Musculoskeletal symptoms among truck assembly workers

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**Background**
Concerns were raised about the possibility of a high prevalence of musculoskeletal symptoms in a truck assembly plant.

**Aim**
The aim of this study was to investigate the prevalence of musculoskeletal symptoms in a group of truck assembly workers.

**Method**
A cross-sectional study of 461 truck assembly workers was carried out using a modified version of the Nordic questionnaire and the General Health Questionnaire (GHQ-12). Employees were further subdivided into three distinct occupational subgroups: skilled line workers (252), bench subassembly workers (108) and material handlers (101). Responses were analysed according to occupational subgroup.

**Results**
Seventy per cent of 461 truck assembly workers responded to the questionnaires. Seventy-nine per cent of respondents had been troubled with musculoskeletal symptoms in the last 12 months. The commonest musculoskeletal symptoms were from the lower back (65%), neck (60%) and shoulders (57%). Musculoskeletal symptoms were related to age, length of service, occupational subgroup and GHQ12 score.

**Conclusion**
There was a high reported prevalence of musculoskeletal symptoms in this group of truck assembly workers, with a differing pattern of symptom reporting depending on occupational subgroup. Risk reduction recommendations were made to the site management. A further study investigating the relationship between symptoms and specific hazards is planned.

**Key words**
Assembly workers; low back pain; musculoskeletal disorders; neck pain; Nordic; shoulder pain.

Introduction
Musculoskeletal symptoms are a common occupationally related cause of ill health in the UK. The publication *Self Reported Work-related Illness in 1995. Results from a Household Survey* [1] (SWI95) estimated that 1.2 million men and women in 1995 believed themselves to be suffering from musculoskeletal symptoms caused or made worse by work. Associations between working environment and musculoskeletal symptoms have been widely reported [2–32]. A number of studies have explored the relationships between automobile assembly work and musculoskeletal symptoms, and have consistently shown an association between musculoskeletal symptoms and automobile assembly work [5–12].

Few studies concerning musculoskeletal symptoms among truck assembly workers have been published. One study, by Johansson *et al.* [13], investigated the differences in prevalence of musculoskeletal symptoms between employees working in two different truck axle assembly systems. The aim of the present study was to investigate the occurrence of self-reported musculoskeletal symptoms in a group of truck assembly workers.
Materials and methods

The study was cross-sectional in design.

Setting

The setting for the study was a UK-based company that assembles large goods vehicles (LGVs). The assembly system consisted of a number of sequential steps. Work is paced, with the production lines moving on every 28 min.

Subjects

The subjects for this study were the 461 truck assembly workers employed by the company. The workers can be subdivided into three distinct occupational subgroups.

Skilled line workers

Skilled line workers ($n = 252$) are highly trained assembly workers. They perform the main assembly process. The work of a skilled line worker involves manual handling of loads, overhead work and requires the worker to adopt awkward postures throughout the 28 min cycle.

Bench subassembly workers

Bench subassembly workers ($n = 108$) work at benches at the side of the main assembly line. They assemble small parts, producing units for the skilled line workers on the production line. They generally perform their work in an upright posture, performing a number of ‘repetitive’ movements using their hands and fingers. They use hand-held tools frequently.

Material handlers

Material handlers ($n = 101$) assist skilled line workers and bench subassembly workers. They move materials and parts around the site, either manually or with trollies and trucks. Their work also involves unloading of palettes involving spinal bending, twisting and manual handling of weights of up to 28 kg.

Procedure

All 461 assembly workers were asked to answer a self-administered questionnaire, concerning age, job type, years worked as a truck assembly worker and occurrence of musculoskeletal symptoms in the past 12 months. The questionnaire used was a modified version of the Nordic Questionnaire (NQ) for the analysis of musculoskeletal symptoms [33]. Presence of musculoskeletal symptoms was defined as ache, pain or discomfort in one of the following nine body regions: neck, shoulders, upper back, elbows, low back, wrist/hands, hips, knees and ankles/feet.

In addition, the 12 item General Health Questionnaire (GHQ12) [34] was administered. There are various systems that can be used to score this questionnaire [34]. The system used to score the GHQ12 questionnaires in this study was the GHQ score method (0–0–1–1 method). Using this method, an employee could score between 0 and 12. A GHQ score of 4 or above indicates a high level of psychological distress [34].

The study was performed with full cooperation of the trade unions and site management. All employees were given oral and written information about the study from the author.

