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ORIGINAL ARTICLE

J. B. Malchaire · Y. Roquelaure · N. Cock · A. Piette
S. Vergracht · H. Chiron

Musculoskeletal complaints, functional capacity, personality and psychosocial factors

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Abstract ***Objectives***: The aim of the research was to study the association between psychosocial and personality factors, and neck and wrist-hand musculoskeletal complaints, taking account of the occupational factors of force, posture and repetitiveness, and non-occupational risk factors such as sport, hobbies, medical history. ***Methods***: During personal interviews 133 women from seven different companies, working at constraining workplaces (very repetitive work), answered several questionnaires. These concerned: personal characteristics and history; work characteristics; psychosocial factors (perception and appreciation of the work situation, satisfaction at work, stress symptoms, Karasek questionnaire) and personality factors (neuroticism, conscientiousness, type-A behavior). They also undertook functional and psychomotor tests (wrist angles, grip strength and a dexterity test). Logistic regression models were calculated. ***Results***: Wrist-hand complaints appear to be associated with some personal characteristics (smoking habits, fewer hobbies), work constraints (fewer breaks, heavy lifting efforts) and some personality (introversion) and psychosocial factors (worse appreciation of work). Neck complaints are also associated with some personal characteristics (young people, small, bad health, hormonal problems, fewer hobbies), some personality (urgency of time) and psychosocial factors (constraints as seen by the supervisor). ***Conclusion***: The study confirms the multifactorial character of the musculoskeletal disorders and underlines the need for a global ergonomic approach to work situations, taking into account all their physical, psychological and social components.

Keywords Risk factors · Neck · Wrist-hand · Ergonomics · Stress

J. B. Malchaire (✉) · N. Cock · A. Piette · S. Vergracht
Université catholique de Louvain, Unité Hygiène et Physiologie du Travail, Clos Chapelle-aux-Champs 30–38, 1200 Brussels, Belgium
E-mail: malchaire@hytr.ucl.ac.be
Tel.: +32-2-7643229
Fax: +32-2-7643954

Y. Roquelaure · H. Chiron
Centre de Consultation de Pathologie professionnelle, CHU, Angers, France

Introduction

Many studies concerning the musculoskeletal disorders (MSDs) of the upper limbs and the neck have been published, and the occupational and non-occupational risk factors are now rather well known. The main biomechanical risk factors are effort, repetitiveness, postures and vibration (Malchaire et al. 1997), and the non-occupational factors most often identified as risk factors are hobbies, the practice of racket sports, systemic diseases and so on, and these factors remain to be taken into account in any study of susceptibility to the MSDs.

These factors explain only part of the prevalence of MSDs. This is why, during the past 10 years, more and more studies were interested in the relationship between certain psychosocial factors and the MSDs, initially for back disorders and then for the upper limbs. From these studies, it becomes evident that such an association indeed exists (Bongers et al. 1993), but it remains vague and leads little to prevention measures.

That is partly due to the fact that these factors were often approached in a different way by the researchers, that the scientific world, at least in the field of the MSDs, did not agree on common definitions of these concepts and that the evaluation tools (questionnaires) were different and often specific to the study.

It is particularly true for the stress questionnaires, developed mainly for the tertiary sector, some directed towards stress factors at work (stressors), others towards somatic disorders and stress signals such as emotional tiredness, rumination, emotional reactions at work and so on. In addition, these questionnaires are not, in general, usable as such in the secondary industrial sector, and must be adapted.

Lastly, very few studies tried to consider the operator as a whole, in terms of general behavior, leisure activities, reactions vis-à-vis the stress, motivation, personality etc., whereas all these factors determine the single way in which the work is approached and the single way in which the operator sees it and is influenced by it.

Whereas the majority of the studies reported in the literature consider only one type of risk factors, either biomechanical or psychosocial, the present study was designed to be as exhaustive as possible, in taking account of the whole of the aspects to try to highlight what could be associated with the development of the MSDs.

The study is cross-sectional and will thus not be able to show any cause-effect relationship. It will, however, make it possible to highlight significant associations, suggesting cause-effect relationships that could be investigated in later prospective studies.

