Perception of difficulties for the back related to assembly work: general findings and impact of back health

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(Received 20 July 1995)

The study objective was to describe the perceptions of airplane assemblers on job demand for the back and how back pain modulated these perceptions. One hundred and seventy-six workers answered two questionnaires concerning back pain and the perception of work related difficulties (work activities, work contexts, tools, work positions, efforts). Results show that positions and work contexts are perceived as greater sources of difficulty than efforts or dynamic activities. The duration of a given position is more important than its frequency. Back pain has a significant but complex impact on the perception of difficulty. Assemblers appear to integrate several factors when evaluating their difficulties as opposed to individual aspects, as it is often measured in ergonomic studies. The results have important implications for the measurement of ergonomic factors in the genesis of back pain and illustrates the potential for misclassification and biases in current epidemiologic studies. © 1997 Elsevier Science Ltd

Keywords: airplane assemblers, low back pain, perception, posture, exertion

Introduction

Back pain is known to be an occupational health problem generating substantial costs from both a medical and compensation standpoint. In this respect, previous studies have identified airplane assemblers as a target population for back pain (Gervais and Hébert, 1987; Bigos et al, 1986a, Bigos et al, 1986b; Rossignol et al, 1992). However, airplane assemblers are a difficult population to characterize in terms of identifying risk factors due to the great variety of tasks performed. In fact, the tasks, the types of parts assembled, the layout of the workstation, the organization and the duration of the work cycles, vary among workstations. For example, the basic assembly cycle may vary from a few minutes to several days. In the case of short cycles, the same assembler may work throughout the year on several dozen different parts. Even if the assemblers all use more or less the same tools and often perform the same basic operations, such as drilling and riveting, the work at each of the workstations is different. For example, the work can be carried out inside or around a piece of the fuselage or on a small part resting on a table. The layout, the sequencing of operations, and the way the operations are organized also differ, not only from one workstation to the next, but between two similar workstations. Consequently, the characterization of the risk factors for these workstations is very difficult, yet essential for the development and evaluation of preventive strategies.

For such characterization, many studies have focused on worker’s perceptions. For example, the limits of loads to be handled are in part based on what the workers consider subjectively acceptable (Ayoub et al, 1980; Ciriello et al, 1993); postural evaluation methods often include subjective indicators (Corlett, 1990). Posture classification, the basis of the OWAS working posture analysis system, is based on the workers’ subjective evaluation of the difficulty associated with different postures (Heinsalmi, 1986). In the field, several authors propose methods based on perception to either identify and rank musculoskeletal stresses or efforts (Blache et al, 1987; Johanson and I. Jonngren,
Methods

The questionnaire

Two questionnaires were distributed to airplane assembly workers in a large plant in Montreal, Canada: one on back pain and one on perception of work-related difficulties for the back.

The back pain questionnaire was distributed to 395 assemblers having over one year of seniority. It was then redistributed one year later to 258 of the 269 assemblers who answered the first questionnaire (eleven had left their jobs during the year). Two hundred and five assemblers returned this second questionnaire. The questions included the presence or absence of back pain, work limitations caused by back pain, as well as the occurrence of back accidents. The details and analytical results of this questionnaire are described in another article (Rossignol et al., 1993). The questionnaire on the perception of back-related difficulties was then distributed to the 258 initial respondents and 183 returned it (response rate: 71%). Seven questionnaires improperly completed were rejected. The results of the second back pain questionnaire were used to divide these 176 respondents into three series of pairs as follows:

(1) Has or has not been compensated for a back problem in the past. (Comp = 49; NComp = 124; unspec. = 3).
(2) Had or had not suffered back discomfort during the week prior to receiving the health questionnaire (Pain = 79; NPain = 79; unspec. = 18).
(3) Had felt limited or was not at work due to a back problem in the week preceding the distribution of the questionnaire; this may have involved being hindered at work, being prevented from doing the regular work or having to stay home at least one day for a back-related reason. (Lim = 40 assemblers; NLim = 114; unspec. = 22).

