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J Occup Health 2012; 54: 278–288

Journal of Occupational Health

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Abstract: Effects of Individual and Work-related Factors on Incidence of Shoulder Pain in a Large Working Population: Julie BODIN, *et al*. LUNAM Université, Université d'Angers, Laboratoire d'ergonomie et d'épidémiologie en santé au travail (LEEST), France—Objectives: The aim of this study was to assess the effects of individual and work-related factors on the incidence of shoulder pain in a large French working population. **Methods:** A total of 3,710 workers of a French region were randomly included in a cross-sectional study between 2002 and 2005. They completed a self-administered questionnaire about musculoskeletal symptoms, individual factors and exposure to work constraints. In 2007, 2,332 responded to a follow-up questionnaire. The Nordic questionnaire was used both times to assess shoulder pain during the preceding 7 days. Associations between incident shoulder pain and individual and work-related factors at baseline were studied by multivariate logistic regression for both genders. **Results:** A total of 946 men and 709 women without shoulder pain at baseline were eligible for the analyses. At follow-up, 105 men (11.1%) and 145 women (20.5%) reported shoulder pain. For men, age (OR 3.3, 95% CI, 1.7–6.5 for ≥50 yr), working with arms above the shoulder (1.5; 1.0–2.3) and high perceived physical exertion (1.6; 1.0–2.5) increased the risk of incident shoulder pain. For women, the factors associated with incident shoulder pain were age (2.9; 1.5–5.8 for ≥50 yr), obesity (2.5; 1.4–4.5), temporary employment (2.1; 1.1–3.7), high perceived physical exertion (2.2; 1.4–3.5) and low decision latitude (1.6; 1.0–2.3). **Conclusion:** Age was the strongest predictor of incident shoulder pain in both genders. BMI and biomechanical and psychosocial factors were also identified as risk factors, whereas no factor related to work organization remained in the final models.
(J Occup Health 2012; 54: 278–288)

Key words: Incidence, Individual factors, Shoulder pain, Work-related factors

Musculoskeletal disorders (MSDs) and musculoskeletal complaints are a major cause of morbidity at work in Europe and North America and the leading causes of compensated occupational diseases in several European countries[1)]. The body regions most often affected are the lower back, the neck and the shoulders.

Shoulder pain (SP) is common both in the general population, with 1-year prevalence rates between 7 and 47%[2)], and in the working population[3)]. A systematic review of occupational risk factors for shoulder pain in 2000[4)] included 29 studies: 26 cross sectional designs, 3 case-control studies and no prospective studies. In the past ten years, additional papers on the incidence of SP have been published[2, 5–12)]. However, neck and shoulder pain were not always distinguished[7, 8, 10–12)]. Some of these studies focused on the general working population[5, 7, 8)], but the majority surveyed specific populations, such as manual workers[6, 10)], nurses[2, 11)] and newly employed workers[9)]. A systematic review of recent longitudinal studies in 2010[13)] reported that the main risk factors found to have reasonable evidence supporting their causal relationship with shoulder pain were heavy physical load and psychosocial factors (high level of distress, monotonous work and low job control) on the basis of only three studies[5, 6, 9)]. It has been shown in other studies that biomechanical factors, such as repetitive movements, arm above the shoulder and pushing or pulling were also associated with incident SP[7, 10, 11)]. The role of individual factors in incident SP was rarely studied or was not the main focus of studies[14)].

Received Dec 14, 2011; Accepted Apr 16, 2012
Published online in J-STAGE May 29, 2012
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We used data gathered between 2002 and 2005 and between 2007 and 2009 from the prospective surveillance program for MSDs implemented by the French Institute for Public Health Surveillance in the Pays de la Loire region. The aim of this study was to assess the relative impact of individual, biomechanical, work organization and psychosocial factors on the incidence of SP in a large working population exposed to various levels of shoulder constraints.

Materials and Methods

Study population

This prospective study was based on two successive surveys of a large sample of workers in the Pays de la Loire region in France. The region contains 5.6% of the French working population, and its diversified socioeconomic structure is close to that of France as a whole[1].

All French salaried workers, including temporary and part-time workers, undergo a mandatory annual health examination by an occupational physician (OP) in charge of the medical surveillance of a group of companies. Between April 2002 and April 2005, a total of 83 OPs, representing 18% of OPs of the region, volunteered to take part in the study. They were representative of the region's OPs in terms of medical practice, working time and geographic and economic sectors covered[3].

