EXTENDED REPORT

Predicting the onset of knee pain: results from a 2-year prospective study of new workers

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Objective: To determine the relative contribution of work-related mechanical (injury) factors and psychosocial factors to the onset of a new episode of knee pain, in a cohort of newly employed workers.
Methods: A prospective cohort study of newly employed workers from 12 diverse occupational settings in England (The New Workers Study). 859 newly employed workers, free of knee pain, were identified. Information about occupational mechanical factors (manual handling and postural activities), the occupational physical environment, and psychological and psychosocial factors was collected by self-completion questionnaires. Participants were followed up after 12 and 24 months to identify cases of knee pain onset. Generalised estimating equations were used to estimate the risk of new-onset knee pain, with respect to the exposures previously measured.
Results: In total, over the 2-year follow-up period, 108 cases of new-onset knee pain were observed. Mechanical load, postural factors, psychological distress and work-place psychosocial factors all influenced the risk of new-onset knee pain over the 2-year follow-up period. On multivariate analysis, two factors remained independently predictive of knee pain onset: lifting or carrying heavy weights in one hand, and the level of general psychological distress.
Conclusion: In addition to mechanical (injury) factors, psychological factors are important risk factors for knee pain onset as shown in a population of young newly employed workers.

The knee is one of the most common sites for regional musculoskeletal pain, with around 1 in 5 people in a general adult population reporting knee pain lasting at least 1 day during the past month.[1] Prevalence is higher in women than in men, and increases with age in both sexes.[2] Knee pain, particularly in the elderly, is often associated with degenerative changes, although it is well documented that such degenerative changes correlate poorly with symptoms. In a UK population study, 38% of those with knee pain had no radiographic changes compared with 59% of those without knee pain.[3] Indeed, it is now recognised that, in assessing healthcare needs from musculoskeletal pain, it is more important to focus on symptoms than on radiographic changes.[4]

There is strong evidence that obesity is associated with a high risk of knee pain or knee osteoarthritis, and has a large population-attributable risk.[1 5] However, many of the risk factors studied have been in relation to knee osteoarthritis and have focused on physical (injury) factors—particularly those that are occupationally related. These studies have identified the increased risk associated with, for example, occupational lifting, kneeling and squatting. There is, however, growing evidence in relation to other regional pain syndromes such as back pain, shoulder and forearm pain that, although specific injury factors may have an influence, individual constitutional factors such as psychological distress, health attitudes and beliefs, and psychosocial factors (such as within the workplace) may also be particularly important.[6]

To study the effect of injury and psychological factors on knee pain, a population of young persons would be most suitable, thereby reducing the influence of osteoarthritic change. Secondly, from the perspective of a study in an occupational setting, where injury factors and psychosocial influences might be particularly common, studying persons close to the start of their employment would minimise the ''healthy worker'' effect, whereby those persons who have suffered adverse consequences as a result of their work might have changed jobs or left employment.

The New Workers Study was established with the aim of determining, in a cohort of newly employed workers across a range of industries, the relative contribution of work-related mechanical (injury) factors and psychosocial factors to the onset of four common regional musculoskeletal pain conditions and widespread body pain. We have previously reported data on low back pain,[7] shoulder pain,[8] forearm pain[9] and widespread body pain[10]; the purpose of this analysis is to examine their relative influence with respect to knee pain.

METHODS

The overall study design was a questionnaire-based prospective cohort study of newly employed workers from 12 diverse occupational settings in England, primarily but not exclusively in the northwest region. We chose newly employed workers from a variety of sources that had such ''cohorts'' and, in order to increase generalisability, did not specifically select them because of perceived high risk of musculoskeletal disorders. Newly recruited workers were recruited from three sources: newly opened workplaces (eg, supermarket, postal distribution centre), service organisations recruiting new trainees (eg, police, fire service) and final-year students on vocational degree courses (eg, nurses, dentists). From all baseline (t_0) respondents, a group of individuals who were free of knee pain was identified. These individuals were followed up after 12 months (t_1), and the occurrence of knee pain was assessed. Individuals who remained free of knee pain at this point were then followed up after a further 12 months (t_2) and the occurrence of knee pain was reassessed. New-onset knee pain at t_1 and t_2 was then examined with respect to various mechanical and psychosocial exposures measured at t_0 and t_1, respectively.