The questionnaire on the perception of difficulties contained 48 questions. It was asked which of the different work factors (n = 18) were felt to have contributed to their back problems or difficulties. Eight questions dealt with activities, five with work contexts, five with tools (shown in Figure 1). The respondents were asked to directly rank the degree of difficulty of a statement on a Likert scale with four levels of difficulty. Thirteen other questions dealt with working positions. The term position will be used in this paper instead of posture because most of the postures were shown in relationship with a work context; the assemblers probably evaluated both in conjunction. Out of these, in ten questions, assemblers were asked to rank in order of difficulty for the back, four positions illustrated by photographs (taken on the work sites) and to indicate how often the most difficult position was adopted. An example of two positions is shown in Figure 1. For the three other questions, they were asked to choose between alternatives. Finally, 17 questions explored what assemblers perceived as more important for their back: the positions or the efforts (seven questions, with five involving the tools), the duration or the frequency (ten questions). The wording of the different questions is summarized in the Appendix.

Analysis

A frequency analysis was performed for all the questions. The null hypotheses were tested using the chi-squared test. Invalid responses (no response or several choices selected) were eliminated in calculating chi-square but retained for the frequency distribution. The odd ratios (ORs) were calculated separately for each of the three contrasts (Comp vs NComp, Pain vs NPain and Lim vs NLim) to verify the impact of back pain on perceptions (Bernard and Lapointe, 1987). For each questions, the ORs were calculated, as following (example for Comp pair):

#assemblers Comp answering yes
# assemblers Comp answering no

# assemblers NComp answering yes
# assemblers NComp answering no

Answering to have several or many difficulties/problems was considered as a ‘yes’ in opposition to answering to
Table 1 Percentage of assemblers perceiving that a work characteristic is "somewhat" or "very hard" on the back, and ORs

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>% Assemblers</th>
<th>Comp (n=49)</th>
<th>Pain (n=79)</th>
<th>Lim (n=40)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Work activity</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Maintaining a position for a long time</td>
<td>51</td>
<td>A(^2)</td>
<td>1.7</td>
<td>3.1***</td>
</tr>
<tr>
<td>Straightening up after being bent over</td>
<td>40</td>
<td>B</td>
<td>1.9</td>
<td>2.4**</td>
</tr>
<tr>
<td>Handling bulky parts</td>
<td>32</td>
<td>BC</td>
<td>1.4</td>
<td>1.1</td>
</tr>
<tr>
<td>Standing for a long time</td>
<td>27</td>
<td>C</td>
<td>1.1</td>
<td>2.9**</td>
</tr>
<tr>
<td>Squatting</td>
<td>24</td>
<td>C</td>
<td>1.4</td>
<td>1.3</td>
</tr>
<tr>
<td>Turning to pick up something behind</td>
<td>11</td>
<td>D</td>
<td>3.9**</td>
<td>4.0*</td>
</tr>
<tr>
<td>Changing position often</td>
<td>11</td>
<td>D</td>
<td>1.4</td>
<td>3.3*</td>
</tr>
<tr>
<td>Climbing or stepping over</td>
<td>7</td>
<td>D</td>
<td>0.6</td>
<td>0.7</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Work context</th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Working area difficult to reach</td>
<td>65</td>
<td>A</td>
<td>1.7</td>
<td>1.0</td>
</tr>
<tr>
<td>Confined space</td>
<td>56</td>
<td>AB</td>
<td>1.3</td>
<td>1.3</td>
</tr>
<tr>
<td>Concrete floor</td>
<td>52</td>
<td>BC</td>
<td>0.7</td>
<td>1.7</td>
</tr>
<tr>
<td>Work requiring mainly a standing position</td>
<td>43</td>
<td>C</td>
<td>0.5</td>
<td>1.7</td>
</tr>
<tr>
<td>Work requiring walking a lot</td>
<td>13</td>
<td>D</td>
<td>0.7</td>
<td>2.2</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Tool</th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Alligator squeeze</td>
<td>45</td>
<td>A</td>
<td>1.2</td>
<td>1.1</td>
</tr>
<tr>
<td>Countersink</td>
<td>37</td>
<td>AB</td>
<td>1.7</td>
<td>1.9</td>
</tr>
<tr>
<td>Bucking bar</td>
<td>32</td>
<td>B</td>
<td>1.6</td>
<td>1.7</td>
</tr>
<tr>
<td>Rivet gun</td>
<td>30</td>
<td>B</td>
<td>1.8</td>
<td>3.3***</td>
</tr>
<tr>
<td>Drill</td>
<td>30</td>
<td>B</td>
<td>1.9</td>
<td>2.0*</td>
</tr>
</tbody>
</table>

