs or not. The prevalence of self-reported diabetes mellitus, whether requiring medical treatment or not, was 2%, with no difference between men and women. Thyroid disorders were more prevalent in women than in men (7% versus 0.1%; $P < 0.001$).

Physical and psychosocial occupational risk factors of MSDs. High numbers of workers were exposed to at least 2 risk factors of MSDs of the neck, shoulder, elbow, or wrist region (43%, 44%, 50%, and 59%, respectively). The mean ± SD number of risk factors (out of a total of 17) did not differ by sex (3.5 ± 2.4 in men and 3.6 ± 2.3 in women). Excluding the neck, <10% of workers were free of exposure to any of the biomechanical or psychosocial risk factors taken into account by the criteria document, 25% were exposed to only 1 risk factor, and 65% were exposed to ≥2. It should be noted that 43% were exposed to at least 4 of these risk factors and 11% to ≥7, out of a total of 17. Exposure to risk factors of MSDs varied across economic sectors and occupations. Exposure was particularly high in farming, construction, most sectors of the manufacturing industry, and in services such as personal services and financial activities. The most exposed occupations were unskilled industrial workers and agricultural workers, followed by skilled workers and clerks.

Classification of the work-relatedness of MSDs. The distribution of occupational risk factors of MSDs, medical

Table 4. Sex-specific prevalence rates of at least 1 musculoskeletal disorder of the upper extremities according to the economic sector of employment*

Economic sector (French classification)	Men			Women		
	N	no.	%	N	no.	%
A. Agriculture (01–05)	31	2	6.5	25	7	28.0
C. Mining industries (10–14)	4	0	0	0	0	0
D. Manufacturing industries (15–37)	568	70	12.3	273	61	22.3
15. Food industries	112	14	12.5	69	11	15.9
17-18-19. Garment, shoe, and leather industries	11	0	0	31	6	19.4
20. Wood industries	23	3	13.0	5	2	–
21-22. Paper and printing works	55	6	10.9	20	5	25.0
24-26. Chemical industries, rubber and plastic industries, and miscellaneous	74	9	12.2	39	14	35.9
27-28. Steel industries and steel work	81	12	14.8	9	3	33.3
29. Machine and equipment industries	72	9	12.5	22	6	27.3
30-31-32. Computer, electronics, television industries	51	4	7.8	32	4	12.5
34-35. Automotive and transport industries	40	8	20.0	3	1	–
36-37. Furniture and wood industries	50	5	10.0	43	9	20.9
E. Production and distribution of electricity, gas, and water (40–41)	11	1	9.1	0	0	0
F. Construction (45)	144	21	14.6	19	1	5.3
G. Commerce, car, and household repair (50–52)	178	15	8.4	177	21	11.9
50-51. Wholesale trade and car commerce and repair	123	13	10.6	43	5	11.6
52. Retail commerce	55	2	3.6	134	16	11.9
H. Hotels and restaurants (55)	26	0	0	30	5	16.7
I. Transportation and communications (60–64)	102	14	13.7	51	5	9.8
J. Financial activities (65–67)	46	6	13.0	44	3	6.8
K. Real estate, leasing, and services to enterprises (70–74)	209	15	7.2	160	17	10.6
L. Public administration (75)	130	25	19.2	101	15	14.9
M. Education (80)	13	0	0	14	2	14.3
N. Health and social work (85)	47	4	8.5	149	20	13.4
O. Collective, social, and personal services (90–93)	35	3	8.6	52	7	13.5
Total	1,561	177	11.3	1,114	168	15.1

* N = number of subjects in the study; no. = number of cases.

conditions that could possibly increase the risk of MSDs (obesity, thyroid disorders, diabetes mellitus), and age in workers with >12 months of service are reported in Table 6 according to the traffic light model of the work-relatedness of MSDs. The level of work exposure was high without any of the 3 medical conditions taken into account in the majority of cases (i.e., age <50: 53% of men and 63% of women, and age >50: 55% of men and 56% of women). No significant differences in these percentages were observed between men and women, regardless of age. A high job exposure coexisted with at least 1 of the medical conditions under review for 10% of men and 13% of women age <50. The corresponding figures for men and women age >50 were 12% and 5%, respectively. The level of work exposure was moderate without these medical conditions for 29% and 12% of men and women age <50, respectively, and 16% and 14% of men and women age >50, respectively. In conclusion, according to the criteria document, a high percentage of MSD cases could be classified as probably work related (95% in men and 89% in women age <50, and 87% in men and 69% in women age >50).

DISCUSSION

The surveillance method was based on a large regional sentinel network of OPs, which allowed the inclusion of a large sample of workers (14). The 80 OPs who participated in the study had professional characteristics similar to the 370 who did not participate. One of the original aspects of this study is the size and representativeness of the sample with regard to the region's workforce. The random selection of workers during their compulsory annual occupational health examination was designed to ensure a representative sample of the region's workforce. This was achieved, with the exception that women were slightly underrepresented, and skilled and unskilled workers were somewhat overrepresented. The underrepresentation of female workers could be explained by the lack of OPs in 2 highly female economic sectors, i.e., education and health. Despite these limits, the relatively good representativeness of the sample allows a better estimation of prevalence rates of MSDs than recent large French surveys conducted in high-risk sectors (15,16).

