Role of mechanical and psychosocial factors in the onset of forearm pain: prospective population based study

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Abstract

Objective To determine the aetiology of forearm pain. In particular to determine the relative contribution of (*a*) psychological factors, features of somatisation, and health anxiety and behaviour, (*b*) work related mechanical factors, and (*c*) work related psychosocial factors in the onset of forearm pain.
Design 2 year prospective population based cohort study, with retrospective assessment of exposures at work.
Setting Altrincham, Greater Manchester.
Participants 1953 individuals aged 18-65 years.
Outcome measures Forearm pain of new onset.
Results At follow up, 105 (8.3%) participants reported forearm pain of new onset lasting at least one day in the past month. Among these, 67% also reported shoulder pain, 65% back pain, and 45% chronic widespread pain. Increased risks of onset were associated with high levels of psychological distress (relative risk 2.4, 95% confidence interval 1.5 to 3.8), reporting at least two other somatic symptoms (1.7, 0.95 to 3.0), and high scores on the illness behaviour subscale of the illness attitude scales. The two work related mechanical exposures associated with the highest risk of forearm pain in the future were repetitive movements of the arm (4.1, 1.7 to 10) or wrists (3.4, 1.3 to 8.7), whereas the strongest work related psychosocial risk was dissatisfaction with support from colleagues or supervisors (4.7, 2.2 to 10).
Conclusions Psychological distress, aspects of illness behaviour, and other somatic symptoms are important predictors of onset of forearm pain in addition to work related psychosocial and mechanical factors. Misleading terms such as "cumulative trauma disorder" or "repetitive strain injury," implying a single uniform aetiology, should be avoided.

Introduction

The aetiology of forearm pain, and conditions of which forearm pain is a feature, has been the subject of intensive controversy.[1] Some believe the pain to be integrally related to exposure to physical factors such as frequent repetitive movements of the upper limb, which can be common in some occupational settings. Others believe that the pain is often a regional manifestation of a fibromyalgia-type syndrome, and that it is associated with high levels of psychological distress and features of somatisation. At a workshop in 1997 (sponsored by the United Kingdom Health and Safety Executive) to propose classification criteria for upper limb syndromes that were potentially work related, one of the conditions identified was "diffuse forearm pain."[2] But owing to a lack of appropriately designed studies, little is known about the occurrence (outside the clinic setting) or aetiology of forearm pain. We aimed to determine the relative contribution of (*a*) psychological factors, features of somatisation, and health anxiety and behaviour, (*b*) work related mechanical factors, and (*c*) work related psychosocial factors in the onset of new forearm pain.

