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Predictors of chronic shoulder pain after 5 years in a working population

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ABSTRACT

The role of psychosocial and physical factors in the development of shoulder pain has now been clearly demonstrated. However, only a few studies have analyzed these associations over time. The main goal of this study was to evaluate the predictive value of work-related psychological and mechanical factors on chronic shoulder pain. A total of 12,714 subjects (65% men) born in 1938, 1943, 1948, and 1953 participating in a French prospective longitudinal epidemiological investigation in 1990 to 1995 Enquête Santé Travail Et Vieillissement (ESTEV) were included. Clinical examination was performed by 400 trained occupational physicians. Personal factors and work exposure were assessed by self-administered questionnaires. Statistical associations between chronic shoulder pain and personal and occupational factors were analyzed using logistic regression modeling. A total of 1706 subjects experienced chronic shoulder pain in 1990, and 2089 experienced chronic shoulder pain in 1995. The incidence of chronic shoulder pain in 1995 was 11% (n = 1355). Forceful effort (odds ratio [OR] = 1.24 95% CI [1.05–1.44], awkward posture (OR = 1.34 95% CI [1.19–1.52]), decision latitude (OR = 1.19 [1.04 to 1.35]), and psychological demand (OR = 1.19 95% CI [1.06–1.32]) in 1990 were significantly associated with chronic shoulder pain in 1995, even after adjustment for personal factors and previous shoulder pain status. Awkward posture (OR = 1.43 [1.25 to 1.63]), psychological demand (OR = 1.24 [1.09 to 1.40]), and decision latitude (OR = 1.21 [1.04 to 1.41] work-related factors in 1990 were associated with the development of chronic shoulder pain between 1990 and 1995. These results suggest that awkward posture, forceful effort, job demand, and decision control are predictors of chronic shoulder pain at work. Interventions designed to reduce the incidence of chronic shoulder pain must include both mechanical and psychological factors.

1. Introduction

Shoulder pain is the third most common type of musculoskeletal pain [4], and can have a major impact on health-related quality of life [36,37]. Recent studies of the working adult population have reported shoulder symptoms in almost 30% [33] of the subjects surveyed.

Biomechanical exposures and certain occupational psychological factors generally have been considered to explain the relationship between work and musculoskeletal disorders (MSDs) [5]. Confirmed work-related physical risk factors related to shoulder conditions are heavy loads, repetitive movements, working in awkward postures and vibration, and particularly combinations of these factors [3,13,47,50]. The role of psychosocial work-related factors including high psychological demands, low work control, poor social support, and job dissatisfaction has also been investigated [1]. Exposure to monotonous work [17] and poor relationships with colleagues [21] have also been proposed as factors associated with shoulder pain in various studies.

However, the consistency of the association with psychological factors across studies is low, and several methodological shortcomings have been highlighted [5,6,25]. Recently, a task force commissioned by the European League Against Rheumatism examined the strength of evidence in published review articles concerning

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workplace psychosocial factors and shoulder/neck musculoskeletal pain [30]. This task force's main criticisms of these reviews were that they often evaluated different bodies of evidence and varied in terms of the explicit criteria used to establish conclusions based on the strength of evidence. The review indicated the need for longitudinal studies in this field.

Another meta-analysis of 19 studies on psychosocial workplace factors and neck–shoulder symptoms concluded that "this relationship is neither very strong nor very specific" [5]. Studies assessing psychosocial risk have found less consistent associations than those concerning physical factors [41].

Moreover, in several studies, shoulder disorders were defined only by using self-reported symptoms, despite the fact that the shoulder is one of the few anatomical areas in which consensus-driven criteria for specific diagnoses have been available for several years [18,43]. Consequently, longitudinal approaches associated with standardized clinical examinations would be useful to identify and more clearly understand the factors responsible for shoulder disorders.

In this context, the objective of the French large-scale prospective ESTEV study (Health Work and Aging Investigation) was to evaluate the predictive value of work-related psychological and mechanical factors on chronic shoulder pain (CSP) confirmed by clinical examination.