Subjects were selected at random, following a two-stage sampling procedure: first, the research team chose 15–45 half-days of scheduled examinations for each OP. Next, using random sampling tables, each OP selected 1 out of 10 workers from the schedule on the half-days of worker examinations considered. Fewer than 10% of the selected workers were not included (no shows, refusals and duplications). Workers completed a self-administered questionnaire about their musculoskeletal symptoms and their working conditions and then underwent a physical examination performed by the OP. A total of 3,710 workers (2,161 men (58.2%) with a mean age of 38.5 yr, standard deviation 10.4 yr, and 1,549 women (42.8%) with a mean age of 38.9 yr, standard deviation 10.3 yr) were included (out of 184,600 under surveillance by the 83 OP, 2.0%). Women were slightly underrepresented in the sample (42% vs. 47% in the region). Overall, the distribution of occupations in the study sample was close to that of the regional workforce, except for the occupations not surveyed by the OPs (e.g., shopkeepers and independent workers)[1, 3]. Subjects worked mainly in the service industry (58.6%) and the manufacturing industry (33.7%) sectors, and more rarely in the construction (5.8%) and agriculture (1.9%) sectors. Men were mainly skilled and unskilled blue collar workers (56.0%), associate professionals and technicians (25.0%) and managers and professionals (9.7%). Most women were low-grade white collar workers (51.7%), skilled and unskilled blue collar workers (24.4%) and associate professionals and technicians (18.7%).

In 2007, a follow-up questionnaire was mailed to subjects. In the case of non-response, they were sent two successive reminder letters with the self-administered questionnaire. If their address was unknown, the new address was sought by contacting either their OP or the French public postal services. For workers who had not returned the self-administered questionnaire in 2007, the OPs were asked to pass on the questionnaire to the workers during a regular health examination in 2008 and 2009.

Shoulder pain

The outcome variable was incident SP.

SP during the preceding 7 days was assessed at baseline and at follow-up using a modified version of the standardized Nordic-style questionnaire[15–19]. The subjects were asked if they had experienced any ache, discomfort, pain or numbness in the shoulders. A mannequin was used to indicate the anatomical areas including the shoulder region, as distinct from the neck region.

Subjects free from SP at baseline were those without SP during the preceding 7 days at baseline and without SP for more than 8 days during the preceding 12 months at baseline. "Incident cases" were defined as subjects free from SP at baseline who stated they had SP during the 7 days preceding the second questionnaire. Subjects with rotator cuff syndrome diagnosed by an OP at baseline were therefore excluded.

Potential risk factors

The potential risk factors were assessed at baseline. Variables were divided into four groups: individual factors, organizational factors, biomechanical factors and psychosocial factors.

1) Individual factors

In the self-administered questionnaire, workers were asked about their age, height and weight. Age was divided into four categories (<30, 30–39, 40–49 and ≥50 yr). BMI was calculated as kg/m^2 and divided into three categories (<25, 25–30 and ≥30 kg/m^2). Upper-extremity MSDs (UE-MSDs) at baseline was defined as the diagnosis of at least one of the following UE-MSDs: lateral epicondylitis, ulnar tunnel syndrome, carpal tunnel syndrome, De Quervain's disease and flexor-extensor peritendinitis or tenosynovitis of the forearm-wrist region. To establish a diagnosis, a standardized physical examination was performed by the OP using a clinical procedure based on the criteria document for evaluating the work-

relatedness of UE-MSDs[20].

2) Work-related factors

Work status and exposure to work-related risk factors were assessed with the self-administered questionnaire including information on the characteristics of the job and tasks and work organization:

- The organizational factors studied were time constraints (paced work, work pace dependent on automatic rate, other technical organization, quantified targets, customers' demand, permanent controls or surveillance), job/task rotation, overtime hours, high visual demand, lack of prior information regarding the amount of work to be done each day, variable weekly working time, working with temporary workers and temporary employment. Responses to the questions were categorized as yes/no.
- The response categories for biomechanical factors were presented on a 4-level Likert-type scale, as follows: never or practically never, rarely (less than 2 h per day), often (2 to 4 h per day) and always (more than 4 h per day). Several factors were defined and quantified according to a European consensus[20]. The risk factors used for the criteria for the shoulder region were repetitiveness of tasks (≥4 h/day), working with arms abducted (≥2 h/day) and holding a hand behind the trunk (≥2 h/day). Workers were defined as being at risk of working with arms above the shoulder if they responded with "rarely", "often" or "always". Additional variables, known or suspected to be risk factors, were considered: use of vibrating handtools (≥2 h/day) and exposure to cold temperature (≥4 h/day). Perceived physical exertion was assessed using the Rating Perceived Exertion Borg scale (20-RPE) graduated from 6 ("very, very light") to 20 ("maximum exertion")[21–23]. Workers at risk (i.e., high perceived physical exertion) were dichotomized at the third quartile (≥15 for men and ≥14 for women).
- Psychosocial work factors (high psychosocial demand, low decision latitude, low supervisor support and low coworker support) were assessed according to the validated French version of the Karasek Job Content Questionnaire. Workers at risk were dichotomized using the median scores of the national French SUMER study[24].