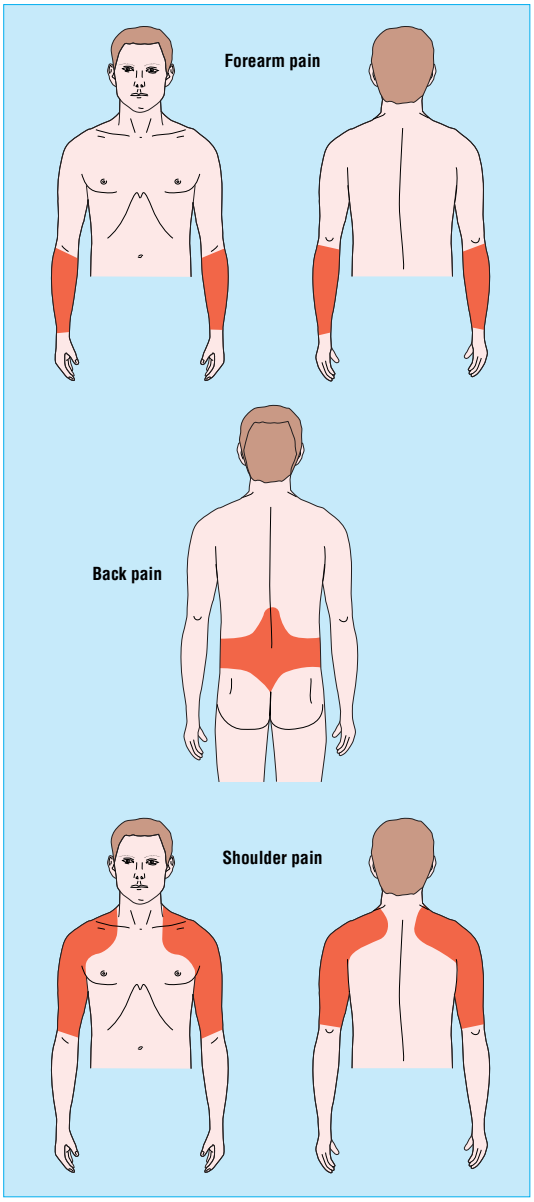
Participants and methods

We conducted a two year prospective population-based cohort study, with retrospective assessment of exposures in the workplace.

Cohort recruitment

Our study population comprised 1953 participants from a cross sectional survey, conducted one year previously. The study has been described in detail.[3] Participants in the original survey were adults aged 18 to 65 years, selected by simple random sampling from the age and sex register of a general practice in Altrincham, Greater Manchester. As over 95% of the United Kingdom population are registered with a general practitioner,[4] this provided a convenient sampling frame for the local population. The sociodemographic characteristics and age and sex structure of the study area were similar to that of the United Kingdom population. The study was approved by the local research ethics committee.

A questionnaire was posted to all participants at baseline, with up to two further questionnaires posted to non-responders. The questionnaire contained a picture of a blank manikin on which respondents were asked to shade the site of any pain experienced during the previous month and lasting at least one day. The information provided by this exercise was coded by using a template, and those respondents who had shaded within the area from the elbow to the wrist were considered to have forearm pain (fig 1). This enabled a cohort of participants free of forearm pain to be identified, and these participants were eligible for follow up. Among participants free of forearm pain, we obtained data on



Definitions of pain according to site shaded

other physical and psychological measures: (*a*) the 12 item general health questionnaire,[5] an instrument that identifies psychological distress; (*b*) the somatic symptom scale,[6] a brief measure of the propensity to present somatic complaints; (*c*) two subscales of the illness attitude scales—health anxiety and illness behaviour,[7] (high scores on the scales indicated, respectively, high levels of health related anxiety and an increased propensity to seek care when experiencing symptoms); and (*d*) other syndromes of regional and widespread pain. We identified participants with low back pain or shoulder pain (experienced during the past month and lasting at least one day) according to the body areas shaded in figure 1. We defined chronic widespread pain according to that used by the American College of Rheumatology criteria for fibromyalgia.[8]

Follow up

At two years follow up we sent a postal questionnaire to those respondents who had been free of forearm pain at baseline. We posted up to two further questionnaires to non-respondents.

Pain status

We inquired about forearm pain experienced during the previous month and lasting at least one day. Among participants reporting forearm pain, we collected further information on date of onset, radiation of the pain to other parts of the upper limb, health seeking behaviour, and whether the pain was associated with disability.

Work related factors

To determine work related mechanical and psychosocial factors experienced at the time of a new onset of forearm pain, we retrospectively assessed exposures at work. We obtained an occupational history for all participants for the entire follow up period. For each job we requested the date of starting and finishing, occupational title, and detailed information on mechanical and psychosocial factors experienced in the job. The questionnaires relating to mechanical and psychosocial factors have been used in previous population studies.[9]

Analysis

Participants free of forearm pain at baseline and who provided data at both baseline and follow up were included in the analyses. The risk of developing forearm pain associated with each factor was calculated with Cox regression models and is expressed as relative risk. The effects of occupational activities on the occurrence of new episodes of forearm pain were analysed by an assessment of those participants who were working during the follow up period. Among those who reported forearm pain at follow up, occupational exposures were defined as those carried out at the time of onset of the pain. Participants who did not develop forearm pain were assigned a dummy date during the follow up year, chosen at random on the basis of the distribution of dates of onset derived from the participants who developed forearm pain. The work related exposures were then assessed by the date of onset of pain (participants with forearm pain) and the dummy date (others). To determine whether an individual exposure or a small group of exposures could reliably identify a group at high risk of developing forearm pain, those factors that on univariate analysis showed a significant risk were selected as candidate variables for entry into forward stepwise Cox regression models, in each of the dimensions considered.