Abbreviations: BMI, body mass index; IQR, interquartile range; PAR, population-attributable risk

Baseline assessment (t_0)

Participants were asked to complete a self-administered questionnaire that measured the 1-month period prevalence of knee pain. Thus, subjects were asked whether they had experienced any pain in the past month that had lasted for ⩾1 day. Those who answered positively were asked to shade a four-view body manikin to identify the area of their pain(s). The construct validity of these questions and manikins has been established in previous occupational and non-occupational studies.[11 12] Individuals who indicated that they had knee pain were excluded from follow-up. Information was gathered on individual factors that could influence the onset of knee pain (height and weight, to allow body mass index (BMI) to be derived), and subjects were asked whether they frequently took part in sports activities or other physical activities (such as gardening or other hobbies).

Participants were also asked about a number of potential risk factors for the future development of knee pain.

Occupational mechanical factors—manual handling and postural activities

Participants were asked to provide information regarding a number of manual handling activities that they had performed, at work, during the last working day, including lifting, carrying, pushing or pulling heavy weights. They were also asked to estimate, using a guide, the weight of items they had lifted. In addition, information was gathered about the amount of time spent in a number of different postural positions, including squatting, standing, kneeling, stretching below knee level and bending forward to work in an uncomfortable position: none, <15 min or >15 min. The upper a priori split was used to differentiate those occupations with only brief physical exposures. All questions to gather information on manual handling and postural activities had been previously validated by comparing self-completion responses with direct observation techniques.[13]

Psychological and psychosocial factors

Participants were asked about various aspects of job demands (work pace, stress/worry, whether they found their job monotonous or boring), job control (whether they felt they were able to make their own decisions, or whether they had the opportunity to learn new things) and job support (from colleagues and supervisors), and overall job satisfaction. These questions were based on Karasek's demand–support–control model,[14] and, in a number of other studies, their association with prevalent musculoskeletal pain and their ability to predict new-onset musculoskeletal pain have been shown.[11 15–17] In addition, a level of general psychological distress was ascertained using the General Health Questionnaire.[17]

Follow-up (t_1 and t_2)

Participants free of knee pain at t_0 were eligible for follow-up 12 months subsequently, at t_1. At this time, knee pain (by definition, new-onset knee pain) was measured in the same manner as at baseline, and all baseline exposures were reassessed. After a further 12 months, participants who were free of knee pain at t_1 were followed up and the 1-month prevalence of knee pain was assessed, as before.

Analysis

For analysis, continuous exposure variables were categorised as follows. For manual handling activities, persons were categorised according to the reported weight that was handled (lifted above shoulder level, lifted or carried in two hands, etc) during the last working day: none, less than or more than the median weight. For work-related postures, persons were categorised according to the amount of time they spent in a particular environment (kneeling, bending, etc) during the last working day.

Generalised estimating equations were used to estimate the risk of new-onset knee pain at either follow-up time point, with respect to the exposures measured previously. Thus, exposure data from t_0 were used to predict new-onset knee pain at t_1 and, simultaneously, exposure data from t_1 were used to predict new-onset knee pain at t_2. Results are expressed as relative risks with 95% confidence intervals (95% CI) computed with robust estimates of standard error. All results were adjusted for age, sex, occupational group, BMI and physical activity.

Variables were assessed for the strength of their overall contribution to the univariate prediction models using a Wald test. Those that predicted new-onset knee pain with a significance of $p<0.2$ (after adjusting for age, sex and occupational group) were included in a forward stepwise regression model to establish which risk factors were independently predictive. Variables were included in the final model at $p\leqslant 0.10$ and excluded at $p\geqslant 0.15$. For the multivariate model, variables were selected for the multivariate procedure using both biological and statistical criteria. Thus, if a variable was significantly contributing to the model, but the relationship was biologically implausible, this variable was omitted from the stepwise procedure. All analyses were conducted using Stata V.8.2.

Finally, for the variables included in the final multivariate model, population-attributable risks (PARs) were calculated for each subcohort, and the median PAR (and interquartile range (IQR)) across cohorts presented.

