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Are determinants for new and persistent upper limb pain different? An analysis based on anatomical sites

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Abstract.
BACKGROUND: Only few longitudinal studies have explored separately predictors of pain incidence and persistence.
OBJECTIVE: To investigate whether biological, lifestyle, occupational and psychological risk factors for the development of new episodes of upper limb pain (ULP) differ from those for its persistence.
METHODS: Spanish nurses and office workers (1105) were asked at baseline about biological, lifestyle, occupational and psychological risk factors and pain in the past month at six anatomical sites in the upper limb (left and right shoulder, elbow and wrist/hand). At follow up, 12 months later, pain in the past month was again ascertained. Analysis was based on anatomical sites clustered by person. Associations were assessed by multilevel logistic regression models.
RESULTS: Nine hundred and seventy-one participants (87.9%) completed follow-up. Job dissatisfaction and older age carried higher risk of new ULP. Somatising tendency (OR 2.2, 95%CI 1.6–3.1) was the strongest predictor of new ULP, with a risk estimate which differed significantly from that for the same exposure and persistence of ULP. Having adverse beliefs about the work-relatedness of ULP carried a significantly reduced risk for persistence of ULP.
CONCLUSION: Our study provides only limited evidence that risk factors predicting new ULP differ from those predicting its persistence.

Keywords: Upper extremity, musculoskeletal pain, risk factors, body regions

1. Introduction

Upper limb pain (ULP) is one of the most common complaints in people of working age, and a major cause of sickness absence with substantial economic impact in industrialised countries [1, 2]. It can arise from various specific disorders of the arm or neck, but often there is no identifiable underlying pathology [3], and in many cases, the symptom is recurrent or persistent [4]. Its occurrence has been linked with occupational physical activities (in particular repetitive movements and awkward postures); psychosocial aspects of work [5]; various biological factors [6]; and with psychological factors such as,

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low mood, tendency to somatise and negative beliefs about its causation and prognosis [7, 8].

As with low back pain [9], it is possible that factors leading to the development of new episodes of ULP differ from those that determine its persistence. However, only a few longitudinal studies have explored separately the predictors of its incidence and persistence [8, 10]. From the limited research that has been conducted, it might be expected that exposure to repetitive movements of the arm or wrist would be associated with a higher incidence of ULP [7]; that having strong adverse beliefs about the prognosis of ULP would be associated with its persistence [8]; and that somatising tendency would relate to both the incidence and persistence of ULP [8].

Confirmation that risk factors for the incidence of ULP differ from those for its persistence, could have important implications for preventive strategies, and for the management and prognosis of established ULP. It would also raise the possibility that in studies which have examined risk factors for prevalent ULP without distinguishing between new and longstanding pain, the effects of some risk factors may have been diluted and perhaps missed.

We conducted a prospective cohort study in which we explored whether biological, lifestyle, occupational and psychological risk factors for the development of new episodes of ULP differ from those for its persistence. The investigation was part of the international CUPID (Cultural and Psychosocial Influences in Disability) study [11].

2. Methods

2.1. Study population and recruitment of participants

Between November 2007 and February 2010, nursing staff (excluding those from out-patient clinics and paediatric wards) and office workers aged 20–59 years, who had been in their current job for at least 12 months, were recruited from four hospitals and a university in Barcelona. Before recruitment began, approval for the study was obtained from the Parc de Salut Mar Ethics Committee of Barcelona and the Health and Safety Committee of each participating centre. At each centre, a trained member of the staff contacted eligible workers and invited them to take part in the study. Those who agreed gave written informed consent and were then interviewed at their place of work by a member of the research team, who administered a computer-assisted baseline questionnaire. Earlier, this questionnaire had been piloted in a separate group of 30 nurses and office workers to ensure that it was understandable and easy to complete.

The questionnaire was a Spanish translation, checked by independent back-translation, of a survey instrument originally drafted in English for use in the CUPID study [11]. Among other things, it asked about sex; age (in four ten-year bands); height (subsequently dichotomized at the median for each sex); smoking habits; occupation; type of contract (permanent or temporary); years in current job; working hours per week; job satisfaction; job security; occupational activities performed with the upper limb in an average working day; health beliefs about pain in the upper extremity; mental health; somatising tendency; and upper limb pain.