Statistical analysis

Analyses were performed separately for men and women to take into account possible differences in exposure to work constraints between genders[25]. Bivariate associations between SP and the risk factors were studied by Chi-squared or Fisher's exact tests. Risk factors with a p-value <0.20 were placed in a multivariable model by groups of variables (individual factors, organizational factors, biomechanical factors and psychosocial factors). Manual backward multivariate logistic regression models were then applied for each group of variables in order to avoid collinearity between exposure variables in the final model (age was forced into the models). Nonsignificant variables (p≥0.10) were excluded after this stage. The remaining factors were entered into a final global multivariate logistic regression model, and manual backward selection retained only significant variables with a p-level <0.05. In the manual backward multivariate logistic regression, all possible confounding effects of relevant variables were checked individually, and if a change in the beta coefficients of ≥15% occurred when a variable was deleted, the variable was considered to be a confounder and forced into the final model. The goodness of fit of the logistic model was determined by the Hosmer-Lemeshow test.

To test the effects of a change of job during follow-up, a composite variable was included in each of the final models obtained in the previous analysis. The variable created had three categories (no change, change of job during follow-up and not working at the time of the second questionnaire).

All analyses were performed with the SAS statistical software package (version 9.2: SAS Institute Inc., Cary, NC, USA).

Each subject provided informed written consent to participation in this study at baseline, and the study received approval from France's National Committee for Data Protection (Commission Nationale de l'Informatique et des Libertés), first in 2001 and then again in 2006.

Results

Participation at follow-up

Between 2007 and 2009, 233 (6.3%) subjects could not be contacted because their addresses were unknown (n=215) or because they were deceased (n=18). Among the contactable subjects, 1,145 did not respond, and finally, a total of 2,332 subjects (67.1%) filled out the second self-administered questionnaire (96.9% filled out the second self-administered questionnaire in 2007) (Fig. 1).

We compared the characteristics of the responding workers to the non-responders (whatever the reason of their lack of participation). Women more often participated than men (65.8% vs. 60.8%). Participation increased with age until 54 yr (from 49.2% under 30 yr to 72.8% between 50 and 54 yr and 64.6% over 55 yr) and with the length of service at baseline (from 50.5% under one year to 68.1% over 10 yr) for both genders. Temporary workers were more often lost to follow-up (48.4% vs. 64.8%). More male white