RESULTS

Figure 1 shows the number of participants at each stage. Of the 1081 individuals (median age, 23 years; IQR, 20–27) who completed a baseline questionnaire (91% participation rate), 222 (20.5%) reported knee pain and were therefore ineligible for follow-up. Of the remaining 859 participants, 671 (78.1%) were followed up at t_1, of whom 55 (8.2%) reported (new-onset) knee pain. Then, of the 616 individuals remaining knee pain free, 518 (84.1%) were followed up at t_2, of whom 53 (10.2%) reported knee pain. In total, therefore, there were 108 cases of new-onset knee pain. At both time points, the new-onset rate was highest in army infantry (t_1, 35%; t_2, 22%). No increase in the prevalence of new-onset knee pain with age was found, and men and women were equally likely to report symptoms. Symptom onset was less common in those with BMI in the lowest quartile (<21.3 kg/m^2), but there was no trend of increasing risk with increasing BMI (table 1). As this was a young cohort, most of the participants were physically active; those who were not had a lower risk (which was not statistically significant) of knee pain onset.

The knee pain reported was not trivial in its impact; 41 (38.0%) participants reported that their knee pain had affected their daily activities (either at home or at work), 10 (9.2%) took sick leave as a result of their knee pain, 17 (15.7%) changed some aspect of their job and 32 (29.6%) reported that they had consulted their general practitioner with their pain. In total, 55% of the episodes of knee pain reported in this study resulted either in self-reported functional limitation or in a health service consultation.

Working postures

For none of the working postures examined were those reporting the highest level of exposure at a significantly increased risk of a new onset of knee pain (table 2). Nevertheless, the data suggested increased risks with any level

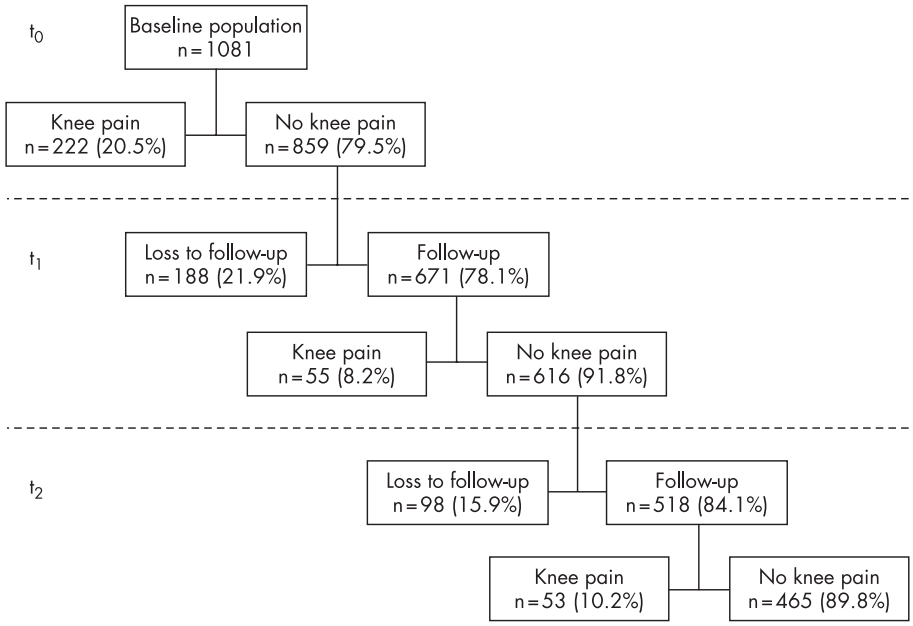

Figure 1 Flow of participants through the study.

of exposure for kneeling at work (relative risks (exposure >15 min) 1.4; 95 % CI 0.8 to 2.3), bending forward to work in an uncomfortable position (1.4; 0.9 to 2.3) and stretching to work below knee level (1.4; 0.7 to 2.7).

Manual handling tasks

Similarly, for none of the manual handling activities assessed were those reporting the highest level of exposure at a statistically significantly increased risk of a new episode of

Table 1 New-onset knee pain in newly appointed workers by age, sex, occupational group, and anthropometrical and lifestyle characteristics