2.2. Work-related physical activity, job dissatisfaction and job insecurity

Subjects were asked whether in an average working day, they: (i) used a keyboard or a typewriter for more than 4 hours in total; (ii) carried out other tasks involving repeated movements of the wrist or fingers more than 4 hours in total; (iii) repeatedly bent and straightened the elbow for more than 1 hour in total; and (iv) worked with their hands above shoulder height for longer than 1 hour in total. Anatomical sites were classed as exposed to relevant work-related physical activity if the subject reported work with hands above shoulder height (shoulders), repeated bending of the elbow (elbows), or either use of a computer keyboard or other repeated movements of the wrist or fingers for longer than four hours (wrist/hand).

Subjects were classed as dissatisfied with their job if they reported that overall they were dissatisfied or very dissatisfied, and were considered exposed to job insecurity if they felt that their employment would be rather or very unsafe if they had a significant illness that kept them off work for three months.

2.3. Health beliefs, mental health and somatising tendency

Questions about health beliefs were adapted from the Fear-Avoidance Beliefs Questionnaire [12], and grouped into three domains concerning the effects of physical activity, work-relatedness and prognosis. Participants were considered to have adverse beliefs about physical activity if they completely agreed or tended to agree that, for someone with arm pain, physical activity should be avoided as it might harm the

arm, and also that rest was needed in order to get better. They were classed as having adverse beliefs about work-relatedness if they completely agreed or tended to agree that arm pain was commonly caused by people's work. And they were deemed to have adverse beliefs about prognosis if they completely agreed or tended to agree that neglecting problems such as arm pain can cause permanent health problems, and also completely disagreed or tended to disagree that arm pain usually gets better within three months.

Mental health was evaluated through the relevant section of the SF-36 questionnaire [13], and scores were grouped in approximate thirds of the overall distribution in the study sample (good, intermediate, poor). Somatising tendency was assessed using a subset of elements from the Brief Symptom Inventory [14], and participants were classified according to the number of common somatic symptoms from a total of five (faintness or dizziness, pains in the heart or chest, nausea or upset stomach, difficulty breathing, and hot or cold spells) that had been at least moderately distressing during the seven days before the baseline interview.

2.4. Upper limb pain

The baseline questionnaire asked about pain in the past month at each of six anatomical sites in the upper limb (right and left shoulder, elbow and wrist/hand), which had lasted for a day or longer. The sites of interest were illustrated in diagrams and the style of questions was similar to that of the Nordic questionnaire [15].

2.5. Follow-up questionnaire

After an interval of 12 months, participants recruited at baseline were re-interviewed with a follow-up questionnaire which used identical questions to ask about pain in the past month at each anatomical site in the upper limb.

2.6. Statistical analysis

Unlike some previous studies [8, 10], in defining whether pain was new or persistent, our study considered not only the part of the arm affected (shoulder, elbow or wrist/hand), but also the laterality of symptoms. Thus, for example, shoulder pain was considered to be new if it had not previously been present in the same shoulder, even if the other shoulder had been affected.

Statistical analysis was carried out with the Generalized Linear Latent and Mixed Models (GLLAMM) [16] program in Stata 11 software [17]. Analysis was based on anatomical sites and the outcome was pain in the past month at follow-up. A site that had been pain-free in the month before baseline was "at risk" of having new pain at follow-up and sites which had been painful in the month before baseline were "at risk" for persistence of pain. To explore biological, lifestyle, occupational and psychological risk factors for: (a) development of new ULP; and (b) persistence of ULP, we fitted multilevel logistic regression models that including all anatomical sites in all subjects, with interaction terms between each risk factor and ULP at baseline to obtain separate risk estimates for incidence and persistence. Associations were summarised by odds ratios (ORs) with their 95% confidence intervals (95% CIs). The interaction terms also allowed assessment of whether the differences between corresponding OR estimates for development of new ULP and persistence of ULP were statistically significant. Initial models included each risk factor separately, together with sex, age (in four ten-year bands) and occupation. Risk factors that were significantly associated with at least one of the two outcomes (i.e. the 95% CI excluded the null value of one) in these first analyses, were then analysed together in a single regression model.

For most analyses, we employed two-level models in which anatomical sites were clustered by person. However, in analyses which included work-related physical activities, we used three-level models that clustered the six anatomical sites within three anatomical areas (right or left shoulder, right or left elbow, right or left wrist/hand), which in turn were clustered by person. We elected to do this because the questions about work-related physical activities did not distinguish which side(s) of the body was involved.