Questionnaires were coded and the code number of the questionnaires was linked to a list of employees. Non-responders could therefore be identified. [In an attempt to ascertain the level of symptoms and therefore assess the potential level of bias that may have occurred due to non-responders, a random sample of 50 non-responders was selected and the questionnaires were sent to this sample, together with a covering letter with a more detailed explanation of the reasons for performing the study.] The questionnaires were also sent out to the 30 employees who were absent from work at the time of the study. In order to evaluate the influence of musculoskeletal symptoms on leaving employment, an analysis of the cause of leaving was performed, by reviewing the files of all leavers over the last 12 months.

Statistical methods

The results were summarized in descriptive statistics. One year prevalences of musculoskeletal symptoms were calculated for the total group and for the occupational subgroups. Statistical analysis was performed using chi-squared testing for categorical variables and by calculating prevalence ratios (PRs) as a measure of association between musculoskeletal symptoms and GHQ scores. The PR is a better approximation of relative risk than the often used odds ratio [35]. Associations between musculoskeletal symptoms and age and length of service were investigated by the use of the Pearson correlation coefficient. The analysis was executed using Microsoft Excel and the STATA computer package. The level of significance was set at $P < 0.05$.

Results

Of the 461 employees who received the questionnaires, 323 responded, giving a response rate of 70%. The mean ($\pm$ SD) age of respondents was 36.5 $\pm$ 12.3 years and the mean period of employment was 13.9 $\pm$ 1.2 years. Response rates of 66, 72 and 77% were received from skilled line workers, material handlers and bench subassembly workers, respectively. Mean ages of the three occupational subgroups were 37.1, 33.9 and 37.5 years for skilled line workers, material handlers and bench subassembly workers, respectively. Mean periods of employment were 13.9, 13.1 and 15.9 years for skilled
line workers, material handlers and bench subassembly workers, respectively.

A total of 79% (n = 255) of respondents reported that they had been troubled with musculoskeletal symptoms in one or more of the nine defined body regions during the last 12 months. One-year prevalence of musculoskeletal symptoms by body part showed differing prevalences for different body parts (Table 1). A higher prevalence was reported in relation to lower back (65%), neck (60%) and shoulder (57%) symptoms. Skilled line workers reported a higher prevalence of musculoskeletal symptoms (84%) than bench subassembly workers (74%) and material handlers (74%). These differences were not statistically significant (P = 0.083).

Prevalence of musculoskeletal symptoms by body part (Table 2) varied between the three subgroups of workers. Skilled line workers reported mainly low back, neck, shoulder and wrist/hand symptoms. Material handlers reported mainly low back and shoulder symptoms. Bench subassembly workers reported mainly wrist/hand, neck and knee symptoms. There were significant difference between the three occupational subgroups in relation to neck, shoulder, low back, wrists/hands and knee symptoms (Table 2).

Older age was positively correlated with complaints of musculoskeletal symptoms (Pearson correlation coefficient = 0.9). In each of the three occupational subgroups, a longer length of service was also positively correlated with complaints of musculoskeletal symptoms (Pearson correlation coefficient = 0.9). A further analysis regarding the effects on age of years of service was performed using a regression model. There was an extremely strong positive correlation between age and length of service (Pearson correlation coefficient = 0.93).

A breakdown of GHQ scores by occupational subgroup is provided in Table 3. The differences in GHQ scores between the three subgroups of workers were not statistically significant (P = 0.7018). This would indicate similar levels of psychological morbidity between the three groups of workers. In the total sample of 323 responders, 51 had a GHQ score of greater than the threshold value of 4 (Table 4). Employees with a GHQ of >4 reported higher prevalences of musculoskeletal symptoms than those with a GHQ score of <4, but this difference was not statistically different. Forty-three respondents with musculoskeletal symptoms had a GHQ of >4. These responses were analysed further to investigate any associations with body part (Table 5). Relative prevalences of neck and back symptoms were significantly higher in employees with a GHQ score of >4.

An analysis of the 138 non-responders was performed. Mean age of non-responders was 37.4 years, with a mean period of employment of 14.4 years. A random sample of 50 non-responders was selected and repeat questionnaires sent to this sample. Thirty-one responses were obtained from this group. Those who responded were termed late-responders. One-year prevalence of musculoskeletal symptoms in late-responders was 84% (n = 26), with an average GHQ score of 2.7. There was a significant difference between late-responders and responders in prevalence of GHQ scores of >4. There was no significant difference in prevalence of musculoskeletal symptoms between late-responders and responders.