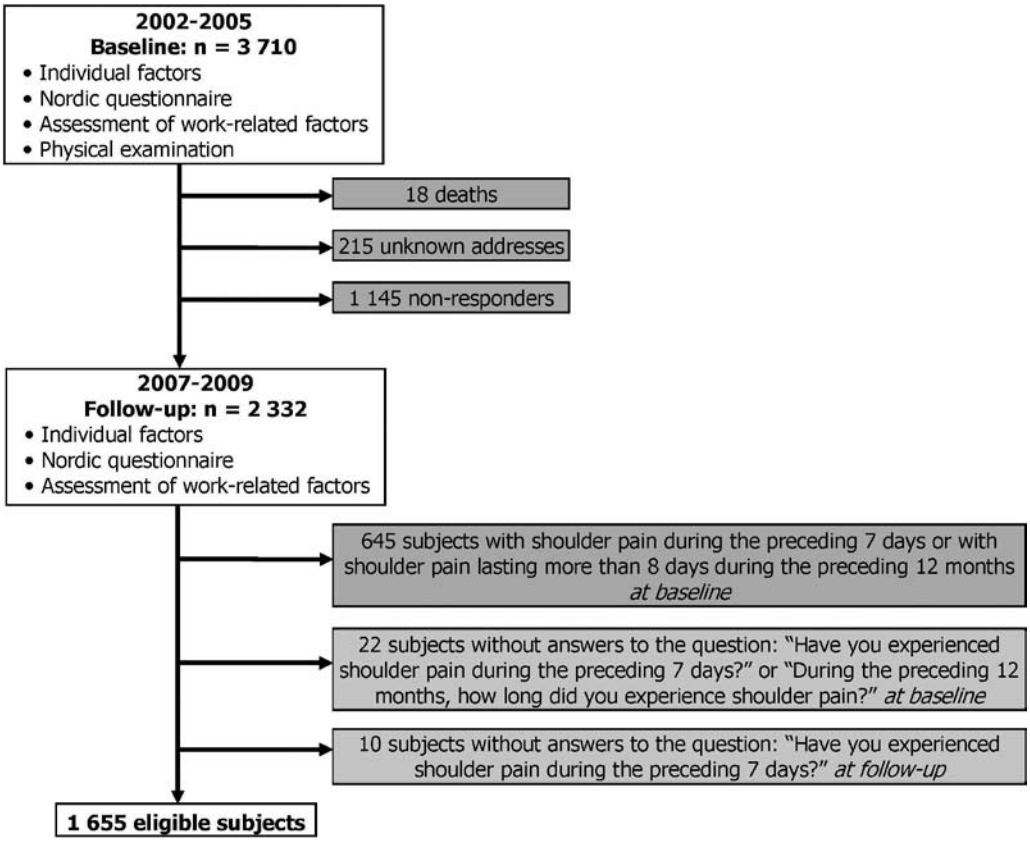

Fig. 1. Flowchart of participant eligibility for analyses of incident shoulder pain.

collar workers participated (65.9%) compared with male unskilled workers (52.8%). More men with UE-MSDs at baseline (73.3% vs. 59.2%), as well as men with SP during the 7 preceding days at baseline (68.9% vs. 59.1%), participated. The latter three differences were not observed in women.

Among the 2,332 subjects, 645 reported SP during the preceding 7 days at baseline or lasting more than 8 days during the preceding 12 months at baseline, and 32 did not answer these questions at baseline or at follow-up. Finally, 1,655 subjects (946 men (57%) and 709 women (43%)) were eligible for analysis of incidence of SP (Fig. 1).

Study population at baseline

Men were more often overweight than women. Occupational factors differed between men and women; men were more exposed to organizational (such as work pace dependent on quantified targets) and to some biomechanical factors (such as arms above the shoulder and use of vibrating handtools). However, women were more often exposed to high repetitiveness of tasks. Among psychosocial factors, women were also more exposed to low decision latitude (Table 1).

Shoulder pain at follow-up

At follow-up, 105 men (11.1%) and 145 women (20.5%) reported shoulder pain ($p<0.001$). Of these, 38 men and 69 women reported pain intensity levels higher than 4 on a visual analog scale ranging from 0 to 10. The right shoulder was involved in 44.2% of cases, and the left shoulder was involved in 28.1% of cases; both shoulders were involved in 27.7% of cases. A difference in incident SP was found between active and inactive men in 2007–2009 (10.4% vs. 18.6%, respectively, $p=0.026$), but the difference was not significant after adjustment for age. No difference was observed in women. Among active subjects, there was no difference between those who changed job and those who did not (14.7% vs. 14.8%, respectively, $p=0.958$).

1) Results in men

Incident SP in men was associated with age, lack of prior information regarding the amount of work to be done each day, a high perceived physical exertion, arms above the shoulder and holding a hand behind the trunk, with a p-value <0.20. No psychosocial factors were associated with SP (Table 2). In the multivariate model, age increased the risk of incident SP. Working with a high perceived physical exertion