2. Subjects and methods

The aim of the ESTEV study, a 5-year longitudinal follow-up study, was to investigate the relationships between work conditions and health status across 4 cohorts ages 37, 42, 47, and 52 years at inclusion [10].

2.1. Population

The study population in 1990 was randomly selected from exhaustive lists of subjects under the supervision of 400 volunteer occupational physicians in 7 French regions. For each physician, the sample selection was stratified by sex and the 4 years of birth considered (1938, 1943, 1948, and 1953) and the main occupational status according to national rates of national employment statistics, resulting in a representative sample of French subjects. All participants filled in a self-administered questionnaire on work conditions and health status. Medical history and various conditions were then completed by the occupational physicians during clinical examination. In particular, symptoms of musculoskeletal disorders were systematically recorded, with a standardized examination of the main anatomical sites (shoulder, elbow, wrist, neck, low back, knee, and ankle). A follow-up examination comprising the same procedures was performed in 1995. In 1990, a total of 21,378 subjects were included in the ESTEV study, and 18,695 subjects (87%) were examined twice.

2.2. Shoulder pain status

Shoulder pain status was based on the presence of self-reported symptoms combined with clinical examination [8]. In this study, cases with chronic shoulder pain were defined as subjects who declared, on the day of the medical examination, shoulder pain present for at least 6 months (duration of current episode or intermittent complaints over the last 6 months) and presenting positive clinical signs (active or passive functional limitations, stiffness, tenderness, etc.). Incident chronic shoulder pain was defined as onset of a new episode in 1995 with a symptom-free period in 1990. Persistent chronic shoulder pain was defined as either a new episode in 1995 after an episode in 1990 and a symptom-free period between the 2 episodes or persistent shoulder pain from 1990 to 1995.

2.3. Determinants of shoulder pain

Exposures were assessed using a checklist of work conditions filled in by the subjects and supervised by the physician. The questionnaire included 30 questions about different kinds of physical activities at work and the psychosocial work environment [8,10,46,48].

2.3.1. Physical work

According to the literature on physical risk factors for shoulder disorders and factorial analyses, we defined 9 physical constraints that were grouped into 6 binary dimensions, namely: forceful effort, effort with tools, heavy loads: movements, posture, and vibration:

→ forceful effort dimension when the following item was present: exposure to considerable physical effort;
→ effort with tools dimension when the following item was present: exposure to physical effort with tools;
→ heavy loads dimension when the following item was present: carrying heavy loads;
→ posture dimension when one of the following items was present: exposure to long, difficult working positions and awkward posture;
→ movements dimension when one of the following items was present: precise movements and repetitive work;
→ vibration dimension when one of the following items was present: exposure to considerable vibrations and exposure to jolts.

2.3.2. Psychological work

According to Vezina et al. [48], 6 items of the self-administered ESTEV questionnaire were used together with a proxy measure of the 2 fundamental psychosocial factors of the Karasek model [22], namely decision latitude or decision control and psychological demand or job demand. Decision latitude was defined as low when the subject answered no to at least 2 of the following 3 items: there is room for learning in my work; my work varies; I can choose how to do my work. Similarly, psychological demand was defined as high when the subject answered yes to at least 2 of the following 3 items: I have to work fast; I have to do several things at once at work; I'm often interrupted at work.

2.4. Covariates

The following covariates were included in this study according to the literature [2,38]: sociodemographic factors (gender, age, social class) and individual risk factors (body mass index [BMI] and participation in sporting activities). The role of these covariates as potential confounders and effect modifiers was investigated.

2.5. Statistical analysis

Variable of interest was defined as the presence of chronic shoulder pain in 1995, for at least 6 months, confirmed by clinical examination, regardless of the pain status in 1990. Possible determinants including psychological or physical dimensions were analyzed in 4 different adjusted models. Model I, using a cross-sectional approach, tested associations between psychological or physical dimensions and CSP in 1995. Model II tested associations between psychological or physical dimensions in 1990 and CSP in 1995 corresponding to a longitudinal design. Model III tested associations between psychological or physical dimensions in 1990 and the onset of CSP from 1990 to 1995. Finally, the model IV tested

associations between psychological or physical dimensions in 1990 and the persistence of CSP from 1990 to 1995. All of these hypotheses were based on a logistic regression model including age, gender, sport, BMI, and social class.