The health assessment procedure combining a self-administered questionnaire with a standardized physical examination is another originality of the study. The Nordic questionnaire permits a sensitive and reproducible assessment of prevalence rates of MSD symptoms (5,17). To our knowledge, this is the first study to apply the recommendations of the criteria document (4,6) to a large working population. This document proposes one of the most ex-

Table 5. Sex-specific prevalence rates of at least 1 musculoskeletal disorder of the upper extremities according to occupation*

Occupations (French classification)	Men			Women		
	N	no.	%	N	no.	%
3. Managers and professionals (31–38)	147	12	8.2	59	4	6.8
32. Administrative managers (32–35)	26	1	5.3	19	0	0
37. Directors and chief executives	60	6	10.0	27	3	11.1
38. Production and operations department managers	54	5	9.3	10	0	0
4. Associate professionals and technicians	385	31	8.1	197	27	13.7
41. Teaching, public services and health associate professionals (41–43,45)	72	6	8.3	86	12	14.0
46. Administrative and commercial associate professionals	79	5	6.3	75	10	13.3
47. Technicians	154	13	8.4	21	3	14.3
48. Foreman	80	7	8.8	15	2	13.3
5. Employees and clerks	143	14	9.8	564	67	11.9
51. Employees of public services (51–53)	61	12	19.7	142	20	14.1
54. Administrative employees and clerk	39	0	0	238	20	8.4
55. Employees of trade and commerce	27	2	7.4	110	12	10.9
56. Employees of personal services	16	0	0	74	15	20.3
6. Skilled and unskilled workers (61–69)	874	118	13.5	292	69	23.6
61. Skilled workers (61–65)	614	85	13.8	83	19	22.9
62. Industrial skilled workers	249	32	12.9	44	10	22.7
63. Craft skilled workers	190	23	12.1	13	6	46.2
64. Conductors	72	11	15.3	15	2	13.3
65. Storekeepers	103	19	18.4	11	1	9.1
66. Unskilled workers (66–69)	260	33	12.7	209	50	23.9
67. Unskilled industrial workers	182	27	14.8	156	38	24.4
68. Unskilled craft workers	54	4	7.4	35	4	11.4
69. Agriculture workers	24	2	8.3	18	8	44.4
Total	1,561	177	11.3	1,114	168	15.1

* N = number of subjects in the study; no. = number of cases.

haustive classifications existing in the literature (4), but to date the diagnostic value of the consensus has not been assessed. However, the disorder and physical examination signs definitions are close to those of the Health and Safety Executive consensus group (2) and of the Southampton examination protocol diagnostic criteria, which demonstrated good diagnostic properties (5,18). The physical examination procedures, particularly the diagnostic criteria charts and the clinical guide using photographs of clinical tests, were judged positively by the OPs and were easy to apply in an occupational health setting to standardize the physical examination of any workers included in MSD surveillance programs. Physicians were trained to increase the homogeneity of the examination procedure and to enhance the quality of data collection (19), but at this time quality control health assessment measures have not been incorporated in the surveillance system. The intraobserver variability was not systematically studied, but we observed no significant year-to-year variation in prevalence rates of MSDs among OPs, which is reassuring. Interobserver variability in the performance of the physical examination may partly explain the variation in the prevalence of MSDs from one OP to another. However, prevalence data collected by each OP fluctuated by a narrow interval

Table 6. Distribution of individual factors and occupational risk factors of MSDs*

Work exposure	Individual factors†	Men		Women	
		<50 years	>50 years	<50 years	>50 years
Acceptable	Yes	1 (1)	4 (6)	3 (2)	2 (3)
Acceptable	No	4 (3)	4 (6)	8 (7)	11 (19)
Moderate	Yes	5 (4)	3 (5)	4 (3)	2 (3)
Moderate	No	35 (29)	11 (16)	14 (12)	8 (14)
High	Yes	13 (10)	8 (12)	15 (13)	3 (5)
High	No	66 (53)	36 (55)	74 (63)	33 (56)

* Values are the number of cases of musculoskeletal disorders (MSDs) in workers with length of service >12 months (percentage).
† Obesity and/or diabetes mellitus and/or thyroid disorders.

(0–30%), following a normal distribution. Consequently, it could be hypothesized that, taking into account the large number of OPs, the global effect of the interobserver variability on the precision of estimates of the prevalence of MSDs was low, because some OPs probably overestimated the prevalence of the MSDs whereas others underestimated the prevalence. It should also be noted that interobserver variability could partly be explained by the differences in the characteristics (age, economic sector, occupations, etc.) of workers surveyed by each OP.