1 For the exact wording of the questions, see Appendix A
2 Results not significantly different at \(p\leq0.05\) have the same letter
3 ***: \(p<0.001\); **: \(p<0.01\); *: \(p<0.05\)

have few or none. For the calculation of the ORs, only assemblers who answered the questions on workmen’s compensation, back pain or work limitations were retained.

The agreement between the respondents on the ranking of the four illustrated positions was, for each series of illustrations quantified using Kendall’s concordance coefficient \(W\). As the proportion of ties among the ranks was large, thus reducing the precision of the estimate of \(W\) value, the correction factor \(T\) was used. Kendall’s \(W\) and \(T\) were calculated as followed (Siegal and Castellan, 1988).

\[
W = \frac{12\sum R_i^2 - 3k^2N(N+1)^2}{k^2N(N^2-1)} - kT
\]

where \(R_i\) = average of the ranks assigned to that photograph by each of the respondents; \(N\) = number of photographs being ranked; \(k\) = number of respondents assigning ranks; \(T\) = correction factor required for the \(j\)th set of rank; \(t_j\) = number of tied ranks in the \(i\)th grouping of ties; \(g_j\) = number of groups of ties in the \(j\)th set of rank.

\(W=1\) indicates a perfect agreement among the respondents in their ranking of the photographs, while ‘0’ means a total absence of agreement. The significance level of \(W\) was tested using the formula \(X^2 = k(N-1)W\), distributed approximately like a chi-square distribution with \(N-1\) degrees of freedom. The effect of the various back health factors (presence or not of a back pain, work limitation or compensation) on the ranking of the photographs in each series was verified using the formula of Hollander and Sethuraman (1978). This permitted to test the null hypothesis between the \(W\)s of the two groups in one contrasted pair. Hollander’s \(B\) is calculated as followed:

\[
B(t_1,...,t_k) = mnK^{-1}(s - t)C^{-1}(s - t),
\]

where \(m\) = number of respondents within the group ‘presence of...’; \(n\) = number of respondents within the group ‘absence of ...’; \(k\) = total number of photographs; \(s_j = S_j/m\) and \(t_j = T_j/n\), which are the mean of the \(J\) ranks for the ‘presence of...’ and ‘absence of...’ respondents, and where \(S\) and \(T\) are the mean vectors of each rank \(j = 1,...,N-1\); \(C\) = covariance matrix.

The positions selected for the photographs were characterized in relation to six posture parameters, namely: the anterior flexion of the trunk, average (20° ≤ x < 45°) or severe (≥45°); the presence or absence of lateral flexion of the trunk (≥20°); the presence or absence of stabilizing supports for an upper limb (on the body, on the working surface); the abduction of the upper limb manipulating the tool, slight (<45°), average (<90°) or important (≥90°); and the effort axis (sagittal, frontal, vertical). We verified whether these parameters had a significant impact on the
ranked positions. Significant differences in the ranking was defined as greater than 0.6 where the frequency distribution of their series was significant at \( p \leq 0.001 \).

