Perceived demands and musculoskeletal symptoms among employees of an Iranian petrochemical industry

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A B S T R A C T

As a part of a comprehensive ergonomics program, this study was conducted among employees of an Iranian petrochemical industry to determine the prevalence of musculoskeletal symptoms and to examine the relationship between perceived demands and reported symptoms. In this cross-sectional study, 928 randomly selected employees, corresponding to nearly 40% of all employees participated. Nordic Musculoskeletal Disorder Questionnaire and Job Content Questionnaire were used as collecting data tools. The results showed that 73% of the study population had experienced some form of symptoms from the musculoskeletal system during the last 12 months. Knees and lower back symptoms were the most prevalent problem among the employees studied. The results revealed that perceived physical demands were significantly associated with musculoskeletal symptoms (OR ranged from 1.45 to 2.33). Among the perceived physical demands, awkward working postures were most frequently associated with reported musculoskeletal symptoms. Association was also found between perceived psychological demands and reported symptoms. Conflicting demands, waiting on work from other people or departments, interruption that other make, working very fast and time pressure were psychological factors retained in the regression models with OR > 1.49. Based on the findings, it could be concluded that any interventional program for preventing or reducing musculoskeletal symptoms among the petrochemical employees studied had to focus on reducing physical demands, particularly awkward working postures as well as psychological aspect of working environment.

Relevance to industry: In petrochemical industry where employees are involved in both static and dynamic activities, determination of musculoskeletal symptoms contributing factors can be considered as a basis for planning and implementing interventional ergonomics program for preventing musculoskeletal symptoms and improving working conditions.

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1. Introduction

Musculoskeletal disorders represent one of the leading causes of occupational injury and disability in the developed and industrially developing countries (Shahnavaz, 1987; Genaidy et al., 1993; Kemmlert, 1994; Maul et al., 2003). The economic loss due to such disorders is high and affects not only the individual but also the organization and the society as a whole (Kemmlert, 1994; Ariëns et al., 2001). At present time, musculoskeletal disorders are one of the most important problems ergonomists are encountered in the workplace around the world (Vanwonerghem, 1996). In many countries, the prevention of musculoskeletal problems has been considered as a national priority (Spielholz et al., 2001).

Musculoskeletal disorders are worldwide concern and distributed among both Industrialized Countries (ICs) and Industrially Developing Countries (IDCs). In IDCs, the problems of workplace injuries are extremely serious (Shahnavaz, 1987). Poor working conditions and the absence of an effective work injury prevention program in IDCs have resulted in a very high rate of musculoskeletal symptoms (Jafry and O’Neill, 2000).

Risk factors of musculoskeletal symptoms are known to include workplace activities such as heavy load lifting, repetitive tasks, awkward working postures and seated static postures (Bernard, 1997; Haynes and Williams, 2008), while individual characteristics, psychosocial and organizational factors are also known to be important predictive variables (Linton and Kamwendo, 1989; Carter...
and Banister, 1994; Weiser, 1997; Buckle and Devereux, 2002; Østensvik et al., 2008).

In petrochemical industry, where petrochemical products are produced in a continuous process, employees may be encountered to diverse musculoskeletal symptoms risk factors. For instance, long hours of seated activities with high rate of mental workload are observed among control room workers. Highly dynamic repetitive activities in maintenance operation and overhauls are also very common among operational workers. In these situations, high rate of musculoskeletal symptoms occurrence is expected in both groups of employees.

As far as we know, few ergonomics study has been conducted on musculoskeletal symptoms and their work-related contributing factors in petrochemical industry. In the petrochemical industry where the present study was done, a comprehensive ergonomics program was being performed to improve working conditions and reduce work-related health problems. As a part of this program, the present study was undertaken with the following objectives: a) determination of the prevalence rate of musculoskeletal symptoms among employees of the petrochemical industry, b) identification of major factors associated with symptoms in the study population, and c) examination of the relationship between perceived physical and psychological demands and reported symptoms in different body regions of workers, taking into consideration the impact of other potentially confounding variables. It was believed that the results of this study could be an appropriate base for planning and implementing intervention ergonomics program in the workplace and improving workers’ health in this industry.

2. Methods

2.1. Design and samples

In this cross-sectional study conducted from December 2006 to September 2007, data were collected via anonymous questionnaires. A random sample of 928 workers, corresponding to nearly 40% of all employees in the industry, with at least one year of job tenure was selected from different units. Each subject received the questionnaire in person in his/her workplace. He/she was given 30 min to complete the questionnaire and return it to the researcher.

The questionnaire consisted of three parts and covered the following items: individual data and demographics (including gender, age, weight, height, job tenure, job type, smoking, education, working schedule, health and medical background); musculoskeletal symptoms in different body regions; and perceived job demands. Reported symptoms were limited to the past 12 months.