The surveillance system implemented in the Pays de la Loire region reported prevalence data for NSRMS symptoms and clinically diagnosed MSDs in a large sample of workers. Few workers failed to participate, but due to the cross-sectional design of the study only individuals who were healthy enough to work were included. Therefore, as in other investigations based on working populations, a healthy worker effect probably occurred. Nevertheless, if some workers with severe disorders do have to leave the workforce, the selection phenomenon was probably low, because the prevalence rates we report are in line with the estimate that 5–20% of individuals of working age are affected by upper-limb disorders (1). Diagnoses were based on a rigorous clinical procedure using a set of physical examination signs, which are recommended to enhance the validity of epidemiologic surveillance of MSDs (19). Our surveillance strategy optimized the precision of estimates of the prevalence of MSDs in the working population compared with surveillance systems based on WC claims data (20–22), because several surveys reported a substantial degree of underclaiming for WC benefits, which contrasts with the fraudulent overclaiming frequently brought to public attention (23). The methodology we used allows better estimates of MSD prevalence rates than surveys based on self-administered questionnaires on musculoskeletal symptoms (24,25). Our results confirm the overestimation of prevalence rates of MSDs when outcomes are defined as symptoms only rather than physician-diagnosed disorders (19,26–28), because an MSD was diagnosed clinically in approximately half of the workers with NSRMS during the preceding week. Implementation of such surveillance systems across European countries will permit more precise comparisons of musculoskeletal health in the European workforce (2,4,19) than the periodic European survey based on self-assessment of symptoms (25).

Work exposure assessments combined with health assessments are recommended for the surveillance of MSDs to determine the level of risk of MSDs with accuracy (1,29). To our knowledge, this is the first European study describing exposure to risk factors of MSDs in a large and representative working population using the criteria document. Occupational risk factors were assessed for each worker through a self-administered questionnaire, which permitted a more reliable assessment than the job category often used for the epidemiologic surveillance of MSDs (30). Nevertheless, self-assessments of work exposures are less accurate than work analysis by direct observation or video and can lead to an overestimation of work constraints (31). The risk factors described in the present study are those defined by the criteria document (4) and include the main occupational risk factors described in the literature on MSDs (1,32,33). Several other risk factors of MSDs involving work organization (e.g., machine paced work and assembly line work) were also included in our study and will be studied in the future. We strictly applied the definitions proposed by the criteria document, except for force, which was assessed according to effort frequency and not its daily duration. The questionnaire presented awkward postures in picture form to facilitate workers' understanding and thus increase the validity of posture self-assessment (34). Work exposures were self-reported and workers who experienced pain may have overrated their exposure levels. Underrating was also possible, especially for workers who moved to lighter work because of recurrent symptoms. As much as possible, we used standardized and validated instruments for assessment of both exposure and outcomes, which reduces potential bias (4). Occupational physical and nonphysical risk factors were ranked according to a 3-level model proposed by the criteria document to standardize risk assessment (4). This approach, which is similar to the procedure used in the European Committee for Standardization Standard European Norm 614-1 and the proposal of the 3-zone model for action by Buckle and Devereux (35), is useful in comparing risk levels across economic sectors and occupations (4). However, the method is too insensitive to assess the risk of MSDs precisely (36) and complementary analyses are needed.

This study provides new information in comparison with several recent studies based on WC claims (20–22) and health self-administered questionnaires (24,25). The high prevalence of clinically diagnosed MSDs (~13% of workers) contrasts with the relatively low level of WC claims for upper-limb MSDs in the Pays de la Loire region (in 2003, ~3.7 WCs for 1,000 workers). This confirms that in France (29), as in other countries (4,22–24), using WCs as the unique source of information about MSDs leads to the underestimation of the prevalence in the working population. Prevalence rates of NSRMS of the upper limbs during the preceding year and the preceding week (approximately one-half and one-third of workers, respectively) were higher than those reported by the third European survey conducted in 2000 (25) and by a large survey conducted in The Netherlands (37). This could be partly due to methodologic differences, particularly a longer reference period defining symptoms in the Pays de la Loire study. Symptoms were predominant in the neck and shoulders, and prevalence rates of shoulder symptoms were higher than estimates (20–50%) reported in the literature (16,38). The frequency of wrist symptoms was close to that observed in a previous large survey of French workers exposed to repetitive work (15). Prevalence rates of symptoms did not significantly differ between men and women, contrary to several surveys conducted in general populations (13,24,37,39) and in French workers exposed to repetitive work (15).