	New-onset knee pain at 1 year			New-onset knee pain at 2 year		
	Yes	No	Difference	Yes	No	Difference
Baseline age (quartiles), years						
16–20	18 (10.5%)	154 (89.5%)		11 (8.5%)	118 (91.5%)	
21–23	11 (6.1%)	169 (98.9%)	χ^2 trend: 3.28,	14 (9.7%)	131 (91.3%)	χ^2 trend: 0.99, p=0.80
24–27	14 (9.9%)	127 (90.1%)	p=0.35	13 (12.3%)	93 (87.7%)	
>27	12 (6.7%)	166 (93.3%)		15 (10.9%)	123 (89.1%)	
Sex						
Male	33 (7.7%)	398 (92.3%)	χ^2: 0.47, p=0.49	38 (11.8%)	283 (88.2%)	χ^2: 2.37, p=0.12
Female	22 (9.2%)	218 (90.8%)		15 (7.6%)	182 (92.4%)	
Occupational group						
Firefighters	10 (9.3%)	98 (70.7%)		13 (14.9%)	74 (85.1%)	
Police	1 (3.1%)	31 (96.9%)		0 (0%)	27 (100%)	
Army officers	3 (8.3%)	33 (91.7%)		3 (13.6%)	19 (86.4%)	
Army infantry	10 (34.5%)	19 (65.5%)		2 (22.2%)	7 (77.8%)	
Army clerks	3 (7.0%)	40 (93.0%)		6 (16.2%)	31 (83.8%)	
Dentists	4 (5.5%)	69 (94.5%)	*	3 (4.5%)	63 (95.5%)	*
Podiatrists	5 (10.2%)	44 (89.8%)		6 (14.6%)	35 (85.4%)	
Nurses	1 (1.6%)	61 (98.4%)		3 (5.8%)	49 (94.2%)	
Foresters	2 (11.1%)	16 (88.9%)		1 (6.3%)	11 (91.7%)	
Retail workers	9 (10.6%)	76 (89.4%)		7 (11.1%)	56 (88.9%)	
Postal workers	1 (2.2%)	45 (97.8%)		5 (17.9%)	23 (82.1%)	
Shipbuilders	6 (6.7%)	84 (93.3%)		4 (5.4%)	70 (94.6%)	
Body mass index (kg/m^2; quartiles)						
<21.3	11 (6.4%)	161 (93.6%)		8 (5.8%)	129 (94.2%)	
21.3–22.8	15 (9.6%)	141 (90.4%)	χ^2 trend: 0.20,	15 (12.6%)	104 (87.4%)	χ^2 trend: 1.07, p=0.30
22.9–25	14 (8.9%)	144 (91.1%)	p=0.66	16 (12.3%)	114 (87.7%)	
>25.0	14 (8.0%)	161 (92.0%)		12 (9.7%)	112 (90.3%)	
Physically active†						
No	3 (4.9%)	58 (95.1%)	χ^2: 0.98, p=0.32	4 (8.0%)	46 (92.0%)	χ^2: 0.32, p=0.57
Yes	52 (8.6%)	554 (91.4%)		49 (10.6%)	415 (89.4%)	

*χ^2 estimate unstable because of low numbers in certain cells.
†Self-report of frequent participation in sports or other physical activities.

Table 2 Relationship between work-related postures and new-onset knee pain among newly appointed workers

	New-onset knee pain at 1 year		New-onset knee pain at 2 years		
	Yes	No	Yes	No	Relative risk* (95% CI)
Sitting at work (last working day)					
None	15 (6.9%)	202 (93.1%)	17 (11.0%)	137 (89.0%)	1.0
<15 min	1 (3.2%)	30 (96.7%)	3 (10.7%)	25 (89.3%)	0.9 (0.3 to 2.6)
>15 min	36 (8.7%)	378 (91.3%)	32 (9.7%)	297 (90.3%)	1.1 (0.7 to 1.8)
Kneeling at work (last working day)					
None	26 (6.4%)	383 (93.6%)	24 (8.4%)	261 (91.6%)	1.0
<15 min	19 (11.1%)	152 (88.9%)	17 (12.0%)	125 (88.0%)	1.5 (0.96 to 2.5)
>15 min	10 (11.5%)	77 (88.5%)	11 (13.1%)	73 (13.1%)	1.4 (0.8 to 2.3)
Squatting at work (last working day)					
None	27 (7.0%)	356 (93.0%)	25 (8.5%)	270 (81.5%)	1.0
<15 min	21 (11.0%)	170 (89.0%)	18 (12.2%)	129 (87.8%)	1.5 (0.9 to 2.3)
>15 min	6 (7.5%)	74 (92.5%)	9 (13.0%)	60 (87.0%)	1.3 (0.6 to 2.1)
Standing at work (last working day)					
None	4 (6.2%)	61 (93.8%)	7 (12.3%)	50 (87.7%)	1.0
<15 min	15 (8.1%)	171 (71.9%)	18 (10.3%)	157 (89.7%)	1.3 (0.7 to 2.6)
>15 min	36 (8.6%)	381 (91.4%)	27 (9.7%)	251 (90.3%)	1.2 (0.6 to 2.3)
Bending forwards at work (last working day)					
None	22 (7.3%)	279 (92.7%)	17 (7.0%)	227 (93.0%)	1.0
<15 min	18 (9.5%)	172 (90.5%)	19 (13.7%)	120 (86.3%)	1.5 (0.98 to 2.4)
>15 min	15 (8.9%)	153 (91.1%)	16 (12.5%)	112 (87.5%)	1.4 (0.9 to 2.3)
Stretching below knee level (last working day)					
None	21 (5.7%)	346 (94.3%)	21 (7.7%)	253 (92.3%)	1.0
<15 min	26 (11.4%)	203 (88.6%)	25 (13.7%)	157 (86.3%)	1.7 (1.1 to 2.6)
>15 min	8 (11.4%)	62 (88.6%)	6 (10.9%)	49 (89.1%)	1.4 (0.7 to 2.7)