2.2. Measurement of variables

The general Nordic Questionnaire of musculoskeletal symptoms (Kuorinka et al., 1987) was used to examine reported cases of symptoms among the study population. The Job Content Questionnaire (JCQ) was used to measure perceived job demands (Karasek, 1985). The JCQ contains items of work demands both physical and psychological aspects. It has been used to study the relation between work demands and work-related outcomes (i.e., musculoskeletal symptoms, cardiovascular disease, etc.) in different countries (Karasek et al., 1998). Additional physical demand items for considering physical activities in more details, as recommended by Trinkoff et al. (2003), were also included. Physical and psychological demands were measured using the twelve-item and the eight-item JCQ scales, respectively (see Appendix for items). Each item was scored based on a 4-point scale (i.e., strongly agree to strongly disagree or often to never).

Based on the methodology used by Trinkoff et al. (2003), responses for perceived physical demands were dichotomized (1 and 2 vs. 3 and 4). The score for 1 and 2 was 0 and for 3 and 4 was 1. The scores were summed to produce total scores ranged from 0 to 12. The results were then categorized as low (0 to 2), medium (3 to 9), and high (10 to 12) physical demands. Items for perceived psychological demands were dichotomized as well (1 and 2 vs. 3 and 4) and summed into a demand score to produce total scores ranged from 0 to 8. Perceived psychological demands were then categorized as low (0 to 5) and high (6 to 8) demands.

2.3. Data analysis

Statistical analyses were performed using SPSS (version 11.5) and STATA (version 7). Chi-square test was used to assess univariate associations between variables (individual and perceived) and reported musculoskeletal symptoms. Multiple logistic regression analysis (Stepwise) was performed for each of outcome retaining the variables (individual and perceived) in the models to adjust for potential confounding. In the regression analysis, if the P value of Chi-square test for assessing association between the variable and reported symptoms was < 0.25, the variable was included in the regression model of that region (inclusion criteria) (Kleinbaum et al., 1982). For each body region, this procedure was performed for all individual and perceived variables.

3. Results

Table 1 summarizes individual data and demographics of the employees participated in the study. Table 2 presents the prevalence of symptoms in different body regions of the participants during the last 12 months. As Table 2 shows, the most commonly affected regions among the workers are knees (37.2%), lower back (33.9%), neck (27.8%), and shoulders (26.3%).

Table 3 compares point prevalence of the symptoms among the petrochemical employees studied, general Iranian population

<table>
<thead>
<tr>
<th>Gender (%)</th>
<th>Female</th>
<th>1.4</th>
<th>Male</th>
<th>98.6</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age (years)</td>
<td>M (SD)</td>
<td>37.99 (5.24)</td>
<td>23–67</td>
<td></td>
</tr>
<tr>
<td>Weight (kg)</td>
<td>M (SD)</td>
<td>76.49 (10.29)</td>
<td>49–114</td>
<td></td>
</tr>
<tr>
<td>Height (cm)</td>
<td>M (SD)</td>
<td>174.18 (6.76)</td>
<td>145–198</td>
<td></td>
</tr>
<tr>
<td>Body Mass Index</td>
<td>M (SD)</td>
<td>25.2 (2.99)</td>
<td>15.31–35.43</td>
<td></td>
</tr>
<tr>
<td>Job tenure (years)</td>
<td>M (SD)</td>
<td>9.42 (4.48)</td>
<td>1–22</td>
<td></td>
</tr>
<tr>
<td>Education (%)</td>
<td>High school degree</td>
<td>69.7</td>
<td>Associate’s degree</td>
<td>13.8</td>
</tr>
<tr>
<td>Smoking (%)</td>
<td>Yes</td>
<td>28.2</td>
<td>No</td>
<td>71.8</td>
</tr>
<tr>
<td>Exercise (%)</td>
<td>Occasionally</td>
<td>72.8</td>
<td>Regularly</td>
<td>11</td>
</tr>
<tr>
<td>Working schedule (%)</td>
<td>Shift</td>
<td>58.4</td>
<td>Day working</td>
<td>41.6</td>
</tr>
<tr>
<td>Type of job (%)</td>
<td>Office</td>
<td>13.9</td>
<td>Operation</td>
<td>63.6</td>
</tr>
<tr>
<td>Bothb</td>
<td>22.4</td>
<td></td>
<td></td>
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</tr>
</tbody>
</table>

* One that is given after completing two years of study at a junior college.

b Workers with both office and operation activities.
(National Research Center of Medical Sciences of Iran, 2001), an Iranian rubber factory (Choobineh et al., 2007) and hospital nurses (Choobineh et al., 2006). Statistical analysis (test of proportion) revealed that the differences between the prevalence rates of symptoms in neck and large joints among the employees studied and the general Iranian population were significant ($P < 0.0001$), while for upper and lower back it was not significant ($P > 0.05$). It was also found that the prevalence rate of symptoms in neck among the employees studied was significantly higher than that of rubber workers ($P < 0.0001$) and less than that of hospital nurses ($P < 0.0001$). The prevalence rates of symptoms in upper and lower back as well as large joints among the employees studied were significantly less than those of rubber workers and hospital nurses ($P < 0.0001$).

