Interactions between physical and psychosocial risk factors at work increase the risk of back disorders: an epidemiological approach

J Jason Devereux, Peter W Buckle, Ioannis G Vlachonikolis

Abstract

Objectives—To investigate the possible interactions between physical and psychosocial risk factors at work that may be associated with self reported back disorders.

Methods—891 of 1514 manual workers, delivery drivers, technicians, customer services computer operators, and general office staff reported risk factors at work and back disorders with a self administered questionnaire (59% return rate). Of the 869 respondents with a valid questionnaire, 638 workers were classified in to one of four exposure groups: high physical and high psychosocial; high physical and low psychosocial; low physical and high psychosocial; and low physical and low psychosocial. Low physical and low psychosocial was used as an internal reference group. The exposure criteria were derived from existing epidemiological publications and models for physical and psychosocial work factors. The frequency and amplitude of lifting and the duration spent sitting while experiencing vibration were used as physical exposure criteria. Ordinal values of mental demands, job control, and social support from managers and coworkers were used as psychosocial exposure criteria.

Results—The highest increase in risk was found in the high physical and high psychosocial exposure group for symptoms of back disorders. In the crude and multivariate analyses, a departure from an additive risk model was found for the 7 day prevalence of symptoms of a low back disorder and also for a recurrent back disorder not present before the current job but also experienced in the past 7 days.

Conclusion—This study suggests that an interaction between physical and psychosocial risk factors at work may exist to increase the risk of self reported back disorders. Ergonomic prevention strategies that aim to minimise the risks of symptoms of work related back disorders should not only focus on physical but also on psychosocial risk factors at work. The greatest benefits are likely to be realised when both physical and psychosocial factors are put right.

Keywords: low back pain; epidemiology, manual work, psychosocial work factors

Recent literature reviews have shown that workplace factors may be determinants of back disorders. A common framework in these reviews dichotomises workplace factors into physical and psychosocial factors. Physical risk factors at work have included heavy manual work, frequent lifting or carrying, whole body vibration, frequent bending and twisting, and static work postures. Psychosocial risk factors at work have included perceived high pressure on time and workload, low job control, job dissatisfaction, monotonous work, and low support from coworkers and management.

The relative importance of physical and psychosocial risk factors at work in the aetiology of back disorders has not yet been established. Some of the more recent epidemiological studies have simultaneously investigated physical and psychosocial work factors and back disorders. The methods of these studies have primarily aimed at identifying the independent effects of each set of factors upon back problems. However, physical and psychosocial work factors coexist and may potentially interact to increase the risk. These possible effects of interaction between physical and psychosocial risk factors at work and work related musculoskeletal disorders have not been satisfactorily investigated. The aim of this study was, therefore, to investigate the potential interaction between these work related risk factors and self reported back disorders.

In publications on epidemiology, interactions have been defined as a departure from a multiplicative or an additive risk model when exposed to both determinants of disease. The decision about which model to use should ideally be based upon the biological mechanism under investigation. However, the biological mechanisms of back disorders and other work related musculoskeletal disorders are not sufficiently understood to enable such a choice to be made, although this does not imply that the choice can be selected arbitrarily. Koopman showed that additive and multiplicative models may be inconsistent with each other when modelling interactions between determinants of disease—for example, no interaction in a multiplicative model may imply a positive interaction with an additive model. The choice of epidemiological risk model should, therefore, not be arbitrary. Deviations from an additive model should be assessed for measuring interaction between determinants for public health concerns even when such data agree with a multiplicative model without interaction.
We designed an epidemiological study, with an additive risk model, to study whether an interaction was present between physical and psychosocial factors at work that increased the risk of back disorders. The potential existence of such interactions could be important in reducing ergonomic risks in the workplace.