3. Results

At baseline, response rates among those invited to take part in the study were 96% (687) in nurses and 98% (471) in office workers; but, 53 participants were excluded because they fell outside the prescribed age range [11]. After these exclusions, usable information at follow-up was obtained for 971 (87.9%) of the 1105 subjects recruited at baseline. Table 1 shows response rates at follow-up according to various characteristics of participants at baseline. Response rates

Table 1
Characteristics of participants at baseline and response rates at follow-up

Characteristic	Number who completed baseline questionnaire	Number who completed follow-up	Response rate (%)
Sex			
Male	136	124	91.2
Female	969	847	87.4
Age (years)			
20–29	240	196	81.7
30–39	360	318	88.3
40–49	348	315	90.5
50–59	157	142	90.4
Height			
≥ median for sex	589	510	86.6
<median for sex	519	461	88.8
Smoking habits			
Never smoked	491	434	88.3
Former smoker	216	193	90.5
Current smoker	398	344	90.4
Occupation			
Nurse	667	578	86.7
Office worker	438	393	89.7
Contract of employment			
Permanent	928	831	89.6
Temporary	177	140	79.1
Seniority			
5 years or less	327	272	83.2
More than 5 years	778	699	89.9
Working hours per week			
37 hours or less	566	505	89.2
More than 37 hours	539	466	86.5
Job dissatisfaction			
No	996	878	86.7
Yes	109	93	89.7
Job insecurity			
No	935	831	88.2
Yes	170	140	82.4
Adverse beliefs about upper limb pain			
Physical activity	339	294	86.7
Work-relatedness	812	708	87.2
Prognosis	378	323	85.4
Mental Health			
Good	370	323	87.3
Intermediate	356	314	88.2
Poor	379	334	88.1
Number of distressing somatic symptoms in past week			
0	632	556	88.0
1	294	264	89.8
≥2	179	151	84.4
Physical activity in an average working day			
Use of keyboards >4 h	550	493	89.6
Hand/wrist repeated movements >4 h	707	621	87.8
Elbow repeated movements >1 h	1027	905	88.1

Table 1
(*Continued*)

Characteristic	Number who completed baseline questionnaire	Number who completed follow-up	Response rate (%)
Hands above shoulder height >1 h	470	409	87.0
Number of anatomical sites with pain in the upper limb in the last month at baseline			
0	707	598	84.6
1	213	210	98.6
2	126	123	97.6
3	36	27	75.0
4	14	8	57.1
5	3	2	66.7
6	6	3	50.0
All subjects	1105	971	87.9

were consistently greater than 80%, except in subjects who had a temporary employment contract (79%) and those who originally reported pain in the past month at three or more sites in the upper limb (68%).

Among the 5234 anatomical sites which had been free from pain in the past month at baseline, new pain had developed at follow-up in 355 (6.8%). And among the 592 anatomical sites for which pain was reported in the month before baseline, 242 (40.9%) remained painful after 12 months.

Table 2 presents the associations of new ULP and persistence of ULP with biological and lifestyle risk factors assessed at baseline. For new pain, risk was higher in women than in men (OR 1.8, 95%CI 1.1-2.8), increased significantly with age (OR 2.4, 95%CI 1.5–3.7, in the oldest compared with the youngest age bands), and was elevated in former smokers (OR 1.7, 95%CI 1.2–2.4, in comparison with never smokers). However, risk estimates in current smokers were lower than in former smokers. In contrast, no significant association was apparent between persistence of ULP and any of the biological or lifestyle risk factors examined. However, the differences between risk estimates for development of ULP and those for its persistence were not statistically significant.

Associations of the same pain outcomes with occupational risk factors are shown in Table 3. The development of new ULP was associated with job dissatisfaction (OR 1.7, 95%CI 1.1–2.5) and with being a nurse (OR 1.4, 95%CI 1.1–1.9, in comparison with being an office worker). No statistically significant association was observed between development of ULP and exposure to work-related physical activity. As with biological and lifestyle risk factors, none of the occupational risk factors analyzed was significantly associated with ULP persistence. Again, the differences between corresponding risk estimates for the two outcomes were not statistically significant.