**Results**

The average age of the assembly workers was 36.9 (±10.4), and the average seniority, 11 years (±5.8), with 3.5 (±3.2) at their current job. There was no significant difference between the groups in each of the three pairs of contrasts.

**Activities, contexts or tools hardest on the back**

Table 1 shows the percentage of all assemblers having answered yes and the ORs. A high % with a low OR means that a majority of assemblers identified that respective characteristic as presenting a problem, whatever their condition. At the opposite, a low % with a high OR indicates that difficulties are almost exclusively felt by assemblers having back problems. The higher the OR, the more the % includes assemblers compensated, with pain or limitations. As shown in Table 1, of the 18 work characteristics investigated, only four were identified by more than 50% of the assemblers as being particularly hard on the back, of which three referred to a postural constraint. These were ‘maintaining a position for a long time’, ‘working area difficult to reach’, ‘working in a confined space’ and ‘working on a concrete floor’. No dynamic activities were identified as presenting problems (e.g. ‘turning to pick up something behind’, ‘walking a lot’). ‘Working on a concrete floor’ was reported more often as contributing to back pain (52%) than ‘working mainly in a standing position’ (43%), ‘standing for a long time’ (27%) or ‘walking a lot’ (13%).

When the responses of the different pairs of contrasts are compared, having been compensated has a significant impact on perception for only one item in 18. However, assemblers who reported back pain or work limitations responded significantly differently from those who reported none of these problems in seven and thirteen questions, respectively. For the latest, the odd ratios were the highest, with half being greater than 3.5. The most discriminant factors were ‘maintaining a position for a long time’ (OR = 7.9), ‘using a rivet gun’ (OR = 7.0) and ‘standing for a long time’ (OR = 5.9).

The value of the ORs varied greatly from one work characteristic to the next, with values ranging from 0.5 to 7.9. In general, however, the questions referring to contexts had the lowest ORs. The OR values did not seem to be related to the level of difficulty first perceived by those having no back problem. High ORs were found as much for characteristics considered difficult by a few as by a large number of assemblers without back problems. Therefore, a characteristic considered not difficult by assemblers without back problems may be a major source of difficulty for those with a back problem. This is the case with the rivet gun. Lastly, when the ORs were ordered, practically the same sequencing was found in the Pain and Lim contrast pairs. A continuum seemed to exist between these two pairs; work limitations could increase the perception of what is difficult for the back.
Difficulties for the back related to assembly work: J. Duquette et al.

Table 2 Distribution of the coefficients of concordance (Kendall's WJ) for the ten series of four photos

<table>
<thead>
<tr>
<th></th>
<th>$0.75 \leq W &lt; 1$</th>
<th>$0.5 \leq W &lt; 0.75$</th>
<th>$0.25 \leq W &lt; 0.5$</th>
<th>$0 \leq W &lt; 0.25$</th>
</tr>
</thead>
<tbody>
<tr>
<td>All assemblers</td>
<td>0</td>
<td>5</td>
<td>4</td>
<td>1</td>
</tr>
<tr>
<td>Comp</td>
<td>1</td>
<td>8</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>NComp</td>
<td>0</td>
<td>3</td>
<td>6</td>
<td>1</td>
</tr>
<tr>
<td>Pain</td>
<td>0</td>
<td>4</td>
<td>5</td>
<td>1</td>
</tr>
<tr>
<td>NPain</td>
<td>1</td>
<td>5</td>
<td>3</td>
<td>1</td>
</tr>
<tr>
<td>Lim</td>
<td>0</td>
<td>4</td>
<td>5</td>
<td>1</td>
</tr>
<tr>
<td>NLim</td>
<td>1</td>
<td>5</td>
<td>3</td>
<td>1</td>
</tr>
</tbody>
</table>