The aim of the research was to study the direct or indirect association between psychosocial and personality factors, and neck and wrist-hand musculoskeletal complaints, taking account of the well-known occupational and non-occupational risk factors.

Material and methods

The dependent variable used in the present study is the existence or not of musculoskeletal complaints in the neck and/or wrists/hands regions. This was determined by the Nordic questionnaire (Kuorinka et al. 1987). People were asked to answer the question "have you at any time, during the last 12 months, had troubles (ache, pain, discomfort) in the neck and the wrists/hands? Yes or No".

Four categories of data were collected as independent variables during an interview of each worker, always with the same physiotherapist. The four categories are given below.

A. Personal characteristics

- Age, weight, height, and seniority.
- Personal factors: health, chronic diseases, and accidents.
- Non-occupational factors such as the practice of a sport or a pastime involving musculoskeletal constraints of the upper limbs (e.g. do-it-yourself, knitting).
- Functional tests:

  1. Measurement of the maximum angles of the wrists in flexion-extension and radio-ulnar deviation using goniometers (Penny and Giles, Blackwood Ltd., UK), the neutral position being with the palm of the hand lying on the table, the middle metacarpal in the axis of the forearm.
  2. Measurement of the maximum grip strength by means of a hydraulic dynamometer standard Jamar (Jamar, Camp, UK). The test was performed with 90°-elbow flexion, forearm horizontal to the floor and wrist in neutral position (Mathiowetz 1990).

- Psychomotor test: the O' Connor finger dexterity test (Lafayette, UK): the subject being requested to fill 20 holes in a plate, as fast as possible, with three stems, with the lowest number of errors (falls of stems, taking of two or four stems etc.).

B. Working conditions

- A questionnaire concerning the work schedules, labor, the products manufactured, initial training and the perception of effort and repetitiveness. In this regard, three questions were asked:
- Does your work involve:

  1. Lifting efforts: none to light or medium-heavy to heavy.
  2. Hand and wrist efforts: none to light or medium-heavy to heavy.
  3. Repetitive work or motions: never to sometimes or often to always.

- In addition, each subject was observed (video recordings) for a representative period of 10 to 20 min depending on the length of the work cycle. Following the procedure described by the OWAS method (Karhu et al. 1981) 100 images at regular intervals were observed and the posture of the wrist in flexion-extension and in radio-ulnar deviation was noted, using the scale defined by Armstrong et al. (1982). The results were expressed in percentages of the time in extreme postures in the two planes.

C. Personality characteristics

We used various questionnaires to determine the following personality characteristics:

- Neuroticism (tendency to emotional instability and susceptibility to negative affectivity) and extraversion (sociability, high level of activity and domination) by means of the questionnaire of personality by Eysenck (Eysenck and Eysenck 1981).
- Conscientiousness (orderliness, perseverance, ambition) by means of the NEO questionnaire developed by Costa and McCrae (1992).
- Type-A behavior (impatience, urgency of time, competitiveness) by means of the questionnaire by Bortner, that some authors (Edwards et al. 1990) recommended be divided into two components: competitiveness and urgency of time.

D. Psychosocial characteristics

These factors were approached under five different and complementary angles.

- A first questionnaire concerned with the perception of the situation and the work constraints (How is the situation concerning...?). This questionnaire was developed on the basis of a review of the literature, by gathering the psychosocial factors liable to be associated with MSDs. The questions were:

  a. Do you have to hurry to do your work?
  b. Can you stop to rest for one moment when you want to (apart from your meals)?
  c. Do you work overtime?
  d. Are you isolated at your workplace (without colleagues in the neighborhood)?
  e. Do you help each other?
  f. Are there problems with the tools or machines you use (breakdowns, manufacturing faults)?
  g. Is your work monotonous or routine?
  h. Are you autonomous in your work (independent, free)?
  i. Is your work physically tiring?
  j. Is your work mentally tiring? (Does it require attention, concentration?)
  k. Is your employment threatened economically (job security)?
  l. Is your work strongly controlled?