P values for the fixed effect were derived from the Wald test, and the statistical significance level was set at .05. All analyses were performed using STATA version 10.0, and random intercept logistic models were estimated by the xi:logit procedure.

3. Results

This sample comprised 12,714 French workers (65% men) who were seen on 2 occasions. Thirteen percent (n = 1706) reported chronic shoulder pain during the previous 6 months in 1990, and 16% (n = 2089) reported CSP in 1995 (Table 1). The incidence of CSP in 1995 was 11% (n = 1355). Analysis of personal factors in 1995 showed that about 50% of subjects were overweight (BMI $\geqslant$ 25), and 38% had a sporting activity. One half of subjects were clerks (27%) or blue collar workers (25%). Concerning work mechanical factors, about 13% of subjects were considered to be exposed to vibrations, 24% presented a movement constraint, 24% presented a forceful effort constraint, 22% presented a carrying heavy load constraint, and 41% presented a posture constraint. Only 8% presented an effort with tools constraint. Sixty percent of the sample presented exposure to high psychological demand, and 17% presented low decisional latitude.

Bivariate analyses between chronic shoulder pain in 1995 and gender, anthropometric variables, behavioral factors, occupational characteristics, and psychological and physical work environment in 1995 and 1990 are presented in Online Supplement Table E1.

As shown in Table 2, psychological factors (psychological demand and decision latitude) and biomechanical factors (forceful effort and posture) in 1990 (model II) were significantly associated with CSP after adjustment for personal factors. Table 3 (model III) presents the results concerning the associations between personal and work factors in 1990 and incidence of CSP from 1990 to 1995. Physical constraints of posture (odds ratio [OR] = 1.37 95% CI [1.19–1.58]) and forceful effort (OR = 1.24 95% CI [1.04–1.47]), latitude decision (OR = 1.21 95% CI [1.04–1.41]), and the psychological demand factor (OR = 1.23 95% CI [1.08–1.39]) in 1990 were significantly associated with the development of CSP from 1990 to 1995. Table 4 (model IV) presents the results concerning the associations between personal and work factors in 1990 and persistence of CSP from 1990 to 1995. Only physical constraints of posture (OR = 1.26 [1.00 to 1.60]) in 1990 and no psychological factors were significantly associated with recurrence of CSP from 1990 to 1995.

4. Discussion

This study clearly demonstrates that certain work-related psychological and physical factors are associated with chronic shoulder pain. Noteworthy, we showed that mechanical exposure, i.e.,

Table 1
Sociodemographic, occupational, behavioral, anthropometric, psychological, and biomechanical factors in 1990 and 1995 (12,714 subjects).