**Material and methods**

The study population comprised 1514 male and female workers from 26 randomly selected sites of a United Kingdom company. Manual workers, delivery drivers, customer service queries workers, computer workers, and general office staff completed a self-administered questionnaire covering personal data and demographics, physical and psychosocial work factors, and musculoskeletal symptoms. The questions on physical work factors refer to current day exposures, which have been validated in a study comparing self-reported responses with instrument recordings. Most of the physical factor questions had a χ coefficient ≥0.4 (except for stooped back posture and trunk rotation). The questions on psychosocial work factors have been validated in a study on the internal consistency of all the psychosocial factors. Acceptable internal consistency α coefficients between 0.65–0.95 were reported.

Data on job title, age, and sex were obtained for each worker in the study population from personnel records to compare survey respondents and non-respondents. The prevalence of back disorders was obtained from company medical severance data over a 5 year period to investigate any potential healthy worker effects. Permission for the cross sectional epidemiological study was obtained from the University of Surrey committee on ethics.

**EXPOSURE CLASSIFICATION**

Each worker responding to the cross sectional survey was classified for physical and psychosocial exposure. The four exposure groups were: low physical exposure—low psychosocial exposure; low physical exposure—high psychosocial exposure; high physical exposure—low psychosocial exposure; high physical exposure—high psychosocial exposure.

Each worker that satisfied the criteria of one of four exposure groups was classified in that group. A worker could not be classified into more than one exposure group. Workers in the low physical—low psychosocial exposure group served as an internal reference population for the other three exposure groups.

Each of the survey respondents were classified into one of two psychosocial exposure strata, high or low, and three physical exposure strata, low, high, and undefined. Workers that did not satisfy the criteria for classification into the low or high physical exposure group were classified into the undefined group. The undefined group represents workers who may have relatively high levels of physical exposure compared with the low physical exposure group but do not satisfy the criteria for high physical exposure classification. Also the undefined group would be subject to the greatest degree of self reported bias and could not be classified into a low or high physical exposure group with confidence as the true exposure classification was unclear. This is because self reported questionnaires used for collecting physical exposure data have been shown to have poor validity and reliability but are able to differentiate between low and high exposure groups. So to minimise self reported bias that may result in exposure misclassification and underestimation of risk, workers with only low and high physical exposures were used for comparison.

Workers classified into the undefined group were excluded from the analysis of risk. To compare covariates between workers in the undefined and the exposure classified groups the age, sex, years of exposure, and outcome characteristics of those workers included in the risk analysis were compared with the total survey response population.

The exposure criteria were predetermined from a contemporary musculoskeletal disorder model and also from epidemiological studies that provided a measure of risk for physical and psychosocial work factors associated with back disorders (up to 1995).

**Derivation of the physical exposure criteria**

Lifting >18 kg has been associated with an increased risk (>2) of low back disorders. This was used as the basis for the first criterion for high physical exposure. Lifting a lower weight (4.5–11.3 kg) very often (once a minute to 25 times a day) has also been associated with an increased risk. This was used as the basis for the first term in the second exposure criterion for high physical exposure. Armstrong et al suggested that it is reasonable that exposure to two known risk factors may additively or multiplicatively increase the risk. Therefore, it is reasonable to suggest that a worker performing light lifting often, and also being exposed to whole body vibration while sitting for a large portion of the day may have an increased risk of experiencing a back disorder. Heavy lifting alone performed often may provide an exposure sufficient to increase the risk of low back disorders without any other exposure present. This rationale was used to formulate the following Boolean algebra expression for high physical exposure criteria from the questionnaire markers (appendix).

**High physical exposure criteria:**

Lifting >16 kg ≥1–10 times an hour (criterion 1)

or

Lifting 6–15 kg 1–10 times an hour and experiencing vibration while sitting ≥half the working day (criterion 2).
Factors at work increase the risk of back disorders

Table 1  Items and scales used for mental demands, job control, and social support