A 63% (n = 19) response rate was obtained from

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### Table 1. One year prevalence of musculoskeletal symptoms in truck assembly workers by body part

<table>
<thead>
<tr>
<th>Body part</th>
<th>Musculoskeletal symptoms, n (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Neck</td>
<td>194 (60)</td>
</tr>
<tr>
<td>Shoulders</td>
<td>184 (57)</td>
</tr>
<tr>
<td>Upper back</td>
<td>55 (17)</td>
</tr>
<tr>
<td>Elbows</td>
<td>65 (20)</td>
</tr>
<tr>
<td>Low back</td>
<td>211 (65)</td>
</tr>
<tr>
<td>Wrists/hands</td>
<td>149 (46)</td>
</tr>
<tr>
<td>Hips</td>
<td>26 (8)</td>
</tr>
<tr>
<td>Knees</td>
<td>126 (39)</td>
</tr>
<tr>
<td>Ankles/feet</td>
<td>42 (13)</td>
</tr>
<tr>
<td>Total</td>
<td>255 (79)</td>
</tr>
</tbody>
</table>

### Table 2. Relations between occupational subgroup and musculoskeletal pain by body part

<table>
<thead>
<tr>
<th></th>
<th>Skilled line workers (n = 167), n (%)</th>
<th>Manual handlers (n = 73), n (%)</th>
<th>Bench subassembly workers (n = 83), n (%)</th>
<th>( \chi^2 )</th>
<th>P value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Neck</td>
<td>107 (64)</td>
<td>31 (42)</td>
<td>56 (67)</td>
<td>12.44</td>
<td>0.002**</td>
</tr>
<tr>
<td>Shoulders</td>
<td>100 (60)</td>
<td>50 (68)</td>
<td>34 (41)</td>
<td>13.2</td>
<td>0.001**</td>
</tr>
<tr>
<td>Upper back</td>
<td>36 (21)</td>
<td>11 (15)</td>
<td>8 (10)</td>
<td>5.83</td>
<td>0.054</td>
</tr>
<tr>
<td>Elbows</td>
<td>40 (24)</td>
<td>9 (12)</td>
<td>16 (19)</td>
<td>4.31</td>
<td>0.115</td>
</tr>
<tr>
<td>Low back</td>
<td>122 (73)</td>
<td>50 (68)</td>
<td>39 (47)</td>
<td>21.23</td>
<td>&lt;0.001***</td>
</tr>
<tr>
<td>Wrists/hands</td>
<td>82 (49)</td>
<td>9 (12)</td>
<td>58 (70)</td>
<td>52.99</td>
<td>&lt;0.001***</td>
</tr>
<tr>
<td>Hips</td>
<td>13 (8)</td>
<td>5 (7)</td>
<td>8 (10)</td>
<td>0.44</td>
<td>0.802</td>
</tr>
<tr>
<td>Knees</td>
<td>65 (39)</td>
<td>20 (27)</td>
<td>41 (49)</td>
<td>7.9</td>
<td>0.019*</td>
</tr>
<tr>
<td>Ankles/feet</td>
<td>24 (14)</td>
<td>9 (12)</td>
<td>9 (11)</td>
<td>0.6479</td>
<td>0.723</td>
</tr>
</tbody>
</table>

*P < 0.05; **P < 0.01; ***P < 0.001.
absentees. One-year prevalence of musculoskeletal symptoms was 79% (n = 15), with an average GHQ score of 2.9. There was a significant difference between absentees and non-absentees in prevalence of GHQ scores of >4 (Table 6). There was no significant difference in prevalence of musculoskeletal symptoms between absentees and non-absentees.

Of the 27 employees who had left the workplace within the last 12 months, 18 (66%) had done so because of musculoskeletal problems (Table 7), with the remaining leaving due to non-medical reasons.

**Discussion**

In this group of truck assembly workers, 79% reported one or more musculoskeletal symptom in the last 12 months. Previous studies using the Nordic Questionnaire in a variety of jobs have reported 1 year prevalence rates of musculoskeletal symptoms of 57, 57, 92, 93 and 96% in nurses [14], bus drivers [15], construction workers [16], aluminium workers [17] and car mechanics [18], respectively. The prevalence rate found in the current study therefore lies slightly above the mid-range of those reported in previous studies, although direct comparisons are difficult to make with different occupations.

The response rate in this study was 70%. This is a similar response rate to previous unsupervised questionnaire studies, e.g. 75% in Miranda et al. [19] and 67% in Smedley et al. [20]. There were no significant differences in response rates between the three occupational subgroups.

This study did not evaluate non-work risk factors for musculoskeletal symptoms. The aims were to assess the scale and prevalence of musculoskeletal symptoms in this group of workers, and to identify any differences within the three occupational subgroups regardless of cause. It is acknowledged that non-work factors could have been responsible for a proportion of the reported symptoms and is a potential confounder.