Difficult positions for the back

The objective was to determine which positions would be identified as being the most difficult and to verify the consensus between assemblers (Kendall's concordance coefficient Wj). Four positions per series, in ten questions, were ranked in order of difficulty for the back. As shown in Table 2, the concordance between the assemblers was never very strong ($W \geq 0.75$). In fact, the rank-to-rank analysis shows that if 62.6% of the assemblers agreed on the most difficult position, only 45.3% agreed on the easiest one and 36.5% on the intermediate positions. Also, the mean rank attributed to the photographs was not significantly affected by back condition. However, the back condition had an impact on the value of the concordance coefficient at $p \leq 0.01$ in seven pairs and at $0.01 < p \leq 0.05$ in eight other pairs. No delineated pattern was found. For example, when looking at the W's of a contrast pair with statistical difference, compensated assemblers showed systematically a better concordance than those not compensated, while those with pain had a lower concordance than those free of pain.

As described in the methods, the positions illustrated six posture parameters (trunk flexion; lateral flexion and/or torsion; upper limb support on the body, on objects; abduction; direction of the effort). The only discriminant item was the presence of anterior flexion $\geq 45^\circ$; it characterized the position considered the most difficult by most of the assemblers.

Factors associated with difficulties

The questions were focused on two types of difficulties, namely the importance of postures in relation to the efforts, and the duration in relation to frequency. In the case of the tools (Table 3), it was clearly the combination of positions and efforts that dominated. Effort never ranked first, even for the alligator squeeze, which weighed 35 pounds and was handled without support. In fact, for three of the five tools, the efforts appeared to be only marginally difficult. Furthermore, when the assemblers were asked to choose (Table 4), they clearly favored improved position over a reduction in effort (80% vs 10%). However, it was not so much adopting a position often as opposed to adopting it for a long time (or for a long time and often) that seemed problematic. However, the assemblers gave less importance to the reduction in standing working time.

Finally, contrary to what was observed in the preceding sections, back pain rarely significantly affected the responses of the different subgroups. Of the 33 ORs calculated in Tables 3 and 4, only three were greater than 2.0 or less than 0.5. Regardless of their back pain, assemblers described their difficulties using the same reasons and favored the same choices.

Table 3 Percentage of assemblers saying that the difficulties in using tools are related to positions and/or to efforts, and ORs

<table>
<thead>
<tr>
<th>Tool</th>
<th>Both position and effort</th>
<th>Position</th>
<th>Effort</th>
</tr>
</thead>
<tbody>
<tr>
<td>Alligator squeeze</td>
<td>58 A1</td>
<td>19 B</td>
<td>187 B</td>
</tr>
<tr>
<td>Countersink</td>
<td>61 A</td>
<td>21 B</td>
<td>16 B</td>
</tr>
<tr>
<td>Bucking bar</td>
<td>51 A</td>
<td>43 AE</td>
<td>4 C</td>
</tr>
<tr>
<td>Rivet gun</td>
<td>54 A</td>
<td>32 D</td>
<td>9 C</td>
</tr>
<tr>
<td>Drill</td>
<td>34 AE</td>
<td>34 DE</td>
<td>7 C</td>
</tr>
<tr>
<td>Overall tools</td>
<td>56 A</td>
<td>30 R</td>
<td>11 C</td>
</tr>
<tr>
<td>Odd ratio</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Comp: NComp</td>
<td>1.3</td>
<td>0.9</td>
<td>0.7</td>
</tr>
<tr>
<td>Pain: NPain</td>
<td>2.1*</td>
<td>0.6</td>
<td>0.8</td>
</tr>
<tr>
<td>Lim: NLim</td>
<td>1.7</td>
<td>0.6</td>
<td>0.9</td>
</tr>
</tbody>
</table>

1 Results not significantly different at $p \leq 0.05$ have the same letter
2 The total of % in a rank can be less than 100% since 2 to 5% of the assemblers chose "another reason" or "I don't know"
3 *: $p < 0.05$