A global score of "perception" was computed as the number of items (out of 12) to which the subject responded positively.

The direct supervisor also answered this questionnaire.

- A second questionnaire concerned the appreciation by the operator of each item of the preceding questionnaire: "Does this situation disturb you?"

Similarly, a global score of "appreciation" was computed as the number of positive answers.

- A third questionnaire included additional questions on the relationships with colleagues and the hierarchy, the satisfaction and interest at work, the appreciation of the stress and of the life in general.
- A fourth questionnaire dealt with the consequences of these constraints on the health of the person (somatic effects): it included eight questions related to tachycardia, headaches, dizziness, nausea, pain in the chest, stomach problems, sleep disorders, abnormal tiredness.
- A fifth questionnaire was based on the model by Karasek (Karasek 1979; Karasek and Theorell 1990), as used by other authors in the context of back disorders, and more recently, of upper limb disorders (Bongers et al. 1993; Josephson et al. 1997; Punnett 1998). The short version of 14 questions prepared by Karasek himself was used. This covers two dimensions of stress:
  - *Psychological demands*, that is, excessive mental constraints.
  - *Decision latitude*, that is, the possibility for the subject of making decisions at work.

The total number of independent data (questions and parameters) recorded was 205. After computation of the scores as indicated, the number was reduced to 85 variables.

Study population

From seven different companies, 133 women took part in the study. The seven work situations were:

- Assembly of disc brakes (36 people).
- Assembly of windscreen wipers (16 people).
- Conditioning of candies (11 people).
- Conditioning of pharmaceutical products (16 people).
- Assembly (welding primarily) of hearing aid components (19 people).
- Loading and unloading of papers in a printing works (20 people).
- Conditioning of biscuits (15 people).

Working conditions with exposure to hand/arm vibration were excluded.

The criteria for inclusion in the study were: to give free informed consent, to be working full-time, with a seniority of at least 1 year and an employment contract with the company (no temporary work). Medically, we retained only the women who, at the level of the upper limbs, had not undergone a surgical operation (carpal tunnel syndrome etc.), or had had an accident (fracture, wound with after-effect and so on) or were suffering from a chronic disease generating disorders such as rheumatoid arthritis. Only one or two operators per workplace did not meet these criteria. All the others were included in the study.

The studied population was, on average, 40 ± 8 years old, with an average weight of 64.4 ± 12 kg and an average size of 161 ± 7 cm. The average seniority of the operators was 19 ± 8 years in the company and 9 ± 7 years at the current workplace. These parameters are broadly distributed since they extend, respectively, from 1 to 37 years and 1 to 30 years.

Table 1 gives the characteristics of age, duration of employment and duration of exposure for the seven workplaces. It shows that the workplaces are reasonably comparable.

Strategy of development of the statistical models of logistic regression

The multivariate logistic regression analysis had to make it possible to study the relationship between MSDs during the past 12 months (at the level of the right wrist and the neck) and the relevant independent variables.

Given the number of independent variables collected (85) compared with the number of subjects (133) and the interactions between some independent variables, we adopted a progressive approach by groups of independent variables. Four groups were formed:

- Personal characteristics (A group), including functional and psychomotor tests for the wrist complaints.
- Characteristics of the workplace (B group).
- Personality characteristics (C group).
- Psychosocial factors (D group).

We calculated a first logistic model by introducing only the personal characteristics. Then, a model was calculated separately for each group of variables B to D, while simultaneously the personal characteristics were introduced. We obtained the final models by again introducing the personal characteristics and those of the three other groups that were statistically significant in the preceding intermediate models.

For each model, the significance threshold was fixed at $P = 0.05$.