Table 1. Baseline characteristics of the study population

Baseline characteristics	Men (n=946)		Women (n=709)		p*
	n	%	n	%	
Personal factors and medical history					
Age					0.763
<30	198	20.9	149	21.0	
30–39	293	31.0	226	31.9	
40–49	280	29.6	217	30.6	
≥50	175	18.5	117	16.5	
BMI					**<0.001**
Underweight-normal (<25)	528	56.5	508	72.3	
Overweight (25–30)	336	35.9	134	19.1	
Obesity (≥30)	71	7.6	61	8.7	
Upper-extremity musculoskeletal disorders	41	4.3	36	5.1	0.477
Occupational class and employment contract					
Occupational class					**<0.001**
Managers, professionals, technicians	382	40.4	182	25.8	
Low-level white collar	81	8.6	372	52.7	
Skilled blue collar	348	36.8	48	6.8	
Unskilled blue collar	135	14.3	104	14.7	
Temporary employment	77	8.2	83	11.8	**0.014**
Factors related to work organization					
Paced work	89	9.6	52	7.6	0.168
Work pace dependent on automatic rate	93	10.0	48	7.0	**0.033**
Work pace dependent on other technical organization	241	25.9	75	11.0	**<0.001**
Work pace dependent on quantified targets	488	52.1	257	37.6	**<0.001**
Work pace dependent on demand of customers	426	45.4	319	45.8	0.867
Work pace dependent on permanent controls or surveillance	220	23.7	161	23.4	0.918
Job/task rotation (≥1 job rotation per week)	341	37.9	225	33.8	0.091
Overtime hours	636	68.0	373	53.6	**<0.001**
Work with temporary workers	263	27.8	192	27.3	0.812
High visual demand	172	18.3	123	17.6	0.732
Lack of prior information regarding the amount of work to be done each day	123	13.1	25	3.5	**<0.001**
Variable weekly working time	542	57.4	342	48.8	**0.001**
Working postures and biomechanical constraints					
High repetitiveness of tasks (≥4 h/day)	179	19.0	194	27.6	**<0.001**
Arms above the shoulder	363	38.5	215	30.5	**0.001**
Arms abducted (≥2 h/day)	121	12.8	82	11.6	0.457
Holding hand behind the trunk (≥2 h/day)	36	3.8	30	4.2	0.662
Use of vibrating handtools (≥2 h/day)	159	16.8	19	2.7	**<0.001**
Exposure to cold temperature (≥4 h/day)	68	7.2	26	3.7	**0.002**
Psychosocial factors at work					
High psychological demand	435	46.3	329	46.9	0.807
Low decision latitude	398	42.6	404	57.7	**<0.001**
Low supervisor support	370	39.5	242	35.1	0.067
Low coworker support	172	18.4	126	18.2	0.915

*Comparison of baseline characteristics between men and women, χ^2 test.

and working with arms above the shoulder were of borderline significance (Table 3).

2) Results in women

More factors were associated with incident SP in bivariate analyses in women. All the individual factors studied were significantly associated with incident SP, with a p-value <0.20. Temporary employment, paced work, work pace dependent on automatic rate, work pace dependent on other technical organization, work pace dependent on quantified targets, a high level of visual demand, working with high repetitiveness of tasks, working with a high perceived physical exertion, working with arms above the shoulder, exposure to cold temperature, low decision latitude and low coworker support were associated with a high incidence of SP (Table 2). In the multivariate model, the strength of association was high for age. Associations were also found for obesity, temporary employment, high perceived physical exertion and low decision latitude (Table 3). Women in temporary employment were mainly low-level white collar (44.4%) and unskilled blue collar workers (32.1%). In the latter group, 38.5% had incident SP.

The reliability of the models was appropriate according to the Hosmer-Lemeshow test, with a p-value of 0.434 for men and 0.183 for women.

Table 2. Incidence of shoulder pain in relation to individual, work organization, biomechanical and psychosocial factors

Baseline characteristics	Men (n=946)			Women (n=709)		
	n	Incidence (%)	*p**	n	Incidence (%)	*p**
Personal factors and medical history						
Age			**0.001**			**0.014**
<30	198	7.1		149	14.1	
30–39	293	8.2		226	17.3	
40–49	280	12.1		217	24.4	
≥50	175	18.9		117	27.4	
BMI			0.542			**0.001**
Underweight-normal (<25)	528	10.2		508	17.9	
Overweight (25–30)	336	12.5		134	22.4	
Obesity (≥30)	71	12.7		61	37.7	
Upper-extremity musculoskeletal disorders			1.000†			**0.005**
No	905	11.2		673	19.5	
Yes	41	9.8		36	38.9	
Factors related to work organization						
Paced work			0.487			**0.133**
No	843	11.0		633	20.1	
Yes	89	13.5		52	28.9	
Work pace dependent on automatic rate			0.841			**0.061**
No	835	11.1		638	19.9	
Yes	93	11.8		48	31.3	
Work pace dependent on other technical organization			0.260			**0.184**
No	688	10.6		608	20.1	
Yes	241	13.3		75	26.7	
Work pace dependent on quantified targets			0.378			**0.081**
No	448	10.3		426	18.5	
Yes	488	12.1		257	24.1	
Work pace dependent on demand of customers			0.576			0.218
No	512	11.7		377	22.3	
Yes	426	10.6		319	18.5	
Work pace dependent on permanent controls or surveillance			0.310			0.581
No	710	10.7		526	20.3	
Yes	220	13.2		161	22.4	
Job/task rotation (≥1 job rotation per week)			0.348			0.310
No	558	12.0		441	19.7	
Yes	341	10.0		225	23.1	
Overtime hours			0.592			0.836
No	299	11.7		323	20.7	
Yes	636	10.5		373	20.1	
High visual demand			0.622			**0.061**
No	769	11.2		575	19.3	
Yes	172	9.9		123	26.8	
Lack of prior information regarding the amount of work to be done each day			**0.189**			0.347
No	818	10.6		681	20.3	
Yes	123	14.6		25	28.0	
Variable weekly working time			0.642			0.283
No	403	11.7		359	18.9	
Yes	542	10.7		342	22.2	
Work with temporary workers			0.613			0.470
No	683	11.4		512	19.9	
Yes	263	10.3		192	22.4	
Temporary employment			0.867			**0.087**
No	868	11.1		622	19.6	
Yes	77	11.7		83	27.7	
Working postures and biomechanical constraints						
High repetitiveness of tasks (≥4 h/day)			0.388			**0.039**
No	764	10.6		508	18.7	
Yes	179	12.9		194	25.8	
High perceived physical exertion‡			**0.028**			**<0.001**
No	753	10.0		575	17.6	
Yes	193	15.5		129	34.1	
Arms above the shoulder			**0.041**			**0.073**
No	581	9.5		491	18.7	
Yes	363	13.8		215	24.7	