*Adjusted for age, sex, occupational group, body mass index and physical activity.

knee pain (table 3). However, some activities for which the data are suggestive of an increased risk were noted—for example, carrying weights of <40 lbs on the shoulders was associated with a 40% increase in the risk of pain onset (RR 1.4; 95% CI 0.9 to 2.4), whereas carrying weights of >40 lbs was associated with a larger increase (1.6; 0.8 to 3.2). Similarly, for carrying heavy weights with either one (1.7; 1.03 to 2.8) or both hands (1.6; 0.9 to 2.7), there was a 60% increase in the risk of future pain onset with the highest level of exposure. For lifting weights (<28 lbs) at or above shoulder level, there was a significantly increased risk for the middle level of exposure (1.8; 1.1 to 2.9), but not for higher weights (0.9; 0.5 to 1.7).

Psychosocial factors

The risk of a new episode of knee pain increased across levels of psychological distress (highest *v* lowest tertile: 1.6; 1.01 to 2.5; table 4). Those who reported their job as monotonous were also at a significantly increased risk (1.7; 1.04 to 2.6). In addition, those who reported that they had little control over their job (1.7; 1.03 to 2.9) or were seldom able to learn new things at work (1.8; 0.8 to 3.9) experienced an increase in the risk of future onset of symptoms.

Multivariate model

Ten factors met the criterion for consideration for the multivariate model. However, one of these factors, lifting or carrying weights above shoulder level, showed an unusual dose–risk relationship—that is, an excess risk in the middle exposure category (RR 1.8), which was significantly higher than the risk at the highest level of exposure (RR 0.9). We examined this in more detail, to see whether individuals who carried lower weights carried them for longer periods, resulting in a high cumulative exposure. However, this was not the case, and analysis of a weight–time product showed similar results (data not shown). We therefore omitted this variable from the stepwise procedure on the basis of the biological implausibility of the dose–risk relationship. Although there were other variables with higher risks in the middle exposure category, they were not statistically significant.

In the multivariate model, two factors remained independently predictive of knee pain onset: lifting or carrying weights in one hand, and general psychological distress (table 5). The onset of knee pain was slightly more likely in the second follow-up period than in the first (1.2; 0.9 to 1.8), although there were no significant time–exposure interactions, suggesting that the effect of these variables did not differ with time.

The median PAR for the mechanical exposure in the final model (lifting with one hand) was 13% (IQR 5–16%), and ranged from 1% in dentists to 32% in firemen. For psychological distress, the median PAR was 15% (IQR 12–18%), and ranged from 8% in army officers to 21% in army clerks.

DISCUSSION

This study of 12 cohorts of newly employed, young workers has shown that knee pain is common (around 1 in 5 persons) across a variety of occupations at the time of starting what was, in most cases, their first full-time employment. Over each of the first 2 years of employment, about 1 in 10 workers who were pain-free at the start of their employment reported a new episode of knee pain. In over half of persons reporting knee pain, this resulted in some disability or consultation with their general practitioner. Load (carrying weights), posture (bending forwards, stretching below knee level), psychological factors (distress) and work-place psychosocial factors (work monotony) all influenced the risk of knee pain. These results have been observed in a young (and therefore pre-osteoarthritis) population—the principal clinical conditions in this age group include chondromalacia and unexplained anterior knee pain.[18]