Results

Of the 1953 individuals posted a questionnaire at baseline, 1715 returned a completed questionnaire. Excluding from the denominator those participants who were unlikely to have received the questionnaire (82 no longer at registered address, one dead), the adjusted participation rate was 92%. At two years' follow up, 317 of the original 1715 respondents were not followed up (14 had died, 251 were no longer either registered with the general practitioner or at the registered address, and 52 had reported forearm pain at baseline). The remaining 1398 participants were sent a follow up postal questionnaire. This was

Table 1 Prevalence of forearm pain at follow up

	No of participants		
	Total	With forearm pain	Prevalence (%)
Sex			
Overall	1260	105	8.3
Men	517	46	8.9
Women	743	59	7.9
Age group			
Overall:			
18-39	308	18	5.8
40-59	670	60	9.0
⩾60	282	27	9.6
Men:			
18-39	116	6	5.2
40-59	278	24	8.6
⩾60	123	16	13.0
Women:			
18-39	192	12	6.3
40-59	392	36	9.2
⩾60	159	11	6.9

completed by 1260 participants (adjusted follow up rate of 90%).

The prevalence of forearm pain at follow up was 8.3% (105 participants), with little difference between men and women (table 1). Overall, prevalence increased with age among the men but not the women. Around one third of participants (34%) reporting forearm pain had consulted their general practitioner about the pain, with a similar proportion (35%) having some related disability. Pain was rarely confined only to the forearm region of the upper limb (9%). Pain was also reported in the wrist (61 participants; 66%), hand (42; 45%), and elbow (45; 48%). Regional pain syndromes at other sites were also common among those reporting forearm pain: 67% reported shoulder pain and 65% low back pain whereas 45% satisfied the American College of Rheumatology's definition of chronic widespread pain.

Risk factors

Morbidities

Participants reporting another regional pain syndrome or chronic widespread pain at baseline were at increased risk of reporting new onset of forearm pain at follow up (table 2). Increased risks (twofold or threefold) for developing forearm pain were observed for those with shoulder pain, low back pain, or chronic widespread pain. Table 3 shows the associations of other baseline measurements with forearm pain of new onset. Participants scoring in the middle or highest groups for the general health questionnaire, who reported ever having at least one symptom on the somatic symptom scale or with high scores on the health behaviour subscale of the illness attitude scales, had a significantly increased risk of forearm pain. In contrast, health anxiety showed only a weak, and not significant, relation with onset of symptoms.

Work related mechanical factors

Of the 105 participants with forearm pain at follow up, 42 (40%) reported being in employment at the time of onset of pain. Of the 1155 participants without forearm pain, 740 were in employment on their assigned dummy date. These 782 participants form the subgroup on whom an analysis of the role of work related exposures on the onset of forearm pain was undertaken. Most (84%; 657 participants) reported only one job during the total follow up period; 14% (109) and 2% (n=16) had two and three jobs respectively.

Table 2 Risk of forearm pain at follow up in relation to pain status at baseline

Status at baseline	Forearm pain at follow up		Relative risk (95% CI)
	Yes	No	
Low back pain			
No	79	1056	1.0
Yes	26	99	2.8 (1.8 to 4.3)
Shoulder pain			
No	89	1081	1.0
Yes	16	74	2.1 (1.2 to 3.6)
Chronic widespread pain			
No	79	1045	1.0
Yes	26	110	2.6 (1.6 to 4.0)

*Adjusted for age and sex.

Table 3 Risk of forearm pain at follow up in relation to morbidities or attitudes to illness

Assessment scores at baseline	Forearm pain at follow up		Relative risk (95% CI)*
	Yes	No	
General health questionnaire			
0	36	598	1.0
1-2	26	206	2.1 (1.2 to 3.4)
⩾3	36	241	2.4 (1.5 to 3.8)
Somatic symptom scale			
0	52	677	1.0
1	30	237	1.7 (1.1 to 2.6)
2-5	16	131	1.7 (0.95 to 3.0)
Illness attitude scales			
Health anxiety:			
0-5	24	334	1.0
6-11	35	344	1.4 (0.8 to 2.3)
12-44	39	367	1.4 (0.8 to 2.3)
Illness behaviour:			
0-3	12	348	1.0
4-7	33	356	2.4 (1.3 to 4.7)
8-24	53	341	3.8 (2.0 to 7.1)

*Adjusted for sex and three age groups: 18-39, 40-59, ⩾60.