Arms abducted (≥2 h/day)			0.884			0.530
No	822	11.2		624	20.2	
Yes	121	10.7		82	23.2	
Holding hand behind the trunk (≥2 h/day)			**0.051**†			0.393
No	907	10.7		677	20.2	
Yes	36	22.2		30	26.7	
Use of vibrating handtools (≥2 h/day)			0.716			0.249†
No	785	11.0		685	20.3	
Yes	159	12.0		19	31.6	
Exposure to cold temperature (≥4 h/day)			0.529			**0.190**
No	875	11.3		679	20.2	
Yes	68	8.8		26	30.8	
Psychosocial factors at work						
High psychological demand			0.778			0.337
No	504	10.9		372	21.8	
Yes	435	11.5		329	18.8	
Low decision latitude			0.949			**0.006**
No	537	11.2		296	15.5	
Yes	398	11.3		404	24.0	
Low supervisor support			0.915			0.614
No	566	11.3		448	19.9	
Yes	370	11.1		242	21.5	
Low coworker support			0.414			**0.081**
No	762	10.6		566	19.3	
Yes	172	12.8		126	26.2	

*χ^2 test. †Fisher exact test. ‡RPE Borg scale ≥15 for men and ≥14 for women.

Table 3. Multivariate model for risk factors of incidence of shoulder pain in the male and female working populations

	Men (n=944; 105 incident SP)						Women (n=688; 142 incident SP)					
	n	%	OR	95%	CI	*p*	n	%	OR	95%	CI	*p*
Age						0.001						0.001
<30	198	7.1	1				143	14.0	1			
30–39	292	8.2	1.2	0.6	2.4		222	17.1	1.6	0.8	2.9	
40–49	279	12.2	**2.0**	**1.0**	**3.8**		210	25.2	**2.9**	**1.6**	**5.3**	
≥50	175	18.9	**3.3**	**1.7**	**6.5**		113	27.4	**2.9**	**1.5**	**5.8**	
BMI												0.010
Underweight-normal (<25)							498	18.1	1			
Overweight (25–30)							129	22.5	1.1	0.6	1.7	
Obesity (≥30)							61	37.7	**2.5**	**1.4**	**4.5**	
Temporary employment												0.016
No							607	19.8	1			
Yes							81	27.2	**2.1**	**1.1**	**3.7**	
Arms above the shoulder						0.073						
No	581	9.5	1									
Yes	363	13.8	1.5	1.0	2.3							
High perceived physical exertion*						0.075						<0.001
No	751	10.0	1				562	17.8	1			
Yes	193	15.5	1.6	1.0	2.5		126	33.3	**2.2**	**1.4**	**3.5**	
Low decision latitude												0.031
No							290	15.9	1			
Yes							398	24.1	**1.6**	**1.0**	**2.3**	

*RPE Borg scale ≥15 for men and ≥14 for women.

Change of job during follow-up

Seventy-four percent of men did not change their jobs during the follow-up period, 18.0% had changed jobs and 8.0% were unemployed. The corresponding values for women were 73.0, 14.2 and 12.8%, respectively. Change of job during the follow-up period was not associated with incidence of SP in either univariate analyses or final multivariate models.