This study involved newly employed workers, in order to avoid the healthy-worker effect whereby in established workforces those who have suffered ill health (particularly as a result of the work done) are likely to have moved jobs, thus

Table 3 Relationship between work-related manual handling activities and new-onset knee pain among newly appointed workers

	New-onset knee pain at 1 year		New-onset knee pain at 2 years		
	Yes	No	Yes	No	Relative risk* (95% CI)
Lift or carry weights in one hand (if yes, weight split at median†)					
None	19 (5.7%)	314 (94.3%)	16 (6.8%)	220 (93.2%)	1.0
<20 lbs	22 (11.5%)	169 (88.5%)	21 (12.3%)	150 (87.7%)	2.1 (1.3 to 3.2)
>20 lbs	14 (10.1%)	125 (89.9%)	14 (13.9%)	87 (86.1%)	1.7 (1.03 to 2.8)
Lift or carry weights in two hands (if yes, weight split at median†)					
None	22 (7.2%)	284 (92.8%)	16 (6.5%)	230 (93.5%)	1.0
<27 lbs	14 (7.1%)	184 (92.9%)	14 (12.0%)	103 (88.0%)	1.2 (0.7 to 2.1)
>27 lbs	18 (11.8%)	134 (88.2%)	21 (14.4%)	125 (85.6%)	1.6 (0.9 to 2.7)
Carry weights on shoulder (if yes, weight split at median†)					
None	39 (7.2%)	500 (72.8%)	34 (8.3%)	378 (91.7%)	1.0
<40 lbs	8 (10.0%)	72 (90.0%)	11 (15.3%)	61 (84.7%)	1.4 (0.9 to 2.4)
>40 lbs	8 (18.6%)	25 (81.4%)	7 (26.9%)	19 (73.1%)	1.6 (0.8 to 3.2)
Lift weights at or above shoulder level (if yes, weight split at median†)					
None	36 (7.1%)	472 (92.9%)	34 (8.8%)	353 (91.2%)	1.0
<28 lbs	10 (12.0%)	73 (88.0%)	15 (17.4%)	71 (82.6%)	1.8 (1.1 to 2.9)
>28 lbs	8 (11.9%)	59 (88.1%)	3 (8.3%)	33 (91.7%)	0.9 (0.5 to 1.7)
Pushing heavy weights (if yes, weight split at median†)					
None	37 (8.4%)	402 (91.6%)	35 (10.1%)	312 (89.9%)	1.0
<86 lbs	10 (8.8%)	104 (91.2%)	9 (7.8%)	106 (92.2%)	1.1 (0.7 to 1.8)
>86 lbs	6 (5.7%)	99 (94.3%)	8 (16.7%)	40 (83.3%)	1.0 (0.5 to 2.0)
Pull heavy weights (if yes, weight split at median†)					
None	37 (7.4%)	461 (92.6%)	37 (9.3%)	360 (90.7%)	1.0
<66 lbs	9 (10.1%)	80 (89.9%)	6 (9.0%)	61 (91.0%)	1.2 (0.7 to 2.2)
>66 lbs	7 (9.7%)	65 (90.3%)	6 (18.7%)	26 (81.3%)	1.6 (0.9 to 2.9)

Median value of weights differed at t_0 and t_1. Weights split at median at t_0 and at this value at t_1.
*Adjusted for age, sex, occupational group, body mass index and physical activity.
†Exposures recorded for ''last working day''.

making it more difficult to detect risk factors. Further, it was prospective to avoid problems of differential recall among those with and without symptoms. However, there were some methodological issues that are important to consider in interpreting the results.