This study reports high prevalence rates of clinically diagnosed MSDs in this representative working population, with 13% of workers experiencing 1 of the 6 MSDs considered and ~3% experiencing at least 2 disorders. Contrary to French and regional WC claims data, the most

prevalent disorder was not CTS but rotator cuff syndrome, the prevalence of which was approximately twice that of CTS. This finding agrees with the predominance of NSRMS in the neck and shoulder region. Estimates of the prevalence rates of rotator cuff syndrome reported in the literature vary widely across studies and study populations (1). The prevalence rate of rotator cuff syndrome in Pays de la Loire workers (9% in women and 7% in men) is nevertheless lower than that previously observed in French workers exposed to repetitive work: 29% in highly exposed workers and 16% in weakly exposed workers (15). This difference could be explained by a more restricted definition of the disorder in the present study and a more varied and representative sample of workers, including economic sectors and occupations characterized by a low risk of MSD. In contrast, the prevalence rate of rotator cuff syndrome in the present study was higher than in a recent study conducted in a large British general population using a similar case definition: 6.1% in women and 4.5% in men for physician-diagnosed shoulder tendinitis (28). The high prevalence rate of rotator cuff syndrome is troublesome because of the poor medical and social prognosis of this disorder (40).

There are few studies of lateral epicondylitis conducted in large working populations (1,41). The prevalence rate estimated in the Pays de la Loire study (2% in women and 2% in men) was higher than the prevalence rate reported in the general population of Southampton (1.3% in women and 1.1% in men) (28), but was similar to that observed in a Swedish general population (1–3%) (42). As observed for rotator cuff syndrome, and probably for the same reasons, the prevalence rate of lateral epicondylitis was lower than in French workers exposed to repetitive work (12% in highly exposed workers and 8% in weakly exposed workers) (15).

Estimates of the prevalence of CTS vary widely between studies conducted in the working population (1), depending on whether or not case definition required symptoms alone, clinical findings, and electrophysiologic testing (26,27). The prevalence rate estimated in Pays de la Loire workers (4% in women and 3% in men) was close to that observed in a Swedish general population (3.8%) using a less restricted clinical definition (26). However, our prevalence rate estimate was higher than in the general population of Southampton using a similar case definition (0.9% in women and 1.2% in men) (28) and was higher than in a large American survey in 1988 (1.5%) (28). As observed for other disorders, the prevalence rate of CTS was lower than in French workers exposed to repetitive work (19% in highly exposed workers and 7% in weakly exposed workers) (15).

Few epidemiologic studies assessed the prevalence of ulnar tunnel syndrome in the working population. Prevalence rates of ulnar tunnel syndrome in Pays de la Loire workers (0.8% in women and 0.6% in men) were much lower than for CTS, which confirms previous results in French workers (43). Moreover, the prevalence of ulnar tunnel syndrome was lower than in French workers exposed to repetitive work (2% in highly exposed workers and 1.2% in weakly exposed workers) (15).

The prevalence rate of de Quervain's disease was lower than that of CTS in men (0.7%) and to a lesser extent in women (2%). The prevalence rate of flexor-extensor tendinitis (0.5% in women and 0.8% in men) was lower than that of CTS for both sexes, as reported by other studies (15,44). The prevalence rate of the 3 types of wrist tendinitis altogether was higher in the Pays de la Loire study than in the large American national health interview survey: 0.5% versus 1.9% (44). As for de Quervain's disease, wrist flexor, and wrist extensor tendinitis, the prevalence rates of these wrist disorders were lower than in French workers exposed to repetitive work (3.9%, 3.6%, and 4.2% in highly exposed workers and 2.2%, 2.5%, and 1.9% in weakly exposed workers, respectively) (15).

The prevalence of clinically diagnosed MSDs increased with age even after adjusting for job seniority, which agrees with some studies of working (1,16,32) and general populations (28). However, it is always difficult to disentangle the role of age from the effects of cumulative exposure to occupational hazards (45), and additional analyses adjusting for work-related risk factors are needed. One important finding for the prevention of MSDs is the very high prevalence rate after age 50. Although these aging workers were all employed at the time of the survey, the majority experienced recurrent nonspecific regional musculoskeletal pain of the upper limbs, of which 25% resulted from 1 clinically diagnosed MSD, particularly rotator cuff syndrome, and 6% resulted from $\geq$2 disorders. This accumulation of MSDs in aging workers probably lowers functional capacities and increases the risk of disability and job dismissal (40).

The study demonstrates wide variations in the prevalence rate of MSDs across economic sectors (1,32). The sectors most affected were the manufacturing industries and public administration. Broadly, this confirms the results of large North American surveys conducted in the working population (24,44) or based on WC claims (20,21,46). Similarly, our study demonstrated wide variations in the prevalence of MSDs according to occupation. Occupations with the highest prevalence rates were those employing unskilled industrial workers and agriculture workers of both sexes, as well as material handlers, drivers, and employees of public services for men, and personal care employees for women. These occupations are similar to those identified as being at high risk of WC claims in the US (20,21). Contrary to findings from comparable surveys from North America, very few cases of MSDs were observed in administrative employees and clerks.