Discussion

This prospective study showed the multifactorial origin of incident SP and highlighted a limited number of individual and work-related risk factors, which differed according to gender.

The incidence of SP was higher in women than in men. The same result was found in previous studies[5, 7, 8, 12]. This can be explained by the differences in exposure at work and/or at home, differences in muscle strength and/or psychosocial risk factors such as low social support and perceived stress[18, 25, 26].

The strongest predictor of incident SP for both genders was age. This is consistent with what is known regarding the occurrence of "normal" degenerative changes in aging rotator cuff tendons[27]. However, age was correlated with length of service, and we cannot exclude the possible effect of cumulative exposure to biomechanical factors. Age has been reported to be associated with prevalent shoulder pain in the literature. The results are highly contrasted in studies on the incidence of SP[5, 26], age being reported as a risk factor in some studies[5, 7] and not in others[9, 11]. Certain surveys studied biomechanical and/or psychosocial factors adjusted for age and did not reach a conclusion regarding the effect of age on incidence of SP[8, 10].

Our study found an association between obesity and incident SP among women. Some epidemiological studies have reported an association with overweight and obesity[2, 5], while others have not[6, 28]. Rechardt *et al*.[29] recently reported that waist circumference and waist-to-hip ratio were associated with shoulder pain.

Among the work-related factors, working with arms above the shoulders was a risk factor for men. This is consistent with the literature[6, 9, 30–32], and several biomechanical mechanisms support this finding. The main pathophysiological mechanisms are compression of the tendons between the humeral head and the coracoacromial arch and ischemia due to impingement or increased intramuscular pressure following extreme arm abduction[18, 27]. Some conflicting results have been reported. Leclerc *et al*.[6] found a significant result for women, whereas Miranda *et al*.[5] found that this factor was not significant in the final model. A prospective study of newly employed workers showed that working with hands above the shoulders was predictive of new onset shoulder pain (adjusted for gender)[9]. For both genders, a high perceived physical exertion was associated with incident SP. This could be explained by high shoulder force requirements, which can cause increased muscle contraction activity and lead to an increase in the muscle fatigue and tensile force of the tendon[30]. Some similar results have been published[5, 9, 28, 30], but assessment of exposure is diverse.

For women, low decision latitude was a risk factor for incident SP. There is evidence that psychosocial factors play a role in shoulder pain[4, 33, 34]. However, no single factor has been implicated in particular[30, 33]. Ostergren *et al*.[8] found that decision latitude was not associated with increased risk of suffering neck and shoulder pain during follow-up but found an association with job strain, whereas Leclerc *et al*. showed that a low level of job control affected the incidence of SP[6]. Other studies have reported job demands[7, 10] or mental stress[5] as risk factors.

Our study failed to reveal an association between SP and factors related to the work organization, but several variables related to the technical aspects of the work organization were associated with SP in the univariate analysis for women. Since the organization of technical processes and workstations has a major influence on mechanical exposure, it can be hypothesized that the relationships between SP and such factors could have been masked by the higher and more direct association between SP and mechanical factors.

Prospective studies on incident SP have been published over the past ten years[2, 5–12]. The population studied has often been specific, thus preventing generalization of results. Our prospective study involved a broad sample of workers and was characterized by a wide variety of activity sectors and occupations, representing a wide range of occupational tasks.

However, some methodological issues should be discussed. The use of the term "incidence" is not completely correct. In our study, an incident case was defined as worker with shoulder pain at follow-up who had no shoulder pain at baseline, so cases occurring between the two data collections and which were negative at follow-up were not considered as incident cases.

The response rate among contactable subjects seems satisfactory, in view of the time between the two surveys (2 to 7 yr). This was due to the significant work of updating the addresses of the workers included in 2002–2005, first through their OPs and then through the postal services (more than 300 were found by this way), and also to the repeated reminders. We found significant differences between the responders and the non-responders. Men, young workers, temporary workers, low-level white collar and unskilled workers less often responded to the follow-up questionnaire. The overrepresentation of women, managers, professionals and technicians among the responders is a common result in the literature involving health questionnaires[35]. Having a history of UE-MSDs or pain in an upper limb or the back at baseline had a positive impact on participation in the follow-up for men, whereas health problems in general are often reported in the literature to have a negative impact. The fact that UE-MSDs are a common and fairly minor health problem might explain why subjects without a UE-MSD (maybe feeling less affected by the study) less often partici-

pated a few years after their inclusion in the study, as reported in women by Goldberg *et al*. in a French cohort[36]. This lower participation would result in an overestimation of risks of UE-MSDs only if participation is higher among workers exposed to UE-MSDs than others[37]. In our study, a higher level of initial exposure may have positively influenced participation of both genders, as found elsewhere[38]. The difference in percentages of exposure factors was nevertheless low between responders and non-responders. Moreover, a study on the impact of loss to follow-up in epidemiological studies on UE-MSDs[38] found that the differences in the characteristics between participants and those lost to follow-up did not influence the risk ratios for associations between exposure factors for UE-MSDs and UE-MSD status. We therefore believe that there is no major selection phenomenon associated with the quality of the follow-up.