Discussion

The results on the assemblers' perception indicate that the positions adopted during work are a greater source of difficulty than the efforts, even with a heavy tool such as the alligator squeeze. These results are based on the workers experience from a given setting and could have been different in other situations. Clearly predominant, is the importance also given to the amount of time that positions are maintained, rather than to their frequency. Other studies demonstrated the impact of duration of the task on the perception of discomfort (Wiker, 1989). It is known, for example, that the greater the amplitude of a
It also appears that the assemblers evaluate their overall positions by integrating several factors. In fact, when positions are characterized element by element, very few appear to have a determining impact. The same abduction of the arm may be considered difficult or not, depending on the nature and direction of the effort applied. Postural imbalance or back flexion will be perceived differently based on whether it is used to push on a tool or to lift something. Postures are the basis of actions, and it is the combination of these two that were evaluated by the assemblers. Furthermore, even though it is clear that assemblers gave great importance to positions, they more or less agreed in their ranking, save for the extremes. Also their evaluations of work context, which refers to a combination of elements, were generally more negative than for work activities. This may explain the difficulties previously encountered when linking work and back pain in assemblers (Bigos et al., 1986b).

From all indications, investigating contexts from conventional methods is very difficult. The use of photographs and diagrams in the questionnaire has the advantage of standardizing the understanding and interpretation of the questions. Perceptions of more complex and specific situations are better investigated with this medium, than being described in words. However, the interpretation is more difficult, since only the interview will permit to know what information was privileged in a given picture.

This study also demonstrates that back pain has an impact on the perception of difficulties. Assemblers reporting back pain and those with work limitations caused by the back answered differently from the others, one time out of three and three times out of four, respectively. The feelings of limitations due to the back conditions appear from both the results of this questionnaire and from the one on spinal health status (Rossignol et al., 1993), to represent a more severe stage than when only reporting of back pain. The different perceptions of the difficulty associated with a task, between workers with and without back pain, comes in part from the integration of the back pain experience into the task. Insofar as different people experience pain differently, the role of pain in shaping the perceptions will differ according to the consequences of the pain on the person's functioning at work and outside work (Melzack and Wall, 1982). The final perception of difficulty is therefore a synthesis of pain and functional status, two health outcomes that are poorly correlated to each other (Deyo, 1988) and of previous back injury mechanisms at the task. The perception is also likely to differ between workers who remember a back pain experience at a task and those

<table>
<thead>
<tr>
<th>Option</th>
<th>Assemblers %</th>
<th>Comp</th>
<th>Pain</th>
<th>Lim</th>
</tr>
</thead>
<tbody>
<tr>
<td>Reducing the efforts or improving the positions</td>
<td>80***</td>
<td>1.4</td>
<td>1.0</td>
<td>1.0</td>
</tr>
<tr>
<td>Reducing the time spent standing</td>
<td>38</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>or reducing the efforts standing</td>
<td>47</td>
<td>1.9</td>
<td>0.9</td>
<td>0.5</td>
</tr>
<tr>
<td>Improving the positions or reducing time spent standing</td>
<td>16</td>
<td>2.0</td>
<td>1.5</td>
<td>0.7</td>
</tr>
</tbody>
</table>

Main factor identified for the position perceived as the most difficult:
- Both adopting it often and a long time: 46 A
- Adopting it for a long time: 28 B
- Adopting it often: 11 C
- Don't know: 8 D
- Another reason: 7 D

1 For all the photos presented
2 Results not significantly different at p<0.05 have the same letter
3 ***: p<0.001; **: p<0.01; *: p<0.05
who currently have a back problem, although to our knowledge, this issue has never been addressed.