Overall, the study shows a high level of exposure to risk factors of MSDs for most workers of both sexes. Contrary to several studies conducted in high-risk sectors, no difference in work exposures was observed between men and women (1,13), except for the neck region. Exposure to risk factors of MSDs did not decrease with age, which demonstrates the need for ergonomic interventions that reduce the level of exposure to occupational risk factors because of the high prevalence of disorders after age 50. Nevertheless, complementary analyses are needed to precisely assess work exposures in this workforce accurately.

For descriptive purposes, we used a modified version of the decision process proposed by the criteria document to

assess the probability of disorders' work relatedness. Exposure bias was limited by the low job turnover in the population studied (87% had been in the same job for over a year), and under exposure to physical work factors, latency periods of MSDs are probably short (i.e., several weeks). It is therefore likely that the risk of MSDs was mainly associated with recent work exposure (47,48). Only workers with length of service >12 months were studied because health and occupational risk factor assessments concerned mainly the last 12 months. This restrictive rule was adopted to respect the first step of the decision process, which is to ensure that all cases of MSDs began, worsened, or recurred after the start of the current job. Our methodology did not allow us to assess nonoccupational risk factors during home duties or leisure. Although the effect of some medical conditions, such as obesity, diabetes mellitus, and thyroid disorders, on the risk of MSDs is controversial (1), these individual characteristics were taken into account in the classification of the MSDs to follow the third step of the decision process proposed by the criteria document. Overall, the prevalence rate of self-reported diabetes mellitus was comparable with that of the general population of the Pays de la Loire (2.2% versus 2.0%) (49). The prevalence of obesity (9% for both sexes) was slightly higher than in the general population (7.2%) (50), and no information was available on the prevalence of thyroid disorders in the general population. Our results demonstrate that the majority of workers diagnosed by OPs were highly exposed to the main work-related risk factors of MSDs, without association with any major potential individual risk factor. This was the case for 53% of men and 63% of women age <50 years and 55% of men and 56% of women age >50 years. No significant differences in work relatedness were observed between men and women, regardless of age. When the decision rules of the criteria document were applied, the majority of cases could be considered as work related. Nevertheless, the classification used is relatively brief and strong residual confounding effect by unmeasured past and current work-related risk factors may remain. Complementary analyses assessing more precisely the relationships between MSDs, occupational risk factors, age, sex, and some medical conditions that could increase the risk of MSDs are necessary. Despite these limitations, the study shows that a large number of MSD cases were probably attributable to work, which is consistent with results from studies of CTS in the general population (50,51) and in the working population (15).

Our study shows the results of the first 2 years of a new sentinel network designed for the epidemiologic surveillance of MSDs in a working population. This type of system can play a significant role in informing government agencies and companies on the state of the current epidemic of MSDs.

Overall, approximately half of the workers experienced nonspecific musculoskeletal symptoms of the upper limbs during the previous year and approximately one-third experienced these symptoms during the previous week. The physical examination performed by OPs confirmed that upper-limb MSDs were common in the working population. According to criteria similar to those currently applied in clinical practice in France, 13% of workers experienced upper-extremity MSDs. The level of work exposures was high for more than half of the workers, which demonstrates the need for prevention programs aimed at reducing the prevalence of MSDs and reducing the associated socioeconomic costs in most economic sectors.

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REFERENCES

1. Hagberg M, Silverstein B, Wells R, Smith MJ, Hendrick HW, Carayon P, et al. Work related musculoskeletal disorders (WMSDs): a reference book for prevention. London: Taylor & Francis; 1995.
2. Harrington JM, Carter JT, Birrell L, Gompertz D. Surveillance case definitions for work related upper limb pain syndromes. Occup Environ Med 1998;55:264–71.
3. Rempel D, Evanoff B, Amadio PC, de Krom M, Franklin G, Franzblau A, et al. Consensus criteria for the classification of carpal tunnel syndrome in epidemiologic studies. Am J Public Health 1998;88:1447–51.
4. Sluiter JK, Rest KM, Frings-Dresen MH. Criteria document for evaluating the work-relatedness of upper-extremity musculoskeletal disorders. Scand J Work Environ Health 2001;27 Suppl 1:1–102.
5. Walker-Bone KE, Palmer KT, Reading I, Cooper C. Criteria for assessing pain and nonarticular soft-tissue rheumatic disorders of the neck and upper limb. Semin Arthritis Rheum 2003;33:168–84.
6. Meyer JP, Frings-Dresen M, Buckle P, Delaruelle D, Privet L, Roquelaure Y. Consensus clinique pour le repérage des formes précoces de TMS: troubles musculo-squelettiques du membre supérieur. Arch Mal Prof 2002;63:32–45.
7. Cole TJ, Bellizzi MC, Flegal KM, Dietz WH. Establishing a standard definition for child overweight and obesity worldwide: international survey. BMJ 2000;320:1240–3.
8. Karasek R. Job demands, job decision latitude, and mental strain: implications for job redesign. Adm Sci Q 1979;24:295–308.
9. Niedhammer I. Psychometric properties of the French version of the Karasek Job Content Questionnaire: a study of the scales of decision latitude, psychological demands, social support, and physical demands in the GAZEL cohort. Int Arch Occup Environ Health 2002;75:129–44.
10. Nomenclature des professions et catégories socioprofessionnelles (PCS). 2nd ed. Paris: INSEE; 1994.
11. Nomenclature des activités et des produits française NAF-CPF. Paris: INSEE; 2000.