Table 4 summarises the relation of psychological risk factors at baseline to subsequent pain outcomes. After adjustment for sex, age and occupation, development of new ULP was strongly associated with somatising tendency (OR 2.2, 95%CI 1.6–3.1, for those reporting multiple distressing somatic symptoms as compared with none), and was more weakly associated with poor mental health (OR 1.4, 95%CI 1.0–1.9, in comparison with good mental health), adverse beliefs about the work-relatedness (OR 1.4, 95%CI 1.0–1.9) and prognosis (OR 1.4, 95%CI 1.0–1.8) of ULP. In contrast, adverse beliefs about the work-relatedness of ULP carried a significantly reduced risk for the persistence of ULP. The associations with adverse beliefs about the work-relatedness of ULP, and with report of one or more distressing somatic symptoms, differed significantly between the two outcomes.

Mutually adjusted risk estimates for the risk factors that had shown significant associations in the univariate analyses presented in Tables 2 to 4 are shown in Table 5. The associations of new ULP with age and somatising tendency both remained highly significant, and weaker associations were still discernible for being a woman, being a former smoker, work as a nurse, job dissatisfaction, poor mental health, adverse beliefs about the work-relatedness of ULP and adverse beliefs about ULP prognosis. The inverse association between strong beliefs about work-relatedness and persistence of ULP was still

Table 2
Baseline biological and lifestyle risk factors for new upper limb pain and persistence of upper limb pain. Analysis based on anatomical sites

	New upper limb pain				Persistence of upper limb pain				
	N[a]	n[b]	OR	(95% CI) [c]	N[a]	n[b]	OR	(95% CI) [c]	*p* value
Sex									
Male	683	26	1		61	18	1		
Female	4551	329	1.8	(1.1–2.8)	531	224	1.9	(0.9–4.1)	0.86
Age									
20–29	1105	49	1		71	25	1		
30–39	1749	106	1.5	(1.0–2.2)	159	55	1.0	(0.5–2.0)	0.32
40–49	1662	132	2.0	(1.3–3.0)	228	99	1.3	(0.7–2.6)	0.31
50–59	718	68	2.4	(1.5–3.7)	134	63	1.5	(0.7–3.1)	0.27
Height									
≥ median for sex	2802	176	1		258	96	1		
< median for sex	2432	179	1.1	(0.8–1.4)	334	146	1.4	(0.9–2.1)	0.58
Smoking habits									
Never smoked	2384	134	1		220	93	1		
Former smoker	1021	94	1.7	(1.2–2.4)	137	52	0.9	(0.5–1.5)	0.03
Current smoker	1829	127	1.4	(1.0–1.9)	235	97	1.1	(0.7–1.7)	0.35
Total	5234	355			592	242			

[a]Number of "at-risk" anatomical sites with exposure to the risk factor. [b]Number of exposed anatomical sites in which the outcome occurred. [c]Each risk factor analysed in a separate two-level (anatomical sites nested within persons) random intercept model that included sex, age (in four ten-year bands) and occupation.

Table 3
Baseline occupational risk factors for new upper limb pain and persistence of upper limb pain. Analysis based on anatomical sites

	New upper limb pain				Persistence of upper limb pain				
	N[a]	n[b]	OR	(95% CI) [c]	N[a]	n[b]	OR	(95% CI) [c]	*p* value
Occupation									
Office workers	2108	118	1		250	90	1		
Nurses	3126	237	1.4	(1.1–1.9)	342	152	1.2	(0.8–1.9)	0.60
Employment contract									
Permanent	4460	312	1		526	219	1		
Temporary	774	43	1.0	(0.7–1.5)	66	23	1.0	(0.5–2.0)	0.93
Seniority									
≤5 years	1514	78	1		118	47	1		
> 5 years	3720	277	1.1	(0.8–1.6)	474	195	0.7	(0.4–1.2)	0.12
Working hours per week									
≤ 37 hours	2743	198	1		287	134	1		
> 37hours	2491	157	0.8	(0.6–1.1)	305	108	0.6	(0.4–1.0)	0.25
Job dissatisfaction									
No	4768	306	1		500	199	1		
Yes	466	49	1.7	(1.1–2.5)	92	43	1.3	(0.7–2.3)	0.47
Job insecurity									
No	4459	308	1		527	216	1		
Yes	775	47	1.0	(0.6–1.4)	65	26	1.2	(0.6–2.3)	0.60
Work-related physical activity									
Not exposed	1497	101	1		189	78	1		
Exposed	3737	254	0.9	(0.6–1.3)	403	164	0.9	(0.5–1.6)	0.96
Total	5234	355			592	242			

[a]Number of "at-risk" anatomical sites with exposure to the risk factor. [b]Number of exposed anatomical sites in which the outcome occurred. [c]Each risk factor analysed in a separate two-level (anatomical sites nested within persons) or three-level (anatomical sites nested within anatomical areas and persons) random intercept models that included sex, age (in four ten-year bands) and occupation.

appreciable, and when we assessed the differences between risk estimates for development of ULP and those for its persistence, only the associations with adverse beliefs about the work-relatedness of ULP remained significant.