Moderately increased risks of forearm pain were found for those who reported that for "half or most of the time" in their job they were lifting or carrying weights with one or both hands or pushing or pulling weights (table 4). The two mechanical exposures associated with the highest (and most important) risk of future forearm pain were both related to repetitive movements of the upper limb. The risk associated with repetitive movements of the arms increased from 1.8 (95% confidence interval 0.6 to 5.1) for occasional exposure to 4.1 (1.7 to 10) for exposure "half or most of the time." Similarly, the risks associated with repetitive movements of the wrists were 1.4 (0.4 to 4.2) and 3.4 (1.3 to 8.7) respectively (table 4). No increased risk was associated with typing for more than 30 minutes without a break.

Work related psychosocial factors

The strongest psychosocial factor associated with the onset of forearm pain was related to the level of satisfaction with support from supervisors and colleagues (table 4). Compared with those who were

Table 4 Risk of forearm pain at follow up in relation to occupational mechanical and psychosocial exposures

Baseline exposure	Forearm pain at follow up: Yes	Forearm pain at follow up: No	Relative risk (95% CI)*
Lift or carry weight with one or both hands			
Never	17	337	1.0
Occasionally	14	280	1.0 (0.5 to 2.0)
Half or most of time	10	119	1.7 (0.8 to 3.6)
Push or pull weights			
Never	21	423	1.0
Occasionally	11	216	1.0 (0.5 to 2.1)
Half or most of time	10	95	2.0 (0.96 to 4.3)
Type for 30 minutes without break			
Never	24	418	1.0
Occasionally	11	187	1.0 (0.5 to 2.1)
Half or most of time	7	126	1.0 (0.4 to 2.4)
Repetitive movements of arms			
Never	6	260	1.0
Occasionally	9	212	1.8 (0.6 to 5.1)
Half or most of time	27	265	4.1 (1.7 to 10)
Repetitive movements of wrists			
Never	5	198	1.0
Occasionally	8	222	1.4 (0.4 to 4.2)
Half/most of the time	29	319	3.4 (1.3 to 8.7)
Feel job too hectic or fast			
Never	5	153	1.0
Occasionally	22	351	1.9 (0.7 to 5.0)
Half or most of time	15	237	2.0 (0.7 to 5.6)
Feel job is boring or monotonous			
Never	10	323	1.0
Occasionally	25	327	2.4 (1.2 to 5.0)
Half or most of time	7	90	2.5 (0.95 to 6.6)
Job causes stress or worry			
Never	2	100	1.0
Occasionally	23	377	3.1 (0.7 to 13.1)
Half or most of time	17	264	3.3 (0.7 to 14.2)
Satisfied with support from supervisor or colleagues			
Most of time	10	376	1.0
Half of time	10	186	2.1 (0.9 to 5.1)
Occasionally or never	20	153	4.7 (2.2 to 10)
Feel can learn new things			
Most of time	10	203	1.0
Half of time	3	192	0.3 (0.1 to 1.2)
Occasionally or never	29	343	1.6 (0.8 to 3.3)
Feel can make decisions			
Most of time	26	517	1.0
Half of time	7	135	1.0 (0.4 to 2.4)
Occasionally	9	88	2.0 (0.9 to 4.2)
Feel satisfied with job			
Most of time	26	498	1.0
Half of time	12	163	1.4 (0.7 to 2.8)
Occasionally or never	4	78	1.0 (0.4 to 3.0)

*Adjusted for age and sex.

satisfied most of the time, those who were only occasionally or never satisfied had a risk of 4.7 (2.2 to 10). Participants who believed that they could rarely make their own decisions at work had double the risk of new onset of forearm pain, whereas non-significant increased risks were also observed in those who thought that their job was too hectic (relative risk 2.0), too boring or monotonous (2.5), or caused stress (3.3).