12. INSEE Pays-de-la-Loire. Tableaux économiques des Pays de la Loire: 2000–2001. Nantes: INSEE des Pays-de-la-Loire; 2001.
13. Hooftman WE, van Poppel MN, van der Beek AJ, Bongers PM, van Mechelen W. Gender differences in the relations between work-related physical and psychosocial risk factors and musculoskeletal complaints. Scand J Work Environ Health 2004; 30:261–78.
14. Matte TD, Baker EL, Honchar PA. The selection and definition of targeted work-related conditions for surveillance under SENSOR. Am J Public Health 1989;79 Suppl:21–5.
15. Leclerc A, Franchi P, Cristofari MF, Delemotte B, Mereau P, Teyssier-Cotte C, et al, and the Study Group on Repetitive Work. Carpal tunnel syndrome and work organisation in repetitive work: a cross sectional study in France. Occup Environ Med 1998;55:180–7.
16. Leclerc A, Landre MF, Chastang JF, Niedhammer I, Roquelaure Y, and the Study Group on Repetitive Work. Upper-limb disorders in repetitive work. Scand J Work Environ Health 2001;27:268–78.
17. Palmer K, Smith G, Kellingray S, Cooper C. Repeatability and validity of an upper limb and neck discomfort questionnaire: the utility of the standardized Nordic questionnaire. Occup Med (Lond) 1999;49:171–5.
18. Palmer K, Walker-Bone K, Linaker C, Reading I, Kellingray S, Coggon C, et al. The Southampton examination schedule for the diagnosis of musculoskeletal disorders of the upper limb. Ann Rheum Dis 2000;59:5–11.
19. Davis TR. Diagnostic criteria for upper limb disorders in epidemiological studies. J Hand Surg (Br) 1998;23:567–9.
20. Silverstein B, Welp E, Nelson N, Kalat J. Claims incidence of work-related disorders of the upper extremities: Washington state, 1987 through 1995. Am J Public Health 1998;88:1827–33.
21. Silverstein B, Viikari-Juntura E, Kalat J. Use of a prevention index to identify industries at high risk for work-related musculoskeletal disorders of the neck, back, and upper extremity in Washington state, 1990-1998. Am J Ind Med 2002;41:149–69.
22. Davis L, Wellman H, Hart J, Cleary R, Gardstein BM, Sciuchetti P. A comparison of data sources for the surveillance of work-related carpal tunnel syndrome in Massachusetts. Am J Ind Med 2004;46:284–96.
23. Shannon HS, Lowe GS. How many injured workers do not file claims for workers' compensation benefits? Am J Ind Med 2002;42:467–73.
24. Tanaka S, Wild DK, Seligman PJ, Halperin WE, Behrens VJ, Putz-Anderson V. Prevalence of work-relatedness of self-reported carpal tunnel syndrome among U.S. workers: analysis of the Occupational Health Supplement data of 1988 National Health Interview Survey. Am J Ind Med 1995;27:451–70.
25. Paoli P, Merllie D. Third European survey on working conditions. European foundation for the improvement of living and working conditions, Dublin, 2000. URL: http://www.eurofound.eu.int/publications/htmlfiles/ef0121.htm.
26. Atroshi I, Gummesson C, Johnsson R, Ornstein E, Ranstam J, Rosen I. Prevalence of carpal tunnel syndrome in a general population. JAMA 1999;282:153–8.
27. Latko WA, Armstrong TJ, Franzblau A, Ulin SS, Werner RA, Albers JW. Cross-sectional study of the relationship between repetitive work and the prevalence of upper limb musculoskeletal disorders. Am J Ind Med 1999;36:248–59.
28. Walker-Bone K, Palmer KT, Reading I, Coggon D, Cooper C. Prevalence and impact of musculoskeletal disorders of the upper limb in the general population. Arthritis Rheum 2004; 51:642–51.
29. Roquelaure Y, Mariel J, Fanello S, Boissiere JC, Chiron H, Dano C, et al. Active epidemiological surveillance of musculoskeletal disorders in a shoe factory. Occup Environ Med 2002;59:452–8.
30. Burdorf A, van der Beek A. Exposure assessment strategies for work-related risk factors for musculoskeletal disorders. Scand J Work Environ Health 1999;25 Suppl 4:25–30.
31. Spielholz P, Silverstein B, Morgan M, Checkoway H, Kaufman J. Comparison of self-report, video observation and direct measurement methods for upper extremity musculoskeletal disorder physical risk factors. Ergonomics 2001;44:588–613.