4. Discussion

Our study gives only limited support to the hypothesis that risk factors for incident ULP differ from those for its persistence. We found that tendency to

Table 4
Baseline psychological risk factors for new upper limb pain and persistence of upper limb pain. Analysis based on anatomical sites

	New upper limb pain				Persistence of upper limb pain				
	N[a]	n[b]	OR	(95% CI) [c]	N[a]	n[b]	OR	(95% CI) [c]	*p* value
Adverse beliefs about upper limb pain									
Physical activity	1622	108	0.9	(0.7–1.2)	142	57	0.9	(0.5–1.5)	0.91
Work-relatedness	3793	280	1.4	(1.0–1.9)	455	176	0.6	(0.3–0.9)	<0.01
Prognosis	1686	134	1.4	(1.0–1.8)	252	110	1.2	(0.8–1.8)	0.60
Mental health									
Good	1799	113	1		139	63	1		
Intermediate	1687	100	1.0	(0.7–1.3)	197	80	0.9	(0.5–1.5)	0.83
Poor	1748	142	1.4	(1.0–1.9)	256	99	0.8	(0.5–1.3)	0.05
Number of distressing somatic symptoms in past week									
0	3045	157	1		291	122	1		
1	1395	119	1.8	(1.3–2.4)	189	74	0.8	(0.5–1.2)	<0.01
≥2	794	79	2.2	(1.6–3.1)	112	46	1.0	(0.6–1.8)	0.02
Total	5234	355			592	242			

[a]Number of "at-risk" anatomical sites with exposure to the risk factor. [b]Number of exposed anatomical sites in which the outcome occurred. [c]Each risk factor analysed in a separate two-level (anatomical sites nested within persons) random intercept model that included sex, age (in four ten-year bands) and occupation.

Table 5
Multivariate risk estimates for new upper limb pain and persistence of upper limb pain. Analysis based on anatomical sites

	New upper limb pain		Persistence of upper limb pain		
	OR	(95% CI) [a]	OR	(95% CI) [a]	*p* value
Sex					
Male	1		1		
Female	1.5	(1.0–2.5)	2.0	(0.9–4.2)	0.57
Age					
20–29	1		1		
30–39	1.5	(1.0–2.3)	1.1	(0.5–2.2)	0.40
40–49	2.0	(1.3–3.0)	1.4	(0.7–2.9)	0.40
50–59	2.5	(1.6–4.0)	1.5	(0.7–3.3)	0.25
Smoking habits					
Never smoked	1		1		
Former smoker	1.6	(1.1–2.3)	0.9	(0.5–1.5)	0.06
Current smoker	1.3	(1.0–1.8)	1.0	(0.6–1.7)	0.43
Occupation					
Office workers	1		1		
Nurses	1.3	(1.0–1.8)	1.4	(0.9–2.2)	0.80
Job dissatisfaction					
No	1		1		
Yes	1.4	(1.0–2.2)	1.5	(0.8–2.7)	0.93
Adverse beliefs about upper limb pain					
Work-relatedness	1.4	(1.0–2.0)	0.5	(0.3–0.9)	<0.01
Prognosis	1.3	(1.0–1.7)	1.2	(0.8–1.8)	0.73
Mental health					
Good	1		1		
Intermediate	0.8	(0.6–1.1)	0.9	(0.5–1.6)	0.73
Poor	1.1	(0.8–1.5)	0.7	(0.4–1.3)	0.23
Number of distressing somatic symptoms in past week					
0	1		1		
1	1.7	(1.3–2.4)	0.8	(0.5–1.3)	0.01
≥2	2.0	(1.4–2.9)	1.2	(0.7–2.2)	0.14

[a]All risk factors analysed together in a two-level (anatomical sites nested within persons) random intercept model.

somatise was the strongest predictor of new onset of ULP, with a risk estimate which differed significantly from that for the same exposure and persistence of ULP. Likewise, having strong beliefs about the work-relatedness of ULP was differentially associated with the incidence of ULP as compared with its persistence. However, no significant differences in association were found for the other risk factors examined. It is possible that this partly reflected a lack of statistical power.