	1990			1995		
Factors	Median	Range	N (%)	Median	Range	N (%)
Pain						
CSP	–	–	1706 (13.4)	–	–	2089 (16.4)
Incidence of CSP	–	–	–	–	–	1355 (10.7)
Persistence of CSP	–	–	–	–	–	734 (5.8)
Recovery of CSP	–	–	–	–	–	972 (7.6)
Anthropometric factors						
Weight	69.9	35–145	–	72.1	38–145	–
Height	167.5	129–199	–	167.3	131–198	–
Body mass index (weight/height^2)	24.8	14.8–48.0	–	25.6	14.9–46.8	–
Body mass index ($\geqslant$25)	–	–	5529 (43.4)	–	–	6669 (52.5)
Behavioral factor						
Sporting activities	–	–	4790 (37.7)	–	–	4766 (37.5)
Sociodemographic factors						
Sex						
Men			8231 (64.7)			8231 (64.7)
Women			4483 (35.3)			4483 (35.3)
Birth year						
1953	–	–	3525 (27.7)	–	–	3525 (27.7)
1948	–	–	3601 (28.3)	–	–	3601 (28.3)
1943	–	–	3444 (27.1)	–	–	3444 (27.1)
1938	–	–	2144 (16.9)	–	–	2144 (16.9)
Work characteristics						
Social class						
Executives	–	–	711 (5.6)	–	–	711 (5.6)
Artisans	–	–	128 (1.0)	–	–	128 (1.0)
Clerks	–	–	3367 (26.5)	–	–	3367 (26.5)
Blue collar workers	–	–	3227 (25.4)	–	–	3227 (25.4)
Others (intermediate professions)	–	–	5281 (41.5)	–	–	5281 (41.5)
Psychological factors						
High psychological demand	–	–	7431 (58.4)	–	–	7327 (57.6)
Low decision latitude	–	–	2158 (17.0)	–	–	2153 (16.9)
Biomechanical factors						
Forceful effort	–	–	2988 (23.5)	–	–	3066 (24.1)
Effort with tools	–	–	1033 (8.1)	–	–	1091 (8.6)
Heavy loads	–	–	2617 (20.6)	–	–	2763 (21.7)
Movements	–	–	3600 (28.3)	–	–	3083 (24.2)
Posture	–	–	5080 (40.0)	–	–	5193 (40.8)
Vibration	–	–	1664 (13.1)	–	–	1692 (13.3)

CSP = chronic shoulder pain.

Table 2
Associations between sociodemographic, individual, and occupational factors in 1995 (model I) or 1990 (model II) and CSP in 1995: results from logistic regression analyses.

	CSP 1995					
	Factors 1995 (model I)			Factors 1990 (model II)		
	OR	95% CI	*P* value	OR	95% CI	*P* value
Anthropometric factor						
Body mass index (<25/⩾25)	1.02	1.00–1.03	$<10^{-2}$	1.01	0.99–1.02	.11
Behavioral factor						
Sporting activities	0.82	0.74–0.91	$<10^{-3}$	0.87	0.78–0.97	10^{-2}
Sociodemographic factors						
Sex (women/men)	1.79	1.58–2.03	$<10^{-3}$	1.63	1.43–1.85	$<10^{-3}$
Age						
(42/37 y)	1.23	1.07–1.42	$<10^{-2}$	1.18	1.02–1.36	.03
(47/37 y)	1.82	1.59–2.08	$<10^{-3}$	1.66	1.44–1.91	$<10^{-3}$
(52/37 y)	2.34	2.01–2.70	$<10^{-3}$	1.97	1.69–2.29	$<10^{-3}$
Pain status						
CSP	–	–	–	4.49	4.01–5.04	$<10^{-3}$
Work characteristics						
Social class						
(Artisans/executives)	1.20	0.69–2.07	.53	1.23	0.70–2.16	.48
(Clerks/executives)	1.10	0.85–1.44	.46	1.15	0.88–1.51	.30
(Blue collar workers/executives)	1.04	0.81–1.34	.76	1.06	0.81–1.37	.69
(Others [intermediate professions]/executives)	1.09	0.84–1.42	.50	1.18	0.90–1.54	.23
Psychological factors						
High psychological demand	1.17	1.06–1.31	$<10^{-2}$	1.19	1.06–1.32	$<10^{-2}$
Low decision latitude	1.39	1.23–1.58	$<10^{-3}$	1.19	1.04–1.35	10^{-2}
Biomechanical factors						
Forceful effort	1.24	1.07–1.43	$<10^{-2}$	1.21	1.05–1.41	10^{-2}
Effort with tools	1.25	1.05–1.50	10^{-2}	1.00	0.82–1.21	1.00
Heavy loads	1.05	0.91–1.21	.53	1.07	0.92–1.24	.39
Movements	1.07	0.95–1.22	.24	1.07	0.95–1.20	.27
Posture	1.43	1.27–1.61	$<10^{-3}$	1.34	1.19–1.52	$<10^{-3}$
Vibration	1.13	0.97–1.32	.12	1.05	0.90–1.24	.53

CI = confidence interval; CSP = chronic shoulder pain; OR = odds ratio.