<table>
<thead>
<tr>
<th>Mental demands (5 questions):</th>
<th>1=Strongly agree, 2=Slightly agree, 3=Slightly disagree, 4=Strongly disagree</th>
</tr>
</thead>
<tbody>
<tr>
<td>a My job requires a great deal of concentration</td>
<td></td>
</tr>
<tr>
<td>b My job requires me to remember many different things</td>
<td></td>
</tr>
<tr>
<td>c I must keep my mind on my work at all times</td>
<td></td>
</tr>
<tr>
<td>d I can take it easy and still get my work done</td>
<td></td>
</tr>
<tr>
<td>e I can let my mind wander and still do the work</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Job control (6 questions):</th>
<th>1=Very little, 2=Little, 3=A moderate amount, 4=Much, 5=Very much</th>
</tr>
</thead>
<tbody>
<tr>
<td>a How much influence do you have over the variety of tasks you perform?</td>
<td></td>
</tr>
<tr>
<td>b How much influence do you have over the order in which you perform tasks at work?</td>
<td></td>
</tr>
<tr>
<td>c How much influence do you have over the pace of your work, that is how fast or slow do you work?</td>
<td></td>
</tr>
<tr>
<td>d How much influence do you have over the decisions concerning which individuals in your work unit do which tasks?</td>
<td></td>
</tr>
<tr>
<td>e How much influence do you have over the decisions as to when things will be done in your work unit?</td>
<td></td>
</tr>
<tr>
<td>f How much do you influence the policies, procedures and performance in your work unit?</td>
<td></td>
</tr>
</tbody>
</table>

Social support (6 questions):

f How much can each of these people be relied on when things get tough at work? Other people at work.
e How much can you count on your immediate supervisor when things get tough at work?
d How easy is it to talk with each of the following people? Other people at work.
c How easy is it to talk with each of the following people? Your immediate supervisor.
b How much do each of these people go out of their way to do things to make your work life easier for you? Your immediate supervisor.
a How much do each of these people go out of their way to do things to make your work life easier for you? Other people at work.

1=Very much, 2=Somewhat, 3=A little, 4=Not at all, 5=Don’t have any such person

Table 2  The number of subjects classified into each exposure group and the number of subjects unclassified

<table>
<thead>
<tr>
<th>Physical exposure</th>
<th>Psychosocial exposure</th>
<th>Totals</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Low</td>
<td>High</td>
</tr>
<tr>
<td>High</td>
<td>183</td>
<td>185</td>
</tr>
<tr>
<td>Low</td>
<td>147</td>
<td>123</td>
</tr>
<tr>
<td>Subtotal</td>
<td>330</td>
<td>308</td>
</tr>
<tr>
<td>Unclassified</td>
<td>71</td>
<td>109</td>
</tr>
<tr>
<td>Total</td>
<td>401</td>
<td>417</td>
</tr>
</tbody>
</table>
1, 2, or 3. People not meeting the criteria were classified as being exposed to high job control.

A person had to have experienced low support from either the supervisor or coworkers to be considered exposed to low social support. To be exposed to low supervisor support, items a, c, and e had to be answered on the support scale as 2, 3, 4, or 5. People not meeting this criterion were classified as exposed to high supervisor support. To be exposed to low coworker support items b, d, and f had to be answered on the support scale as 2, 3, 4, or 5 also. People not meeting this criterion were classified as exposed to high coworker support.

DEFINITION OF OUTCOMES
Back disorders were defined by the prevalence of aches, pain, and discomfort of the lower back within the past 7 days and also the past 12 months. A study has validated these outcome measures against a physical examination with a symptom classification scheme proposed by Nachemson and Andersson in 1982.44

Recurrent back disorders were defined as: having experienced problems >3 times or for >1 week in the previous year,27 31 45 not experienced before starting the present job, which were also present within the past 7 days at the time of the survey.

STATISTICAL ANALYSES
The crude odds ratios (ORs) and prevalence rate ratios were estimated for each exposure group with Epi Info 6.