To address our aim we based our analysis on anatomical sites rather than on individuals. We looked at associations with new ULP among those anatomical sites which had been free from pain at baseline for at least one month, and with the continuing presence of ULP in those anatomical sites which had been painful in the month before baseline. As we had observed previously for low back pain [9], somatising tendency was more strongly associated with the incidence of ULP than with its persistence. Most of the evidence that is available on the role of somatising tendency in non-specific musculoskeletal illness comes from cross-sectional studies [18], making it difficult to discern cause from effect. However, our finding that somatising tendency was a risk factor for subsequent ULP incidence is consistent with two other longitudinal studies [7, 8]. It has been shown that individuals with a tendency to somatise consult a doctor more frequently when they have a new episode of ULP [19], and it seems plausible that people who tend to worry about other common physical symptoms would also have a heightened awareness of, and be more likely to report, ULP.

We also observed that the development of ULP was rather more common in workers who had adverse beliefs about its causation by work and prognosis. Previously, adverse health beliefs about ULP, and especially those concerning prognosis, have been linked with the persistence of pain [8] rather than incidence of new pain. Whether the relationship is with incidence, persistence, or both, it is likely to arise through a nocebo effect [20], analogous to the analgesic effects of a placebo, in which a belief that the treatment will be effective causes it to reduce pain. Pain which is perhaps triggered by physical activities may be rendered more prominent and troublesome in individuals who are concerned that it is being caused by their work or has a poor prognosis. More difficult to explain is the inverse association which was observed between strong beliefs about work-relatedness and persistence of ULP. A careful search of the available literature did not reveal any similar findings in previous studies. It might be that individuals with strong beliefs about the work-relatedness of ULP selectively modify their occupational activities in a way that promotes resolution of symptoms (possibly through a placebo effect). However, there is little evidence to suggest that altering occupational activities can importantly reduce arm symptoms among nurses or office workers. Alternatively, this may have been a chance observation.

The absence of associations with persistence of pain in this cohort of Spanish workers might reflect cultural differences between Spain and other countries where such associations have been observed. It is possible that the effects of negative beliefs about musculoskeletal pain are importantly modified by the behaviours and attitudes that are prevalent in the society in which an individual lives [5, 21, 22]. If so, exposure to such risk factors might produce different coping strategies in relation to pain causation and prognosis which would not necessarily be the same across different cultural settings. We are not suggesting that underlying mechanisms differ between countries, but, that the nature and consequences of health beliefs, and perhaps also somatising tendency, might be different. Theoretical models have postulated that avoidance behaviours related to low back pain are influenced by personal and cultural health beliefs [23]; and we have no reason to believe that for ULP it would be different.

Despite consistent evidence from elsewhere that repetitive work and awkward postures are risk factors for upper limb disorders [1, 6, 7, 10], we found no significant association of work-related physical activity with either the development or persistence of ULP, after adjustment for occupation. This may be explained by limited heterogeneity of exposure to relevant physical activities within each of the two occupational groups assessed. Use of keyboards and exposure to repetitive movements and awkward postures were quite common in both groups.

Women had a significantly higher incidence of new ULP than men, and the risk of developing ULP increased significantly with age. These findings are in agreement with previous studies [6, 10, 24]. Another earlier study suggested that current smoking was associated with the persistence of ULP [4]. However, we were unable to confirm this. We found an increased risk of new ULP among former smokers, but only a weak association was discernible for current smokers. The absence of clear trends in risk across the smoking categories suggests that this could be a chance observation. Nevertheless, it has been

postulated that, even in former smokers, tobacco smoking can cause damage to musculoskeletal tissues through reduced blood flow and hypoxia [25]. If so, this might account for the increased risk of new ULP in ex-smokers. We also found that job dissatisfaction was significantly associated with the development of ULP, although a systematic review by Bongers et al. [26] concluded that job dissatisfaction was not a consistent risk factor for shoulder, elbow or hand/wrist symptoms. Job satisfaction is an attitudinal variable which is influenced, among other things, by workers' expectations about what their job should provide [27], and it is possible that in some circumstances, failure to achieve job expectations produces stress leading to increased musculoskeletal tone, and subsequently to pain [28].