Based on the participants’ reports, during the last 12 months there were totally 1626 days of sick leave due to musculoskeletal symptoms. Accordingly, the average sick leave for each employee was 1.75 days/year ($SD = 10.65$). Due to musculoskeletal symptoms, during the preceding year, $33.2\%$ of the study population had to visit a physician; $13.4\%$ of the employees had to take medical rest; during the preceding year, there were totally 1626 days of sick leave due to musculoskeletal symptoms. Accordingly, the average sick leave for each employee was 1.75 days/year ($SD = 10.65$). Due to musculoskeletal symptoms, during the preceding year, $33.2\%$ of the study population had to visit a physician; $13.4\%$ of the employees had to take medical rest; during the preceding year, $33.2\%$ of the study population had to visit a physician; $13.4\%$ of the employees had to take medical rest; $7.7\%$ of them needed to use physiotherapy services.

Table 4 presents significant factors associated with musculoskeletal symptoms for each body region. The significant factors for each body region are the result of a multiple logistic regression analysis performed to adjust for potential confounding. As Table 4 shows, some items of perceived physical as well as psychological demands are significantly associated with reported musculoskeletal symptoms of different body regions. Static and awkward postures, moving/lifting and pushing/pulling heavy objects are physical factors retained in the regression models with odds ratios (OR) generally greater than 1.5. Conflicts at work, waiting on work from other people or departments, working very fast, interruption that others make and no enough time to get the job done are the psychological factors retained in the regression models with OR generally greater than 1.5. Smoking was the only individual factors retained in the regression model of upper back region with $OR = 1.52$. These indicate that among all factors included in the regression models, the mentioned physical, psychological and individual items have noticeable association with reported symptoms in different body regions.

The association between the level of perceived demands and reported symptoms in different body regions are presented in Table 5. Since the number of the employees categorized in low perceived physical demands level was small, to perform meaningful statistical analysis, the low and the medium levels were combined to form low-medium physical demands level. As shown in Table 5, in shoulders, elbows, thigh and knees the prevalence of symptoms is significantly higher in high physical demands level group ($P < 0.05$).
indicating the association between high-perceived physical demands and the prevalence rate of symptoms. Regarding psychological demands, in neck, wrists/hands and knees the prevalence of symptoms was significantly higher in high psychological demands level group ($P < 0.05$). This indicated association between high perceived psychological demands and the prevalence rate of symptoms.

4. Discussion

4.1. Musculoskeletal symptoms prevalence

The questionnaire showed that symptoms from the musculoskeletal system were common among the petrochemical employees studied. A vast majority of the study population had experienced some form of symptoms during the past 12 months (73%). Knees and lower back symptoms were the most prevalent problem among the employees studied.

The results demonstrated that the prevalence rates of symptoms in office and operation workers were not significantly different ($P > 0.05$), with exception for neck in which the prevalence rate was significantly higher among workers with both activities. This might indicate that exposure to contributing factors of symptoms occurred in both groups.

Comparisons revealed that the differences between the prevalence rates of symptoms in neck and large joints among the employees studied and the general Iranian population were significant. This may indicate that jobs in petrochemical industries can be considered as occupations with risk of developing musculoskeletal symptoms in the mentioned regions. The results also showed that symptoms in back and large joints among petrochemical workers occurred in low rate in comparison with rubber workers and hospital nurses. This might indicate that the jobs and activities in petrochemical industry were not as demanding as those in rubber industry or hospital nursing where workers were exposed to high level of risk factors, particularly physical risk (i.e. awkward posture and manual material handling) (Choobineh et al., 2006; Choobineh et al., 2007).

4.2. Musculoskeletal symptoms associated factors

4.2.1. Perceived physical demands

Statistical analysis of our data showed that perceived physical demands i.e. static and awkward postures and moving/lifting and pushing/pulling heavy objects were significantly associated with musculoskeletal symptoms in different body regions. Based on our observations, perceived physical demands were originated from long hours of seated work with static postures in control room for office workers and manual material handling activities and awkward postures while doing operational activities such as maintenance tasks for operational workers. In their systematic review among telecommunications workers, Crawford et al. (2008) reported manual material handling as physical risk factors associated with the development of musculoskeletal symptoms. Studies have shown that in jobs with manual material handling (such as jobs of operational workers in petrochemical industry) and jobs with more sedentary activities (such as jobs of control room and office workers in petrochemical industry) high rate of lower back problems and low back pain could occur (Haynes and Williams, 2008). This is in agreement with our results.