Firstly, the influence of mechanical factors was relatively modest. Could this be explained by poor measurement of exposure? The questionnaire used was previously validated by comparing responses to the questionnaire with worker observation over the same period.[13] This gave high values for sensitivity and specificity of reporting exposures, including both those that have and those that have not been found to be associated with knee pain in the current study. Secondly, it is possible that persons have developed knee pain during either of the follow-up years and that this had resolved more than 1 month before the next follow-up. If this is the case, and these cases of knee pain have the same aetiology as those detected, then we will have underestimated these effects. We chose not to gather information on these cases of knee pain because, firstly, recall of pain episodes over a long period is poor and, secondly, these episodes, by definition, have been short-lived and are likely to have been less severe. Thirdly, we have not measured prior knee injury. Previous studies in a working population have shown a cumulative incidence of prior knee injury of around 10%,[19] but, given the young age of these working cohorts, the cumulative incidence is likely to be lower. However, among persons with such a history, this is very likely to be associated with an increased risk of a further episode. Fourthly, we have not measured psychosocial factors outside the workplace. Workplace and non-workplace psychological factors are likely to be highly correlated, and identifying one origin of such distress is both difficult and implausible in many cases. Finally, the knee pain reported will vary greatly in terms of ''severity''. Nevertheless, more than half of the episodes of knee pain reported resulted either in self-reported functional limitation or in a health service consultation—which suggests an important clinical problem. When we conducted a supplementary analysis using disabling/consulting episodes as the outcome of interest, the effect of both physical and psychosocial factors was maintained (data not shown).

In terms of the external validity of the study, the participation rates at each of the follow-up stages was high (around 80%), and it is therefore unlikely that the results have been strongly influenced by participation bias. Indeed the prevalence of knee pain reported at baseline is close to those reported among young men aged 16–44 years in a population survey also conducted in Northwest England.[2] We selected a diverse range of occupations rather than occupations that were noted for high rates of particular musculoskeletal disorders such as knee pain. This was done for the following reasons: (a) to increase the generalisability of the study results; (b) the factors that have been noted to be related to specific regional pains are mechanical (injury) factors, and our aim was to measure the relative contribution across a variety of occupations with a range of physical and psychosocial exposures. In particular, it was not our aim in this study to identify specific occupations with high rates of knee pain, but, more usefully, to identify what the particular occupational markers (or risk factors) were for developing symptoms—which may then be the focus for intervention.

In agreement with the results of this study on knee pain, a case–control study of persons wait-listed for surgical treatment of knee osteoarthritis found a significant association with having a job that involved regularly lifting weights of at least 25 kg.[20] The same study also found a relationship with prolonged work-related kneeling and squatting—factors that were, at best, weakly associated with knee pain in the current study. The important role of mechanical load in relation to knee

Table 4 Relationship between psychological and work-related psychosocial factors and new-onset knee pain among newly appointed workers

	New-onset knee pain at 1 year		New-onset knee pain at 2 years		
	Yes	No	Yes	No	Relative risk* (95% CI)
General psychological distress (GHQ tertiles)					
Low	20 (6.4%)	291 (93.6%)	17 (8.5%)	182 (91.5%)	1.0
Medium	13 (7.3%)	165 (92.7%)	24 (13.0%)	161 (87.0%)	1.4 (0.9 to 2.2)
High	22 (12.6%)	153 (87.4%)	12 (9.0%)	121 (91.0%)	1.6 (1.01 to 2.5)
Job satisfaction					
Satisfied	47 (8.1%)	536 (91.9%)	41 (9.8%)	377 (90.2%)	1.0
Neither	6 (10.2%)	53 (89.8%)	7 (11.9%)	52 (88.1%)	1.2 (0.7 to 2.2)
Dissatisfied	2 (9.5%)	19 (90.5%)	4 (14.8%)	23 (85.2%)	1.4 (0.6 to 3.0)
Job monotonous or repetitive					
Rarely	46 (7.9%)	533 (92.1%)	37 (8.8%)	384 (91.2%)	1.0
>Half the time	9 (10.7%)	75 (89.3%)	15 (18.1%)	68 (81.9%)	1.7 (1.04 to 2.6)
Job hectic					
Rarely	38 (8.2%)	428 (91.8%)	36 (9.6%)	340 (90.4%)	1.0
>Half the time	17 (8.6%)	181 (91.4%)	16 (11.9%)	119 (88.1%)	1.1 (0.7 to 1.6)
Job stressful					
Rarely	42 (8.2%)	472 (91.8%)	43 (10.1%)	382 (89.9%)	1.0
>Half the time	13 (8.7%)	137 (91.3%)	9 (10.5%)	77 (89.5%)	1.2 (0.8 to 1.9)
Have control over job					
Often	30 (7.1%)	391 (92.9%)	32 (8.4%)	347 (91.6%)	1.0
Sometimes	15 (8.8%)	155 (91.2%)	15 (13.8%)	94 (86.2%)	1.4 (0.9 to 2.0)
Seldom	10 (14.5%)	59 (85.5%)	5 (22.7%)	17 (77.3%)	1.7 (1.03 to 2.9)
Able to learn new things at work					
Often	45 (8.1%)	509 (91.9%)	33 (8.6%)	350 (91.4%)	1.0
Sometimes	8 (10.5%)	68 (89.5%)	11 (12.2%)	79 (87.8%)	1.3 (0.7 to 2.2)
Seldom	2 (5.7%)	33 (94.3%)	8 (21.1%)	30 (78.9%)	1.8 (0.8 to 3.9)
Satisfied with the amount of support from colleagues					
Satisfied	49 (8.3%)	541 (91.7%)	43 (10.2%)	380 (89.8%)	1.0
Neither	6 (8.5%)	57 (90.5%)	7 (10.3%)	61 (89.7%)	1.3 (0.7 to 2.2)
Dissatisfied	0 (0%)	9 (100%)	2 (10.5%)	17 (89.5%)	0.8 (0.2 to 3.3)