32. Bernard BP. Musculoskeletal disorders and workplace factors: a critical review of epidemiologic evidence for work-related musculoskeletal disorders of the neck, upper-extremity, and low back. Cincinnati: DHHS (NIOSH); 1997.
33. National Research Council. The National Academy of Sciences. Musculoskeletal disorders and the workplace: low back and upper extremity musculoskeletal disorders. Washington (DC): National Academy Press; 2001.
34. Halpern M, Hiebert R, Nordin M, Goldsheyder D, Crane M. The test-retest reliability of a new occupational risk factor questionnaire for outcome studies of low back pain. Appl Ergon 2001;32:39–46.
35. Buckle P, Devereux J. Work-related neck and upper limb musculoskeletal disorders. European Agency for safety and Health at Work, 1999. URL: http://agency.osha.eu.int/publications/reports/201/index.htm.
36. Roquelaure Y, Mariel J, Dano C, Leclerc A, Moisan S, Penneau-Fontbonne D. Surveillance program of neck and upper limb musculoskeletal disorders: assessment over a 4 year period in a large company. Ann Occup Hyg 2004;48:635–42.
37. De Zwart BC, Frings-Dresen MH, Kilbom A. Gender differences in upper extremity musculoskeletal complaints in the working population. Int Arch Occup Environ Health 2001;74: 21–30.
38. Jacobsson L, Lindgarde F, Manthorpe R. The commonest rheumatic complaints of over six weeks' duration in a twelve-month period in a defined Swedish population: prevalences and relationships. Scand J Rheumatol 1989;18:353–60.
39. Franklin GM, Haug J, Heyer N, Checkoway H, Peck N. Occupational carpal tunnel syndrome in Washington state, 1984-1988. Am J Public Health 1991;81:741–6.
40. Roquelaure Y, Cren S, Rousseau F, Touranchet A, Dano C, Fanello S, et al. Work status after workers' compensation claims for upper limb musculoskeletal disorders. Occup Environ Med 2004;61:79–81.
41. McCormack RR Jr, Inman RD, Wells A, Berntsen C, Imbus HR. Prevalence of tendinitis and related disorders of the upper extremity in a manufacturing workforce. J Rheumatol 1990; 17:958–64.
42. Allander E. Prevalence, incidence, and remission rates of some common rheumatic diseases or syndromes. Scand J Rheumatol 1974;3:145–53.
43. Descatha A, Leclerc A, Chastang JF, Roquelaure Y, and the Study Group on Repetitive Work. Incidence of ulnar nerve entrapment at the elbow in repetitive work. Scand J Work Environ Health 2004;30:234–40.
44. Tanaka S, Petersen M, Cameron L. Prevalence and risk factors of tendinitis and related disorders of the distal upper extremity among U.S. workers: comparison to carpal tunnel syndrome. Am J Ind Med 2001;39:328–35.
45. Krause N, Rugulies R, Ragland DR, Syme SL. Physical workload, ergonomic problems, and incidence of low back injury: a 7.5-year prospective study of San Francisco transit operators. Am J Ind Med 2004;46:570–85.
46. Yassi A, Sprout J, Tate R. Upper limb repetitive strain injuries in Manitoba. Am J Ind Med 1996;30:461–72.
47. Hakkanen M, Viikari-Juntura E, Martikainen R. Incidence of musculoskeletal disorders among newly employed manufacturing workers. Scand J Work Environ Health 2001;27:381–7.
48. Nahit ES, Macfarlane GJ, Pritchard CM, Cherry NM, Silman AJ. Short term influence of mechanical factors on regional musculoskeletal pain: a study of new workers from 12 occupational groups. Occup Environ Med 2001;58:374–81.
49. Ricordeau P, Weill A, Vallier N, Bourrel R, Fender P, Allemand H. Epidemiology of diabetes in metropolitan France. Diabetes Metab 2000;26 Suppl 6:11–24. In French.
50. Roquelaure Y, Ha C, Pelier-Cady MC. Réseau expérimental de surveillance épidémiologique des troubles musculo-squelettiques dans les Pays de la Loire: surveillance en population générale du syndrome du canal carpien dans le Maine et Loire en 2002. Institut de veille sanitaire, 2004. URL: http://www.invs.sante.fr/publications/default.htm.