The commonest reported symptom was that of low

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**Table 3. GHQ scores**

<table>
<thead>
<tr>
<th></th>
<th>Mean</th>
<th>Median</th>
<th>Mode</th>
<th>Range</th>
<th>Percentage with a score of &gt;4</th>
</tr>
</thead>
<tbody>
<tr>
<td>Skilled line workers</td>
<td>2.13</td>
<td>1</td>
<td>0</td>
<td>0–10</td>
<td>16</td>
</tr>
<tr>
<td>Material handlers</td>
<td>2.28</td>
<td>2</td>
<td>0</td>
<td>0–10</td>
<td>15</td>
</tr>
<tr>
<td>Bench subassembly workers</td>
<td>2.33</td>
<td>2</td>
<td>0</td>
<td>0–9</td>
<td>17</td>
</tr>
<tr>
<td>All employees</td>
<td>2.22</td>
<td>2</td>
<td>0</td>
<td>0–10</td>
<td>16</td>
</tr>
</tbody>
</table>

**Table 4. Relationship between GHQ scores using a threshold value of 4 and musculoskeletal symptoms**

<table>
<thead>
<tr>
<th></th>
<th>GHQ score ≤ 4, n (%)</th>
<th>GHQ score &gt; 4, n (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total number</td>
<td>272</td>
<td>51</td>
</tr>
<tr>
<td>Number with musculoskeletal symptoms</td>
<td>212 (78)</td>
<td>43 (84)</td>
</tr>
<tr>
<td>Number without musculoskeletal symptoms</td>
<td>60 (22)</td>
<td>8 (16)</td>
</tr>
</tbody>
</table>

Relative prevalence of musculoskeletal symptoms between group GHQ score > 4, and group GHQ score ≤ 4 = 1.08 [95% confidence interval (CI) = 0.95–1.24].

**Table 5. Relationship between GHQ scores of >4 and musculoskeletal symptoms by body part**

<table>
<thead>
<tr>
<th>Body part</th>
<th>Number of employees with GHQ scores &gt; 4 and with symptoms, n (%)</th>
<th>Relative prevalence (95% CI)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Neck</td>
<td>31 (72)</td>
<td>1.24 (1.01–1.53)*</td>
</tr>
<tr>
<td>Shoulders</td>
<td>26 (61)</td>
<td>1.07 (0.83–1.39)</td>
</tr>
<tr>
<td>Upper back</td>
<td>6 (14)</td>
<td>0.8 (0.36–1.75)</td>
</tr>
<tr>
<td>Elbows</td>
<td>9 (21)</td>
<td>1.09 (0.58–2.03)</td>
</tr>
<tr>
<td>Low back</td>
<td>33 (77)</td>
<td>1.20 (1.02–1.45)*</td>
</tr>
<tr>
<td>Wrists/hands</td>
<td>20 (47)</td>
<td>1.01 (0.72–1.43)</td>
</tr>
<tr>
<td>Hips</td>
<td>3 (7)</td>
<td>0.85 (0.27–2.71)</td>
</tr>
<tr>
<td>Knees</td>
<td>17 (40)</td>
<td>1.02 (0.68–1.51)</td>
</tr>
<tr>
<td>Ankles/feet</td>
<td>5 (12)</td>
<td>0.86 (0.36–2.06)</td>
</tr>
</tbody>
</table>

Relative prevalences are prevalences of symptoms in employees with GHQ score > 4 compared with prevalences of symptoms in employees with GHQ score ≤ 4.

*Significantly different.
back pain, with 65% of the study population reporting back symptoms. Material handlers and skilled line workers had significantly higher prevalences of low back symptoms than bench subassembly workers. This was not a surprising finding as these jobs are more demanding in terms of manual handling and adopting awkward postures than the work of a bench subassembly worker. Previous studies have identified heavy manual handling [20,22–24] and awkward trunk postures [6,25] as risk factors for the development of low back pain. The results from the current study support this.

Sixty per cent of the study population reported neck symptoms. Skilled line workers and bench subassembly workers had significantly higher prevalences of neck symptoms than material handlers. At all workstations, skilled line workers often work with their necks extended for periods of time when performing overhead work. Bench subassembly workers often need to hold their necks in ~45° of flexion for protracted periods of time whilst assembling parts at a bench. Generally, material handlers do not have to hold their necks in one particular posture for long periods of time. It has been suggested that maintaining muscles in one particular non-neutral posture for extended periods of time can lead to musculoskeletal disorders [4,25,36]. This static muscle loading would appear to be a plausible explanation for the higher prevalence of neck symptoms in skilled line workers and bench subassembly workers.