Unconditional multiple logistic regression techniques (SPSS) were used to estimate the ORs for self reported back disorders and each exposure group after controlling for age, sex, and cumulative exposure (years spent in the present job). The maximum likelihood estimates of model variables for the prevalence proportion ratios were obtained with GLIM.46

Variables for the exposure terms were coded 0 for low exposure and 1 for high exposure. Indicator terms for age and sex were coded 0 for references (<40 years and women respectively) and 1 (>40 years and men respectively). Two binary indicator variables were used for the cumulative exposure variable with 3 strata (<6 years, 6–15 years and >15 years). Separate

Table 3  Site combined age and cumulative exposure for each sex across exposure groups

<table>
<thead>
<tr>
<th>Exposure</th>
<th>Low physical, low psychosocial</th>
<th>Low physical, high psychosocial</th>
<th>High physical, low psychosocial</th>
<th>High physical, high psychosocial</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sex (n):</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Men</td>
<td>64</td>
<td>53</td>
<td>180</td>
<td>177</td>
</tr>
<tr>
<td>Women</td>
<td>58</td>
<td>63</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Age (y, median (interquartile range)):</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Women</td>
<td>31–35 (26–45)</td>
<td>36–40 (26–50)</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td>Duration of the job (y, mean (SD)):</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Men</td>
<td>9.9 (10.2)</td>
<td>5.8 (8.3)</td>
<td>6.4 (7.5)</td>
<td>7.1 (8.1)</td>
</tr>
<tr>
<td>Women</td>
<td>7.1 (9.1)</td>
<td>6.9 (9.3)</td>
<td>—</td>
<td>—</td>
</tr>
</tbody>
</table>

Table 4  Prevalence of self reported back pain /100 workers

<table>
<thead>
<tr>
<th>Prevalence</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Recurrent back problems lasting &gt;1 week or occurring &gt;3 times in the past year*</td>
<td>39</td>
</tr>
<tr>
<td>Prevalence of low back pain in the past 7 days</td>
<td>49</td>
</tr>
<tr>
<td>Prevalence of low back pain in the past 12 months</td>
<td>61</td>
</tr>
<tr>
<td>Recurrent back problems not experienced before the present job and also experienced in the past 7 days</td>
<td>23</td>
</tr>
</tbody>
</table>

Figure 1  The prevalence (%) of self reported recurrent back disorders by intensity, duration, and time of onset.
Factors at work increase the risk of back disorders

Table 5 Site combined age and cumulative exposure for each sex across exposure groups

<table>
<thead>
<tr>
<th>Exposure</th>
<th>Male and female population:</th>
<th>Male population only:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Low physical, low psychosocial</td>
<td>Crude OR (95% CI) 1.00</td>
<td>Crude OR (95% CI) 1.00</td>
</tr>
<tr>
<td>Low physical, high psychosocial</td>
<td>1.2 (0.72 to 2.01)</td>
<td>1.4 (0.65 to 2.99)</td>
</tr>
<tr>
<td>High physical, low psychosocial</td>
<td>1.33 (0.84 to 2.12)</td>
<td>1.4 (0.65 to 2.99)</td>
</tr>
<tr>
<td>High physical, high psychosocial</td>
<td>2.41 (1.51 to 3.85)***</td>
<td>2.80 (1.48 to 5.35)***</td>
</tr>
</tbody>
</table>

* p<0.05; ** p<0.01; *** p<0.001; **** p<0.0001.
Male population only

A separate analysis of the data for men only (table 5) showed a similar trend as for the mixed sex population analysis. The crude risk measures for both musculoskeletal outcomes indicated a higher risk for the high physical exposure groups than the low physical—low psychosocial exposure group. The risk was greatest for the high physical—high psychosocial exposure group and was significant (p<0.001) for the 7 day prevalence of low back pain (OR 2.97 95%CI 1.58 to 5.62); and recurrent back disorders not present before the current job and also present within the past 7 days (OR 3.58 95% CI 1.99 to 6.77).

MODELLING

Mixed sex population

The exposure variables in the logistic regression analysis (table 6) for the 7 day prevalence of back pain were similar to the crude ORs. Sex, age, and years in the job were not found to be important effect modifiers for this outcome. The only variable producing a 95% CI >1 was high physical—high psychosocial exposure (OR 2.35 95%CI 1.36 to 4.05).

For recurrent back problems not present before the present job and experienced within the past 7 days (table 7), being exposed to high physical exposure resulted in increased risks that were confident at the 95% level. The risk was greatest, however, for those workers exposed to high physical and high psychosocial exposure. The risk also increased with the increasing number of years spent in this employment (ORs 2.86–3.67). Being >40 years old reduced the risks of recurrent back problems with the 95% CI <1.