Multivariate model

To ascertain whether, when considered together, a small group of factors collected at baseline could reliably characterise those participants who would develop forearm pain, we conducted further Cox regression analyses by using a forward stepwise model. In the model for mechanical exposures, the only factor entered was repetitive use of the arms, whereas in the model for work related psychosocial factors, only the level of satisfaction with support from supervisor or colleagues was included. The model considering other morbidities and illness attitudes included two factors: high scores on the illness behaviour subscale of the illness attitude scales and high scores on the general health questionnaire. When these four factors were entered into a single multivariate model, all factors remained important independent predictors of the onset of symptoms (table 5). For each participant we calculated the number of factors (among the four in the final model) for which they reported exposure in the highest category. The prevalence of forearm pain increased from 0.4% among those exposed to none of the factors to 15.4% for those reporting all factors.

Table 5 Combined regression model of risk factors for new onset of forearm pain

Exposure	Relative risk (95% CI)
Repetitive movement of arms	
Occasionally	1.2 (0.4 to 3.7)
Half or most of time	2.9 (1.2 to 7.3)
Satisfied with support from supervisor or colleagues	
Half of time	1.6 (0.7 to 3.9)
Occasionally or never	2.6 (1.1 to 5.8)
Illness behaviour score	
4-7	6.6 (1.5 to 29)
8-24	6.6 (1.5 to 29)
General health questionnaire score	
1-2	1.9 (0.8 to 4.5)
⩾3	1.8 (0.8 to 4.1)

Discussion

This is the first population based prospective study, of which we are aware, examining the epidemiology of diffuse forearm pain. Forearm pain is a common symptom, which frequently results in interference with daily activities or consultation to a general practitioner. Forearm pain rarely, however, occurs in isolation. Given its co-occurrence with other syndromes of regional and widespread pain, it is not surprising that the aetiology is similar. Onset was independently related to psychological factors, aspects of illness behaviour, other somatic symptoms, and work related mechanical and psychosocial factors.[9 10] This remained true even when analysis was restricted to those participants with forearm pain or upper limb pain only (data not shown).

The role of mechanical factors in the onset of forearm pain has long been suspected, in particular repetitive movements of the arms and wrists. It is a common symptom in occupations that involve writing or keyboard work, with particularly high exposures.[11] One study of 17 patients diagnosed with "repetitive strain injury" found symptoms and objective signs consistent with a minor polyneuropathy, whereas a group of 29 keyboard workers (most without symptoms) showed early signs of the condition.[12] Other studies have shown vascular abnormalities in affected upper limbs.[13 14]

The onset of forearm pain was not related to mechanical factors alone: high levels of distress and

What is already known on this topic

Several countries have experienced "epidemics" of forearm pain in occupational settings

Little is known about risk factors for onset of forearm pain

What this study adds

High levels of psychological distress, experiencing other somatic symptoms, and aspects of illness behaviour predict onset of forearm pain

In the workplace, repetitive movements of the arms or wrists and adverse psychosocial factors (for example, lack of support from supervisors and colleagues) both predict onset of forearm pain

Forearm pain commonly co-occurs with other regional musculoskeletal pain syndromes

adverse psychosocial factors also predicted the onset of symptoms. The strongest psychosocial predictor was dissatisfaction with support form work supervisors or colleagues, but aspects of demand such as stress, worry, job pace, and level of interest were also associated (although not significantly) with future symptoms. Further, the concept that forearm pain may be one feature of a wider process of somatisation was supported by the observation that participants who developed forearm pain were more likely to report having previously had other somatic symptoms. Similar risk factors have been found for other syndromes of regional pain such as shoulder and back pain, and these are common features of chronic widespread pain and fibromyalgia.[15 16] These observations support the view that in many cases forearm pain may be a regional manifestation of a more widespread pain syndrome.

Our study emphasises the multifactorial nature of forearm pain in the population. It confirms a long suspected relation between work related repetitive movements and onset of forearm pain but also that the onset of symptoms can be predicted by high levels of psychological distress and adverse work related psychosocial experiences. Future studies examining and refining hypotheses about the aetiology of diffuse forearm pain should consider each of these domains, and misleading terms such as "cumulative trauma disorder" or "repetitive strain injury," implying a single uniform cause, should be avoided.

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