Table 3
Associations between sociodemographic, individual factors and occupational factors in 1990 and the incidence of CSP from 1990–1995 (model III): results from logistic regression analyses.

	Incidence of CSP from 1990–1995 (n = 1355)			
	Incident: n (%)	OR	95% CI	*P* value
Anthropometric factor, 1990				
Body mass index (<25/⩾25)	607 (44.8)	1.01	0.99–1.03	.15
Behavioural factor, 1990				
Sporting activities	459 (33.9)	0.91	0.81–1.04	.16
Sociodemographic factors, 1990				
Sex (women/men)	569 (42.0)	1.68	1.44–1.95	$<10^{-3}$
Age				
(42/37 y)	320 (23.6)	1.15	0.97–1.36	.11
(47/37 y)	440 (32.5)	1.85	1.57–2.17	$<10^{-3}$
(52/37 y)	308 (22.7)	2.19	1.83–2.61	$<10^{-3}$
Work characteristics, 1990				
Social class				
(Artisans/executives)	15 (1.1)	1.34	0.73–2.48	.35
(Clerks/executives)	403 (29.7)	1.02	0.75–1.39	.91
(Blue collar workers/executives)	295 (21.8)	0.97	0.72–1.30	.82
(Others [intermediate professions]/executives)	582 (43.0)	1.03	0.75–1.40	.87
Psychosocial factors, 1990				
High psychological demand	820 (60.5)	1.23	1.08–1.39	10^{-2}
Low decision latitude	277 (20.4)	1.21	1.04–1.41	.01
Biomechanical factors, 1990				
Forceful effort	390 (28.8)	1.24	1.04–1.47	.02
Effort with tools	119 (8.8)	0.95	0.76–1.20	.68
Heavy loads	333 (24.6)	1.07	0.90–1.28	.46
Movements	412 (30.4)	1.06	0.90–1.28	.46
Posture	647 (47.7)	1.37	1.19–1.58	$<10^{-3}$
Vibration	181 (13.4)	1.05	0.87–1.27	.61

CI = confidence interval; CSP = chronic shoulder pain; OR = odds ratio.

awkward posture and forceful effort, but also job demand and decision control, were all related to the 5-year incidence of CSP. Mechanical exposure appeared to be the most consistent predictor of CSP.

Table 4
Associations between sociodemographic, individual factors and occupational factors in 1990 and the persistence of CSP from 1990–1995 (model IV): results from logistic regression analyses.

	Persistence of CSP from 1990–1995 (n = 734)			
	Incident: n (%)	OR	95% CI	*P* value
Anthropometric factor, 1990				
Body mass index (<25/⩾25)	345 (47.0)	1.01	0.94–1.04	.49
Behavioral factor, 1990				
Sporting activities	195 (26.6)	0.72	0.58–0.90	$<10^{-2}$
Sociodemographic factors, 1990				
Sex (women/men)	369 (50.3)	1.50	1.17–1.94	$<10^{-2}$
Age				
(42/37 y)	175 (23.8)	1.22	0.89–1.66	.22
(47/37 y)	233 (31.7)	1.16	0.86–1.56	.34
(52/37 y)	214 (29.2)	1.41	1.03–1.92	.03
Work characteristics, 1990				
Social class				
(Artisans/executives)	15 (11.7)	0.77	0.22–2.74	.69
(Clerks/executives)	403 (12.0)	1.36	0.77–2.40	.29
(Blue collar workers/executives)	295 (9.1)	1.29	0.74–2.25	.38
(Others [intermediate professions]/executives)	582 (11.0)	1.17	0.67–2.07	.58
Psychosocial factors, 1990				
High psychological demand	820 (11.0)	1.08	0.87–1.34	.48
Low decision latitude	277 (12.8)	1.12	0.87–1.45	.38
Biomechanical factors, 1990				
Forceful effort	258 (35.1)	1.13	0.86–1.51	.39
Effort with tools	83 (11.3)	1.14	0.79–1.54	.49
Heavy loads	212 (28.9)	1.09	0.81–1.45	.58
Movements	237 (32.3)	1.10	0.87–1.38	.42
Posture	406 (55.3)	1.26	1.00–1.60	.05
Vibration	120 (16.3)	1.07	0.79–1.45	.66

CI = confidence interval; CSP = chronic shoulder pain; OR = odds ratio.