51. Rossignol M, Stock S, Patry L, Armstrong B. Carpal tunnel syndrome: what is attributable to work? The Montreal Study. Occup Environ Med 1997;54:519–23.
52. Novak CB, Lee GW, Mackinnon SE, Lay L. Provocative testing for cubital tunnel syndrome. J Hand Surg [Am] 1994;19:817–20.
53. Starkey C, Ryan JL. Evaluation of orthopaedic and athletic injuries. Philadelphia: FA Davis Company; 1996.
54. Gonzalez del Pino J, Delgado-Martinez AD, Gonzalez Gonzalez I, Lovic A. Value of the carpal compression test in the diagnosis of carpal tunnel syndrome. J Hand Surg [Br] 1997; 22:38–41.
55. Tetro AM, Evanoff BA, Hollstien SB, Gelberman RH. A new provocative test for carpal tunnel syndrome: assessment of wrist flexion and nerve compression. J Bone Joint Surg Br 1998;80:493–8.

APPENDIX A: DIAGNOSTIC CRITERIA OF MSDs BASED ON SYMPTOMS AND PHYSICAL EXAMINATION SIGNS

MSD (ICD-10 code)	Symptoms present currently or at least 4 days during the last 7 days	Physical examination sign(s)
Rotator cuff syndrome (M75.1)	At least intermittent pain in the shoulder region without paresthesias worsened by active elevation movement of the upper arm as in scratching the upper back	At least 1 of the following tests positive: resisted shoulder abduction, external, or internal rotation; resisted elbow flexion; painful arc on active upper-arm elevation
Lateral epicondylitis (M77.1)	At least intermittent, activity-dependent pain directly located around the lateral epicondyle	Local pain on resisted wrist extension
Cubital tunnel syndrome (G56.2)	At least intermittent paresthesias in the 4th or 5th digit or both or on the ulnar border of the forearm, wrist, or hand	A positive combined pressure and flexion test (52)
Carpal tunnel syndrome (G56.1)	Intermittent paresthesias or pain in at least 2 of the digits I, II, or III; either may be present at night as well (allowing pain in the palm, wrist, or radiation proximal to the wrist)	At least 1 of the following tests positive: flexion compression test; carpal compression test; Tinel's sign; Phalen's test; 2-point discrimination test; resisted thumb abduction or motor loss with wasting pollicis brevis muscle (53–55)
Flexor-extensor peri-tendinitis or teno-synovitis of the forearm-wrist region (M70.0/M70.8)	Intermittent pain/ache in the ventral or dorsal forearm or wrist region	Provocation of symptoms during resisted movement(s) of the muscles under the symptoms area and reproduction of pain during palpation of the affected tendons or palpable crepitus under the symptom area or visible swelling of the dorsum wrist-forearm
De Quervain's disease (M65.4)	Intermittent pain or tenderness localized over the radial side of the wrist; either may radiate proximally to the forearm or distally to the thumb	At least 1 of the following tests positive: Finkelstein's test; resisted thumb extension; resisted thumb abduction
Nonspecific MSDs (M79.9)	Pain, stiffness, tingling, numbness, paresthesias, cold feeling, localized or not, involving a part or totality of the neck and upper extremities; Nordic questionnaire: symptoms present during at least 1 day during the last 7 days	—

MSD = musculoskeletal disorder; ICD-10 = International Statistical Classification of Diseases and Related Health Problems, Tenth Revision.

APPENDIX B: DEFINITION OF OCCUPATIONAL PHYSICAL AND PSYCHOSOCIAL RISK FACTORS OF MUSCULOSKELETAL DISORDERS

Criteria	Definition	Positive if present
1. High repetitiveness	Actions performed more than 2–4 times a minute, or cycles <30 seconds	> total of 4 hours/workday
2. High force	Hand weights of more than 4 kg	>1 exertion/hour
3. Too little recovery	Less than 10-minute break possible for every 60 minutes of highly repetitive movements	No break and high repetitiveness
4. High psychological demands	Scale score ≥75% maximum score	Scale score ≥75th percentile
5. Low social support	Scale score ≤25% maximum score	Scale score ≤25th percentile
6. Extreme posture (neck)	61. Neck flexion	> total of 4 hours/workday
	62. Neck extension	> total of 4 hours/workday
	63. Work with arm abducted	> total of 4 hours/workday
	64. Computer or binocular work	> total of 4 hours/workday
7. Extreme posture (shoulder)	71. Work with hands above shoulders	> total of 2 hours/workday
	72. Work with arm extended	> total of 2 hours/workday
	73. Work with arm abducted	> total of 2 hours/workday
8. Extreme posture (elbow)	81. Full elbow flexion/extension movements	> total of 2 hours/workday
	82. Full pronosupination movements	> total of 2 hours/workday
9. Extreme posture (wrist)	91. Wrist bending in extreme posture	> total of 2 hours/workday
	92. Holding tools or objects in a pinch grip	> total of 4 hours/workday
	93. Use of vibrating handtools	> total of 1 hour/workday
	94. Computer or mouse work	> total of 2 hours/workday

Exposure score for the neck region (total out of 8): sum of criteria 1,3,4,5,61,62,63,64.
Exposure score for the shoulder and arm region (total out of 8): sum of criteria 1,2,3,4,5,71,72,73.
Exposure score for the elbow and forearm region (total out of 7): sum of criteria 1,2,3,4,5,81,82.
Exposure score for the wrist and hand region (total out of 9): sum of criteria 1,2,3,4,5,91,92,93,94.