In interpreting our findings, certain strengths and limitations of our study should be considered. As far as we know, this is the first study in a large sample of Spanish workers, which has examined the role of lifestyle, biological, occupational and psychological risk factors for the incidence and persistence of ULP. The longitudinal design, with collection of information at baseline about pain at each of six anatomical locations within the upper limb, allowed us to distinguish new from persistent pain more reliably than in some previous investigations [8, 10]. Also, the response rates, both at baseline [11] and follow-up were high, and response at follow-up differed little in relation to the baseline risk factors of interest. A slightly lower response rate in temporary workers was to be expected, since some temporary contracts would have come to an end during the follow-up period. However, because the number of non-responders was small, this seems unlikely to be an important cause of bias.

The items from the CUPID questionnaire [11], concerning mental health, tendency to somatise and adverse health beliefs, were based on instruments which have previously shown predictive validity [12, 13, 14], and have been used successfully in earlier longitudinal studies related to back [9] and arm pain [8]. Also, questions about upper limb musculoskeletal complaints were similar to those in the Nordic questionnaire [15], which has been considered a useful screening tool with acceptable reliability [29] and sensitivity [30].

Against these strengths, it is possible that workers prone to persistent or recurrent ULP tend to be selected out of work, and therefore were underrepresented in our baseline sample. If so, the absolute risks of pain at follow-up may have been underestimated. Although the validity of internal comparisons and associations with risk factors should not have been compromised by healthy worker selection at baseline, bias could have occurred if participants who were both exposed to risk factors and experienced pain over the study period, were selectively lost to follow-up. As Table 1 indicates, loss to follow-up was somewhat higher (32.2%) among the 59 subjects with pain at three or more anatomical sites at baseline. On the other hand, it was lower in the 339 subjects with pain at one or two sites (1.8%) than in the 707 with no pain at all (15.4%). Nor was attrition substantially higher among workers who were exposed to risk factors at baseline. Thus, we think any such bias will have been minimal.

Also, our definition of a new episode of ULP required that an anatomical site had been free from pain for at least one month before baseline. However, it may be that some of the incident ULP at follow-up was not the first occurrence of pain at the anatomical site in question. It is also possible that some sites which were classed as having persistent pain were free from pain for part of the time between baseline and follow-up, while others with long-term recurrent pain happened not to be painful in the month before follow-up. This may have somewhat obscured associations with persistence of pain. In addition, the information that was collected about pain was not supported by any form of clinical examination or investigation. However, there is evidence that more complex case definitions for upper limb disorders, which include physical findings, produce similar associations with occupational risk factors as simpler definitions based only on symptoms [31].

Our sample was predominantly female, and although risk estimates were adjusted for sex, it is possible that findings would have been different in a largely male population. However, we are not aware of any evidence that sex differentially modifies associations of other risk factors with incidence as compared with persistence of musculoskeletal pain.

Another limitation was the statistical power to detect differences in associations with incidence as compared with persistence of pain. Although the study sample was quite large and we looked at multiple anatomical sites for each participant, confidence intervals indicate that in many cases there was substantial uncertainty in risk estimates, especially for persistence of pain.

In conclusion, our findings provide limited evidence that risk factors predicting the new development of ULP differ from those predicting its

persistence. However, the differences observed are not consistent with the limited evidence that is available from elsewhere, and further research is needed to resolve the outstanding uncertainties. This may be possible using data from the CUPID study that have been collected in other countries. If it is correct that predictors for onset of ULP differ from those for its persistence, there could be important practical implications for primary and secondary prevention. Unlike for low back pain, evidence of the effectiveness of work-related interventions to prevent ULP is scarce [32]. Looking separately at predictors of new and persistent ULP may allow potential targets for workplace preventive interventions to be identified more reliably.

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Conflict of interest

The authors declare that they have no conflict of interest.

Ethical standards

Subjects' written consent was obtained prior to their inclusion in the study according to the Declaration of Helsinki (updated 2008), and the study has been approved by Parc de Salut Mar Ethics Committee of Barcelona and the Health and Safety Committee of each participating centre approved this study.

Authors' contributions

All authors jointly participated in the design of the study and data interpretation. SV-P was responsible of the data collection and wrote the first draft of the manuscript. SV-P, DC, JMM and GN were responsible for the statistical analysis. All authors discussed the results, commented on the manuscript and approved the final version of the manuscript.

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