The prevalence of shoulder pain reported in the literature varies between 5% and 47% in the general population [28], increasing up to 70% among occupational populations exposed to shoulder loading work [20,26,28,53]. Miranda et al. reported a prevalence of 7% for chronic shoulder disorder in the general population [34]. Our prevalence of CSP in a working population is consistent with the results reported in the literature.

Job demand and decision control were predictors of CSP at 5-year follow-up. According to a systematic review largely based on cross-sectional studies [5,6,30,32,41,47,51], job demand is the psychological factor most consistently associated with shoulder pain, but no definite conclusions can be drawn in the absence of longitudinal studies. This study clearly demonstrated the role of job demand on the incidence of shoulder pain. Moreover, in contrast with most published studies, decision control was also found to be an equally important predictor of shoulder pain. Low decision control was partly defined by the item: ''my work does not vary''. This single item was significantly associated with the incidence of CSP after adjustment for individual and occupational factors (OR = 1.19 [1.02 to 1.40]) (data not shown). Harkness et al., in a longitudinal study, also found that subjects who perceived their work to be monotonous or boring were at an increased risk of developing new shoulder pain, independently of other work-related factors [17].

The potential mechanisms for these associations between psychosocial factors and risk of shoulder symptoms have not yet been fully elucidated. A central assumption of the psychosocial model is that exposure to high effort-reward imbalance [42] or job strain [23] triggers psychophysiological stress reactions. In the long term, job stress experiences can lead to the development or exacerbation of MSDs via physiological and possibly hormonal mechanisms. Moreover, recent studies have demonstrated the existence of links between repetitive movements and cognitive constraints with physiological modifications of deltoid and trapezius muscles. Mackey et al. showed that women with work-related neck–shoulder complaints had muscle metabolic insufficiencies at rest and during standardized repetitive and stress tasks [31]. Moreover, a study concerning shoulder/neck symptoms showed that low decision latitude acted synergistically with exposure to awkward body positions [7].

We also confirmed that, as expected, mechanical factors (forceful effort and posture) were predictive of CSP at 5 years. The most robust predictor was awkward posture, as this factor was statistically significant for the presence of existing or incident CSP. Three studies [26,34,44] addressing work-related psychosocial factors reported associations over time between shoulder pain and mechanical exposures at work, particularly for lifting heavy loads, awkward upper arm posture, and repetitive forceful movements or vibrations depending on gender and study design. None of these specific physical factors (heavy loads, repetitive movements, or vibration) is associated over time with chronic shoulder pain regardless of gender in the ESTEV study. These discrepancies may be explained by differences in follow-up duration or in the definitions of symptoms (shoulder disorders, symptoms or pain, acute or chronic) and risk factors. Interestingly, in our study, awkward posture found to be predictive of shoulder pain at 5 years in both genders (data not shown) contrary to Leclerc et al. [26], with a 3-year follow-up, who reported this association in women only. The man-specific risk factors in our 5-year follow-up study (forceful effort and awkward posture) are close to those in the 20-year follow-up study by Miranda et al. [34], which showed that repetitive forceful movements and posture were the strongest predictors of shoulder pain in men.