Among the perceived physical demands investigated in this study, awkward working posture was found to be the most frequently associated with reported musculoskeletal symptoms in different body regions. For neck and shoulder regions, there is strong evidence that awkward posture is a work-related physical risk factor (Buckley and Devereux, 2002). It is in line with the result of the present study.

4.2.2. Perceived psychological demands

Statistical analysis revealed that some psychological factors including conflicts at work, waiting on work from others, interruption that others make and time pressure were significantly associated with musculoskeletal symptoms in different body regions and retained in the regression models. It is in contrast with the results of Choobineh et al. (2006) in which no association was found between perceived psychological demands and reported symptoms among hospital nurses. Kerr et al. (2001) pointed out that when physical demands were included in a model of musculoskeletal symptoms, the significance of psychological demands would disappear. In our study, remaining psychological factors in the regression models may indicate the strong influence of these factors on symptoms occurrence and imply that the employees studied could be encountered with high level of psychological demands. It is to be noted that many studies have indicated the significant role of psychosocial factors in the development of musculoskeletal symptoms (Crawford et al., 2008) which is in accord with our findings.

A number of studies have found evidence for positive relationship between neck and back pain and some dimensions of psychological job demands (i.e. low social support, low job control and job satisfaction) (Hoogendoorn et al., 2000; Ariëns et al., 2001). For upper extremities (i.e. shoulder, elbow and hand/wrist) there is also some evidence for a relationship between high psychological job demands and symptoms occurrence (Bongers et al., 2002). In our study, we did not have these dimensions in the regression models, but among the psychological items only “interruption that others make ” and “conflicts at work and waiting on work from others” remained in the models for back and neck, respectively, showing the effect of these kinds of factors on the occurrence of the mentioned region symptoms. It is to be noted that Ariëns et al. (2001) found inconclusive evidence for the effect of “conflicts at work” on occurrence of neck symptoms. It is not in agreement with the results of the present study.

4.2.3. Individual factors

Among all individual factors presented in Table 1, which were introduced in the regression models, only smoking was retained in the model for upper back with OR = 1.52. Some researches have found similar positive association between smoking and musculoskeletal symptoms (Liljana et al., 2004; Brage, 1996). Type of job i.e. office and operational work was not retained in the models indicating that in this study population the chance of symptoms occurrence among white and blue collar workers was the same. It is in line with the results shown in Table 2.

Statistical analysis also revealed that when comparing the low and the high-perceived demands groups, both physical and psychological demands had influence on the prevalence rate of symptoms in some body regions. This indicated the consistency of the results of statistical analyses presented in Tables 4 and 5.

Regarding to the cross-sectional design of the study and data collection by self-report method, the findings of this study should be interpreted with caution. Self-report methodology may suffer from some weak points namely difficulty in recall, denial or deception. In this study, however, by limiting the recall period for reported symptoms to the past 12 months, the time over which data needed to be recalled was restricted. Finally, since the analysis was limited to currently working employees, workers who had left jobs due to musculoskeletal symptoms may have been excluded from the study and healthy worker effect might occur. Thus, the data may underestimate reported symptoms and the association of perceived demands with musculoskeletal symptoms.
5. Conclusion

Musculoskeletal symptoms occurred among the petrochemical employees studied. The results of this study showed the importance of perceived both physical and psychological demands in relation to reported musculoskeletal symptoms in different body regions. Among the perceived physical demands, those involving awkward postures were most frequently associated with reported musculoskeletal symptom. Based on the findings of this study, it can be concluded that any interventional program for preventing or reducing musculoskeletal symptoms among the study population should focus on reducing awkward postures as well as psychological aspect of working environment.

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Appendix

Physical demand items:

- My job requires:
  - Lots of physical efforts
  - Rapid and continuous physical activity
  - In my job, I am:
    - Working for long periods with my head or arms in awkward positions
    - Working long periods with my body in awkward positions
  - How often in a typical workday do you:
    - Lift or lower objects to/from shoulder height
    - Lift or lower objects to/from floor
    - Lift or lower objects to/from shoulder height
    - Stand in one place/static position (>30 min)
    - Perform repetitive motions with hands/wrists
    - Apply pressure with hands/fingers

  a Original items from the JCQ (Karasek, 1985).
  b Items from Trinkoff et al. (2003).

Psychological demand items:

- My job requires:
  - Working very hard
  - Working very fast
  - An excessive amount of work
  - Long periods of intense concentration on the task
  - Enough time to get the job done

- My job:
  - Is free from conflicting demands that others make
  - Has tasks that are often interrupted before they can be completed
  - Requires waiting on work from other people or departments

  a Original items from the JCQ (Karasek, 1985).

References


a Original items from the JCQ (Karasek, 1985).

b Items from Trinkoff et al. (2003).