Male population only

For low back pain experienced in the past 7 days (table 8), high physical—high psychosocial exposure was the only variable that had 95% CIs >1. An OR of 2.8 (95% CI 1.51 to 5.19) was present for this exposure group. The risk was highest for the high physical exposure groups as in the crude ORs.

CRUDE ANALYSIS

Mixed sex population

For the mixed sex population, the crude risk measures for both musculoskeletal outcomes (table 5) indicated an increased risk for each exposure group compared with low physical—low psychosocial exposure, although the increased risk was greatest for the high physical—high psychosocial exposure group. The ORs for high physical—high psychosocial exposure was significant for the 7 day prevalence of low back pain (OR 2.41 95% confidence interval (95% CI) 1.51 to 3.85) and also for recurrent back

INTERACTIONS

The proportion of disease (adjusted ORs) among those with high exposures to both physical and psychosocial factors that was attributable to their interaction (fig 3) was greater for low back disorders experienced in...
Factors at work increase the risk of back disorders

The greatest risk associated with self reported back disorders was from high exposure to both physical and psychosocial work factors. Physical or psychosocial work factors acting in the relative absence of the other also increased the risk of these disorders. The combination of high physical exposure and low psychosocial exposure increased the risk of recurrent back disorders in the mixed sex population (adjusted OR 2.38, 95% CI 1.13 to 4.99) indicating that physical risk factors at work acting relatively independently may increase risks. Tentative associations for exposure to low physical—high psychosocial exposure and musculoskeletal disorders were found.

Men who had been exposed for \( \geq 6 \) years in highly physical jobs involving manual work and driving had an increased risk of recurrent back problems (ORs 2.84–4.13). Cumulative exposure has been shown to increase the risk of work related musculoskeletal disorders in other studies. A cross sectional study showed that 10 years of professional driving incurred a risk of self reported neck and back pain (OR 3.43, 95% CI 1.5 to 7.81) and the risk increased non-linearly with an increase in \( \geq 10 \) years of driving. As in this study, other studies have found that age seemed to be unrelated to back and neck pain. Baseline data from a longitudinal study also showed that male bricklayers (lifting and carrying bricks weighing 5–24 kg at a rate of 100 times an hour) had twice the risk of clinically diagnosed low back disorders after controlling for age, previous work related accidents, and individual factors.

The data from the logistic regression analyses for the mixed and the men only populations suggested that interactions between physical and psychosocial risk factors at work were present as indicated by a departure from an additive model of risk. Workers exposed jointly to both sets of physical and psychosocial risk factors at work experienced the biological effects of high physical exposure, high psychosocial exposure, and the interaction effects of these two factors. The proportion of the interaction effect varied according to the outcome and the mixed and men only groups. The derivation of a potential interactive effect in multiple logistic regression by estimating the coefficient of a product term in the model is incorrect. It could easily be inferred that there is no evidence of an interaction with such an approach when there might be considerable evidence of a deviation from additivity.

Logistic regression models can be used to assess interactions with the method outlined in this paper. To our knowledge no other study has investigated the potential interaction effects between physical and psychosocial risk factors at work on the risks of work related back disorders. A previous cross sectional survey investigated the combined effects of physical and psychosocial exposure. The combined effects of a heavy lifting and a poor psychosocial work environment required medical attention within the previous year (OR 2.68, 95% CI 2.02 to 3.57) in a Swedish study of about 22,000 workers.
The OR for the combined factors was greater than the ORs for lifting and a poor psychosocial work environment when considered separately. Possible interaction effects were not investigated because workers were not classified into low physical—high psychosocial or high physical—low psychosocial exposure groups. The relations found by others for the lower back\(^4\) concur with the combined effect of high physical and high psychosocial exposure found in this study.