A major strength of this study was in particular the analysis of the other main etiological factors of MSDs. We confirmed a strong effect of age for the development of shoulder pain [16,40]. No age–work variable interactions were significant for the incidence or recurrence of CSP in our study. We also observed similar results to those reported in various studies conducted in working populations [9,15,19,32,37,39,40] related to the fact that women have a higher risk of shoulder or upper-extremity MSDs than men. This sex difference could be due to physiological differences, or to

differences in exposure to constraints at work [15,37] or at home. Sporting activities seem to be a protective factor [35]. Contradictory findings have been reported concerning the association between overweight and shoulder pain [29], and most associations have been found in occupational populations [49].

A number of strengths or limitations of this study need to be discussed. First, the diagnosis of CSP may be questioned, because a number of research reports refer to pain in the cervicobrachial region as a single entity [11,12]. However, because shoulder pain was confirmed by clinical examination, the present study was confined to shoulder pain. Diagnoses derived from physical examination are deemed to be more valid measures of MSDs compared with subjective self-reported pain only [27,52]. In our study, physical examination and subjective self-reports of pain were used to define the outcome of work-related musculoskeletal disorders (WRMSDs). The prospective design of our study allowed us to investigate the chronological order of the predictors and their assumed health effects.

The validity and reliability of exposure data probably constitute a more serious concern. Information was obtained from the worker's response to self-administered questionnaires. Only validated self-administered questionnaires were used to collect occupational characteristics [8,10,48], allowing our findings to be compared with data of the literature. Self-reports yield information that is subject to systematic bias and lack of precision. The possibility of response bias resulting from the subjects' perception of a possible gain or disadvantage in their employment related to their responses to the questions is unlikely in the context of this study. All questionnaires used in the survey were anonymous, and each participant was clearly informed about this aspect. Physical factors can be overestimated by self-administered questionnaires compared with ergonomic tools, although only a few studies have compared these 2 approaches in upper-extremity work-related musculoskeletal disorders [45]. The validity of the information on working conditions obtained by the questionnaire used in this study was controlled by the occupational physician for exposures in 1990. The occupational physician checked the consistency of the subjects' statements with information on the job specification sheet included in the medical file. In the case of disagreement, the worker's opinion prevailed.

The global definition of some physical constrains (vibration and heavy load in particular) may also contribute to explaining the absence of statistical relationships with CSP at 5 years in our study. However, these findings suggested at least that these variables were not major risk factors of chronic shoulder pain when other factors have been taken into account.

The healthy worker effect may have played a role in selection of the study population during the first phase of the survey [24]. A longitudinal study is usually considered to be a good response to this general problem when the percentage of subjects lost to follow-up is not too high. This condition was met in our study because only 13% of subjects were lost to follow-up. Finally, by separating the assessment of factors (in 1990) and the assessment of effects (CSP in 1995), the subject bias was reduced. A recent study did not provide any evidence in support of a differential bias in exposure ratings in studies on musculoskeletal disorders in which subjects reported both exposure and outcome variables [8]. The size of the study population, the study design, and the small proportion of subjects lost to follow-up also minimize the risk of artifacts.

Finally, our study sample may not be entirely representative of the general French working population, although the geographical regions surveyed covered the diversity of socioeconomic conditions observed in France. Sampling rates were based on National Statistics in the 7 regions; we checked that the regional distributions of subjects according to age, sex, and social class did not markedly differ from National Statistics. Moreover, the results of the study were not modified by taking the region effect into account by means of a multilevel model [14]. The high participation rate (88% in 1990, and 87% in 1995), stable for age and sex in all 7 regions, limited the potential bias due to nonparticipation.

4.1. Conclusions

This study emphasizes the multifactorial nature of chronic shoulder pain during a prospective 5-year follow-up in a large representative sample of workers. In particular, our results strongly support the hypothesis that awkward posture is the most robust predictor of chronic shoulder pain. Moreover, decision control, particularly the subject's perception of their work as monotonous, was a more important predictor of CSP than job demand over a 5-year follow-up. Prevention of work-related musculoskeletal disorders must therefore include physical as well as psychosocial factors including decision control.

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Appendix A. Supplementary data

Supplementary data associated with this article can be found, in the online version, at http://dx.doi.org/10.1016/j.pain.2012.07.024.

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