When workers with back pain are compared to those who do not report any problems, there is a difference in what is perceived as being difficult for the back. For example, a work characteristic causing little difficulty for an assembler without back problems may be a major source of difficulty for another. The most marked example is the rivet gun. This type of tool would have gone unnoticed if only responses of the assemblers without back problems were considered. On the other hand, the perception of difficulty for something considered usually difficult by workers without back problem is not necessarily amplified when there is a back problem. This was shown for the alligator squeeze. The impact of back pain on the perception of difficulty is therefore complex. It appears that we cannot always extrapolate our knowledge about perception obtained from subjects without problems to subjects with back problems.

Until now, few studies focused on workers experiencing back problems but nevertheless working. As shown by Rossignol et al (1993) in a one-year longitudinal study, the presence of limitations and a history of compensations are significant indicators of subsequent back disability. It is therefore important to prevent the worsening of early stages of spinal disorders toward the disabling condition. The perception data does not tell us what caused the back pain or how the assemblers coped with the pain. But perceptions of difficulty after a back pain episode might be of a critical importance for planning a successful return to work.

Waddell et al. (1993) have shown that some workers develop fears and avoidance behaviors after a back injury and those become an important predictor of prolonged incapacity. When considering risk factors in the workplace, it seems therefore critically important to attach to the task, the perception of difficulty. Without the latter, prevention efforts may serve useless.

Furthermore, it seems that assemblers with back problems are clearly more sensitive to prolonged postures than to movements. This agrees with the results of other studies which show that static activities are harder on the back than dynamic activities in subjects with back pain (Bergquist-Ullman and Larsson, 1977; Buckle et al., 1986; Million et al., 1982; Vällfors, 1985). Isometric endurance of the back muscles is known to be lower in back pain sufferers (Biering-Sorensen, 1984; Jorgensen and Nicolaisen, 1987; Holmstrom et al., 1992); the latter need to change position more frequently (Dionne and Turcotte, 1992). Back pain sufferers exposed to stationary working positions have relapses that last longer than the others (Bergquist-Ullman and Larsson, 1977). This could explain the lack of a relationship noted by Battie et al. (1990) between flexibility measurements in assemblers and risks of subsequent back pain. From a preventative standpoint, it therefore seems particularly important to question the workers about activities involving prolonged postures.

Conclusions

One of the reasons for considering perception is that it covers aspects that are difficult to measure, such as comfort and difficulty. Assemblers evaluate difficulties by considering combinations of factors rather than by considering individual aspects. Back pain appears, furthermore, to modulate these perceptions in a complex way. Perception does not allow risk factors to be measured, but its analysis is nonetheless a useful and pertinent tool in identifying the sources of difficulties on which preventative action should be taken.

Acknowledgements

This work was sponsored by the Institut de Recherche en Santé et Sécurité du Travail du Québec.

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Appendix

Summary of the questionnaire

(1) Eight questions about activities: is the following activity causing you a problem? Very¹, somewhat¹, a little², none².

(2) Five questions about contexts: in your opinion, do these situations contribute to back pain? Very much¹, somewhat¹, a little², not at all² difficult for the back, I don't know.

(3) Five questions about tools: two questions per tool.
   (a) In your opinion, using (name of tool) helps make your work: A lot¹, somewhat¹, a little², not at all² difficult for the back, I don't know.
   (b) Why? (If the assembler answered a little, somewhat, or a lot.) Particularly due to the position adopted, efforts that must be made, both positions and efforts, other reason, I don't know.

(4) Ten questions on four photographs showing different positions. Three questions were asked per series.
   (a) Rank the four positions in decreasing order of difficulty.
   (b) The position identified as the most difficult is adopted at your workstation: Very often, somewhat regularly, occasionally, never.
   (c) What makes this position hard on the back? Using it often, for a long time, both, another reason, I don't know.

(5) Three questions about alternatives: If you had to choose between two types of changes to your workstation, which would you choose? Reducing efforts, or adopting more comfortable positions? Reducing the time that you have to work in a standing position, or reducing efforts? Adopting more comfortable positions, or reducing the time that you have to work in a standing position?

¹ Considered as a 'yes' answer, ² considered as a 'no'.

[1]