**PLAUSIBILITY OF THE INTERACTIONS**

Illustrative models of the pathways by which physical and psychosocial factors may influence work related musculoskeletal disorders have been proposed.\(^1\)\(^-\)\(^5\)\(^1\)\(^4\)\(^4\)\(^5\) It is thought that psychosocial work factors may influence physical exposure—for example, lifting frequency and poor working postures may be increased by perceived pressure on time and high work demands. High social support between workers and managers may promote the development of ergonomics strategies to reduce physical exposure—such as alterations in work technique, lifting equipment, taking rests, and being involved in organizational health and safety issues.\(^5\)

Current explanations of how psychosocial work factors may also directly influence work related musculoskeletal disorders are through two mediating routes—neuromuscular tension and local sensitivity to pain. Neuromuscular tension has been correlated with psychosocial risk factors at work and the development of work related musculoskeletal disorders, defined as muscle pain, but the relations are unclear.\(^5\) Three mechanisms have been proposed for this possible correlation. Firstly, psychosocial factors act through increased neuromuscular tension. Secondly, psychosocial factors may act through an interaction with neuromuscular tension brought about by physical work demands. Thirdly, psychosocial factors may act through an alternative mechanism independent of neuromuscular activity. At present, the most convincing evidence suggests that neuromuscular activity and psychosocial factors can act independently towards the development of work related musculoskeletal disorders.\(^6\)\(^-\)\(^8\) Also, a feeling of general tension (a psychological stress symptom) may also act independently of muscle fibre activation measured by surface electromyography.\(^9\)

Alternatively the strain from psychosocial exposure may indirectly modify the biological effect of the biomechanical load upon the development of work related musculoskeletal disorders. For example, people experiencing high exposure to physical and psychosocial risk factors at work may have increased sensitisation to discomfort and distress that may affect individual capacity such that the response to further strain or physical and psychosocial exposure is intensified. An alternative model proposed that the experience of back disorders and other work related musculoskeletal disorders may also alter perceptions of psychosocial work factors. This may increase the psychosocial strain that may then increase the physical work demands on a person with already reduced physical and psychological capacities.\(^9\)

Current models of how psychosocial work factors are static, however, it has been shown in a longitudinal study of office workers that they are dynamic and the relation between psychosocial work factors and hand-arm discomfort and worker strain can vary over time.\(^9\)

**STUDY DESIGN AND BIASES**

**Response rates**

Although it seems that the participation rate varied between sedentary, manual, and driving jobs, the percentage responses are, nevertheless, large enough to allow valid comparisons. Also, sufficient numbers were classified into each exposure group to provide the required study power at the 95% CI for the mixed sex population.

**Exposure criteria**

Predetermined exposure criteria were used for classification of individual cases into low or high physical and psychosocial exposure groups. Combinations of long term whole body vibration and frequent lifting have produced the highest risks of low back pain, neck pain, and shoulder pain compared with the risks associated with individual factors.\(^1\) Combinations of high psychological demands, low decision latitude, and low social support may also result in the greatest risks compared with individual factors.\(^9\)\(^1\)\(^0\)

For physical exposures in this study, 180 subjects did not satisfy the criteria for classification into low or high physical exposures. The contrast between low and high physical exposure was required to reduce the potential effects of exposure misclassification.\(^1\)2 The removal of these subjects from the risk analyses did not affect the distribution of age, sex, years of exposure, and musculoskeletal outcomes. The disadvantage of such an approach is that a large variation in exposure is required within the study population to provide sufficient numbers with contrast between low and high exposures. Also a large study population is needed to provide sufficient study power, especially for studying interactions.\(^9\)

**OCCUPATION GROUPS WITHIN EACH EXPOSURE GROUP**

This study investigated work tasks that could be classified as general manual, delivery driving, or sedentary office work. As expected, individual workers from each job classification were spread across exposure groups. Most workers performing delivery driving and general manual work were classified into the high physical exposure groups. Most sedentary office workers were classified into the two low physical exposure groups. The risk associated with the high physical exposure groups was supported by data from a United States national survey.\(^9\) The occupational groups at the highest risk of back pain all included heavy physical work and driving motor vehicles. Occupational groups that performed sedentary
work were not considered to be at a high risk of back pain.