GHQ, general health questionnaire.
*Adjusted for age, sex, occupational group, body mass index and physical activity.

pain was also reported in a study of 113 nursing staff members in a United States Veterans' hospital.[21] A large cohort study of forestry workers in Finland found that a high lifting index score (composed of weight and frequency) predicted onset, whereas frequent twisting movements and lack of job satisfaction predicted persistence.[19] Interestingly, as with this study, the relationships with physical factors were not monotonic, with the highest risk being noted in the ''middle exposure'' categories. Other studies have noted particularly high rates of knee pain in certain occupations (such as carpenters, miners and construction workers) and concluded that this was likely to be as a result of knee bending and heavy lifting.[22] The current study adds to these data by showing psychological distress as a risk factor for onset. In addition, this study has found similar, albeit rather modest, PARs overall for the mechanical and psychological influences on knee pain.

Table 5 Multivariate model: predictors of knee pain onset

	Relative risk* (95% CI)
Lift or carry weights in one hand (if yes, weight split at median†)	
None	1.0
<20 lbs	2.1 (1.3 to 3.2)
>20 lbs	1.7 (1.03 to 2.8)
General psychological distress (GHQ—tertiles)	
Low	1.0
Medium	1.5 (0.9 to 2.3)
High	1.6 (1.02 to 2.6)

GHQ, general health questionnaire.
The median value of weights differed at t_0 and t_1. Weights split at the median at t_0 and at this value at t_1.
*Adjusted for age, sex, occupational group, height, weight, body mass index and physical activity;
†Exposures recorded for ''last working day''.

The results from this study can be compared with data from the same study, reported on the predictors of other regional pain syndromes: low back, shoulder and forearm pain.[7–9] These have all shown relationships with mechanical load, posture or repetitive movement, although the specific risk factors identified varied between regional pains. For example, forearm pain was most strongly related to repetitive movements of the wrists and forearm; shoulder pain was associated with a variety of manual handling activities and with working with hands above shoulder level, whereas back pain was related to lifting weights above shoulder level and pushing or pulling heavy weights.

The relationship with psychological and psychosocial factors is more consistent than mechanical factors across the different sites of regional pain. Perception of work as monotonous was significantly related to the onset of knee pain in this study, and a similar finding has been reported for each of the other three regional pains about which information was collected. Whether this is as a result of being related to physically repetitive jobs, or jobs with little mental stimulation, or whether it is an effect at the individual level of perception irrespective of the actual nature of the job is unclear at present. Studies are under way to further understand the mechanisms underlying the consistent

evidence that is emerging. For other psychosocial factors, the evidence is less consistent across regional pains. Forearm pain was linked to lack of job autonomy, back pain to lack of colleague support and not learning new things, and shoulder pain was not related to any additional psychological factors.[7–9] In this analysis, risk of future knee pain was also related to prior psychological distress and reports of not learning new things at work.

How can the results from this study contribute to the prevention of musculoskeletal pain in the workplace? Firstly, it adds to the evidence for the role (albeit modest) of workplace mechanical influences on the onset of musculoskeletal pain. This is further emphasised also by the high prevalence of knee pain even before young persons join the workplace. Secondly, it has also shown that psychological and psychosocial influences are as important for knee pain as other major regional pain syndromes. However, before we can hope to use this knowledge in trials of prevention, we first need to understand the mechanism by which these psychosocial factors are related to a high prevalence of knee and other musculoskeletal pains.

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