We chose to define SP as that occurring during the preceding 7 days to limit memory bias. For the group without SP at baseline, we excluded workers with SP of more than 8 days during the preceding 12 months or with SP during the preceding 7 days. We studied shoulder pain by means of a self-reported questionnaire, the Nordic questionnaire, which is the most widely used questionnaire to collect musculoskeletal symptoms[2, 5, 8, 11, 12]. It permits sensitive and reproducible assessment of the prevalence and incidence rates of musculoskeletal symptoms[16].

A self-administered questionnaire was also used to assess the work-related factors. Stock *et al*.[39] showed there is no perfect instrument for measuring dimensions of physical load. Self-reported measures offer the possibility to survey a large sample of workers that includes a wide variety of job titles and hence occupational tasks. Assessment of occupational factors was requested for a typical workday in the preceding 12-month period, and awkward postures were presented in picture form to facilitate workers' understanding and increase the validity of self-assessment of posture. Furthermore, as far as possible, standardized and validated instruments were used such as the European consensus for biomechanical factors and the Karasek Job Content Questionnaire for psychosocial factors[20, 24].

Some studies have reported sport as a risk factor for incident SP[5, 7, 12, 14]. Miranda *et al*. showed that some sports activities such as jogging decreased the risk of shoulder pain, whereas dancing increased the risk of shoulder pain[5]. In a review of factors associated with MSDs, Malchaire *et al*.[26] showed that there was a lack of significance for hobbies and sports. Muscles and tendons are not stressed in the same way according to the sport, and questions should be more specific because information was often vague in questionnaires. A more recent study showed that life events were related to the occurrence of incident neck/shoulder pain (for example, entering a new permanent relationship with a partner or changing workplace, profession or employer)[40]. Due to the length of our self-administered questionnaire, we preferred not to ask questions about sports, hobbies, life events or depressive symptoms. Although non-work activities may represent important confounders in our study, we believe that their influence is probably not sufficient to affect the value of the study.

In conclusion, this study showed that incident SP was related both to individual and work-related factors and differed according to gender. The effect of age was greater than that of other factors. However, in contrast to work-related factors, age is not modifiable. Mechanical and psychosocial exposure should therefore be an important target for strategies for the prevention of shoulder pain in the working population.

Acknoledgments: This project was supported by grants from the French Institute for Public Health Surveillance, Saint-Maurice, France (grant 9/25/2002-5 "Réseau expérimental de surveillance des troubles musculo-squelettiques"), and the French National Research Agency (ANR-grant SEST-06-36). We thank the occupational physicians involved in the baseline sentinel network: Doctors Abonnat, Banon, Bardet, Becquemie, Bertin, Bertrand, Bidron, Biton, Bizouarne, Boisse, Bonamy, Bonneau, Bouguer-Diquelou, Bourrut-Lacouture, Breton, Caillon, Cesbron, Chisacof, Chotard, Compain, Coquin-Georgeac, Cordes, Couet, Coutand, Danielou, Darcy, Davenas, De Lansalut, De Lescure, Diquelou, Dopsent, Dufrenne-Benetti, Dupas, Evano, Fache, Fontaine, Frampas-Chotard, Guillier, Guillimin, Harinte, Harrigan, Hervio, Hirigoyen, Jahan, Jube, Kalfon, Labraga, Laine-Colin, Laventure, Le Dizet, Lechevalier, Le Clerc, Ledenvic, Leroux, Leroy-Maguer, Levrard, Levy, Logeay, Lucas, Mallet, Martin-Laurent, Mazoyer, Meritet, Michel, Migne-Cousseau, Moisan, Page, Patillot, Pinaud, Pineau, Pizzalla, Plessis, Plouhinec, Raffray, Robin-Riom, Roussel, Russu, Saboureault, Schlindwein, Soulard, Thomson, Treillard and Tripodi. The authors declare that they have no conflicting or competing interests. The authors are responsible for the content and writing of the paper.

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