**POTENTIAL UNDERESTIMATION OF RISKS OF BACK DISORDERS**

Sedentary office workers in this study population mostly performed computer work and answered continuous customer phone enquiries for most or all of the working day. Therefore, postures were constrained to sitting for most of the working day. The prevalence of back disorders in the past 7 days was 40% and 44% for low physical—low psychosocial exposure and low physical—high psychosocial exposure, respectively. High prevalences of back pain in light (static) work have been shown in some professions.\(^6\)\(^5\) The estimates of back pain in light (static) work have been expressed as pain within the past 12 months\(^10\) and pain on \(>30\) days during the preceding year\(^4\) may overestimate exposure. However, the evidence is not conclusive. In this study, subjects were asked to report exposures for the current day to attempt to minimise any misclassification bias. A study showed that a short recall period (symptoms in the past 7 days or right now) would probably reflect effects of current exposures at work.\(^1\) In the presence of differential exposure misclassification the bias effect may be minimised with the 7 day prevalence rather than the 12 month prevalence, as subjects are less prone to make recall errors and positive symptoms may have less of an adverse effect upon recall.

**HEALTHY WORKER EFFECTS**

Analysis of medical severance data for work related musculoskeletal disorders showed that there was a healthy worker selection bias in the total study population. The data could not be disclosed for reasons of confidentiality. However, adjustment of the crude ORs for medical severance from back injury were not greatly different from the crude ORs suggesting that the size of the selection bias due to workers lost from medical severance was not great. An interaction remained between high exposures to physical and psychosocial risk factors at work. Adjustment could not be made for workers who had resigned or had not received medical severance. The survivor population tended to be younger and have less cumulative work exposure, which might make them a healthier population. This may partially explain why age was found to be a protective factor for recurrent back problems contrary to other epidemiological studies.\(^1\)\(^4\)\(^6\)\(^7\)\(^8\)\(^9\) This effect was in accordance with another study that showed a selection bias.\(^7\) The selection bias, can therefore, not only mask associations but can also result in apparent improvement of low back trouble with age and the number of years spent exposed at work. For recurrent back disorders in this study, there was an improvement with age but not for increasing years employed. This suggests that cumulative exposure is a risk factor for workers who are relatively young.

The average measures for the number of years spent exposed and age were higher in the...
Appendix: Questions used to formulate Boolean algebra expressions from Devereux, Buckle, Vlachonikolis

Lifting weight (kg):
6–15 + exposed to vibration? Y es No
1=Not at all, 2=<1 time/h, 3=1–10 times/h, 4=10–30 times/h, 5=>30 times/h

Interactions between physical and psychosocial exposure both to physical and psychosocial risk factors for work related back disorders should reduce at the prevention or intervention of risks for physical and psychosocial work related back disorders. Scand J Work Environ Health. 1994;20:139–45.


Conclusions
Physical and psychosocial risk factors at work may act independently to increase risks or they may also interact to further increase the risks of self reported back disorders. Strategies aimed at the prevention or intervention of risks for work related back disorders should reduce exposure both to physical and psychosocial risk factors at work. Further epidemiological studies concerned with work related back disorders and other work related musculoskeletal disorders are needed to confirm the presence of interactions between physical and psychosocial risk factors at work.

Appendix: Questions used to formulate Boolean algebra expressions from which the physical exposure criteria were decided.

<table>
<thead>
<tr>
<th>Lifting weight (kg):</th>
<th>0–15</th>
<th>16–45</th>
</tr>
</thead>
<tbody>
<tr>
<td>1=Not at all, 2=&lt;1 time/h, 3=1–10 times/h, 4=10–30 times/h, 5=&gt;30 times/h</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Sitting When sitting are you:</th>
<th>Yes</th>
<th>No</th>
</tr>
</thead>
<tbody>
<tr>
<td>Exposed to vibration?</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sitting at a keyboard?</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Exposed to both vibration and work at a keyboard at different times?</td>
<td>Yes</td>
<td>No</td>
</tr>
</tbody>
</table>

Factors at work increase the risk of back disorders


43 Oppenheim AN. Questionnaire design and attitude measurement. London: Heinemann, 1966.


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