Fifty-seven per cent of the study population reported shoulder symptoms. Material handlers and skilled line workers had significantly higher prevalences of shoulder pain than bench subassembly workers. This may be due to the fact that material handlers and skilled line workers perform more manual handling activities, and adopt more extreme shoulder postures, than bench subassembly workers. Previous studies have found shoulder pain to be associated with heavy manual work [4,13,26], shoulder flexion [5] and shoulder abduction [5]. The current study would appear to support these findings.

Forty-six per cent of the study population reported wrist/hand symptoms. Bench subassembly workers had a significantly higher prevalence of wrist/hand symptoms than skilled line workers and material handlers. This is not a surprising finding, considering that bench subassembly workers do perform frequent repetitive tasks using their hands. Significant positive associations between wrist/hand symptoms and repetitive arm movements have been described previously [2–4,12,27,28]. Also, bench subassembly workers use hand tools. The use of hand tools has been associated with wrist/hand symptoms [9]. A combination of the use of these tools and repetitive arm movements would appear to place bench subassembly workers at a higher risk of development of wrist/hand symptoms.

Age and length of service were both positively correlated to prevalence of musculoskeletal symptoms in all three occupational subgroups. Increasing age has been found to be associated with an increasing prevalence of musculoskeletal symptoms as has years of employment [3,14,16–18]. The findings of the present study are therefore consistent with this. In this study, age and length of service were so strongly correlated that it was impossible to determine the degree to which each factor influenced symptom prevalence.

Other studies have shown that psychological factors and stress are associated with musculoskeletal symptoms [9,16,19,21,22,29–32]. In this study, the average GHQ12 score in truck assembly workers was 2.2, with 16% scoring above a threshold value of 4. These results are similar to results obtained in the general population [37]. Employees with a GHQ score of >4 reported a higher prevalence of musculoskeletal symptoms, and a GHQ score of >4 was a statistically significant predictor for neck and back pain (Table 5). This reflects other studies where spinal pain has been associated with psychological factors [16,22,31,32].

Late-responders reported a higher prevalence of musculoskeletal symptoms than responders although this difference was not statistically significant. If it is assumed that late-responders are representative of the non-responders, the higher prevalence of musculoskeletal symptoms in late-responders means that any associations found in the study may have been weakened due to the level of non-responders. Extrapolating from this small sample of (late) non-responders, an assumption could be made that had they been included in the main study higher prevalences of musculoskeletal symptoms would have been reported in this study. The study found that a high percentage of leavers (66%) cited a musculoskeletal symptom as their reason for leaving. However, leavers may give a medical reason for leaving when the actual reason for leaving may have been non-medical. In the present study, we were unable to evaluate the effect of this. If workers have been leaving this workplace due to musculoskeletal symptoms, the current workforce may be a ‘survivor population’. If this is the case, one could postulate that the true prevalence of musculoskeletal

### Table 6. Prevalence ratios for GHQ scores and musculoskeletal symptoms in non-responders and absentees

<table>
<thead>
<tr>
<th></th>
<th>Prevalence ratio for GHQ &gt; 4</th>
<th>Prevalence ratio for musculoskeletal symptoms</th>
</tr>
</thead>
<tbody>
<tr>
<td>Non-responders</td>
<td>1.84 (1.00–3.37)*</td>
<td>1.06 (0.90–1.25)</td>
</tr>
<tr>
<td>Absentees</td>
<td>2.33 (1.23–4.43)*</td>
<td>1.00 (0.79–1.27)</td>
</tr>
</tbody>
</table>

Prevalence ratios refer to a comparison of prevalences in non-responders and absentees with prevalences in the responder group.

*Significantly different.
symptoms in truck assembly workers may be even higher than the reported prevalence.

Conclusions
There is a high prevalence of musculoskeletal symptoms in this group of truck assembly workers, who reported symptoms mainly affecting the lower back, shoulders, neck and wrist/hand areas. Symptoms were found to be associated with age and length of service, occupational subgroup, and GHQ score. The study results were provided to the site management team, with emphasis placed on the high prevalence of musculoskeletal symptoms. Recommendations include advice to perform more adequate and appropriate risk assessments for musculoskeletal hazards, to introduce appropriate ergonomic changes to the workplace, to reduce overhead work, and to consider job rotation and automation of certain processes. A further study investigating the relationship between symptoms and specific hazardous physical exposures in this workplace is planned.

References
in 12 occupational groups. Occup Environ Med 2001;58:374–381.