Results

The work situations were selected, at the beginning, for their high prevalence of MSDs, and 66% of the

Table 1 Means and standard deviations (*SD*) of age, duration of employment in the company and duration of exposure at the workplace (in years) for the seven work situations

Work situation	*n*	Mean age (± SD)	Mean duration of employment (± SD)	Mean duration at the workplace (± SD)
Assembly of disc brakes	36	43.2 (3.6)	22.8 (5.3)	6.3 (5.9)
Assembly of windscreen wipers	16	36.3 (5.8)	12.9 (5.1)	6.1 (4.1)
Conditioning of candles	11	41.3 (7.1)	19.3 (7.8)	7.4 (6.4)
Conditioning of pharmaceutical products	16	40.3 (8.6)	18.8 (8.6)	7.1 (4.0)
Assembly of hearing aid components	19	43.5 (9.7)	17.5 (6.1)	14.4 (8.0)
Loading and unloading of papers in a printing works	20	43.7 (6.3)	24.1 (6.0)	14.3 (9.7)
Conditioning of biscuits	15	31.9 (7.0)	9.1 (4.9)	7.4 (5.2)

operators suffered from the neck, 47% complained about the right wrist and 38.3% about the left wrist. This explains the fact that the work situations were found to be constraining by the operators (for 63% of the people, lifting efforts judged medium-heavy to heavy; for 77%, hands and wrists efforts judged medium-heavy to heavy; for 98%, very repetitive work). The analysis of the video recordings (Table 2) showed that the percentages of the time with the wrists in extreme flexion-extension and deviations were also high at some workplaces.

Sport is practiced by 19% of the people during their leisure activities, but very few (2%) practice a sport using the upper limbs. On the other hand, most (53%) are *very* busy with a whole range of domestic activities: gardening, knitting, painting and so on.

The results of the functional and psychomotor tests as well as the personality and psychosocial characteristics are presented in Table 3.

The maximum angles and forces are on average similar to those reported for a female population (Hoppenfeld and Hutton 1984; Mathiowetz 1990) with also approximately the same interindividual variations. The interindividual differences for the O' Connor dexterity test are also large.

This is also the case for the type A-behavior extending from 27 to 62, out of 70.

The distribution of the score of *conscientiousness* extends only from 27 to 48, which suggests that very few people judge themselves as a little conscientious. For a female population, the average score is 35, a score

Table 2 Percentage of time (and standard deviation) with the wrists/hands in extreme flexion/extension and in deviation

Work situation	Percentages of time in extreme	
	Flexion/extension	Radio-ulnar deviation
Assembly of disc brakes	14.9 (10.6)	9.7 (8.7)
Assembly of windscreen wipers	37.4 (10.7)	31.8 (5.2)
Conditioning of candles	24.7 (4.4)	20.8 (9.3)
Conditioning of pharmaceutical products	18.4 (6.9)	26.2 (14.2)
Assembly of hearing aid components	61.0 (16.1)	32.0 (15.4)
Loading and unloading of papers in a printing works	19.5 (7.4)	19.8 (6.4)
Conditioning of biscuits	37.4 (7.7)	42.2 (9.4)

Table 3 Results of functional and psychomotor tests, psychosocial and personality characteristics

Test or characteristic	Average	Standard deviation	Minimum	Maximum
Maximum angles (°)				
Ulnar deviation	34.6	9.7	16	40
Radial deviation	22.8	8.9	12	30
Extension	69.2	9.8	40	86
Flexion	70.7	10.2	42	90
Maximum grip strengths (kg)				
Right	28.9	6.4	12	44
Left	28.6	5.5	11	44
O' Connor test				
Time to fill two lines (s)	99.4	21.9	55	186
Number of holes filled (of 20)	16.3	4.1	5	20
Type-A behavior				
Total score	45.1	7.2	27	62
Competitiveness	9.3	2.4	4	15
Urgency	35.9	6.2	20	50
Other personality characteristics (scores)				
Conscientiousness	39.7	4.9	27	48
Extraversion	11.4	3.6	3	19
Neuroticism	9.3	5.1	0	23
Psychosocial factors (scores)				
Perception by the operator	26.6	3.6	15	35
Appreciation by the operator	17.4	4.6	5	30
Somatic disorders	5.4	3.7	0	18
Relationship with colleagues	4.3	2.0	2	8
Psychological demands	29.6	7.1	14	48
Decision latitude	23.3	6.1	12	43

above 38 is regarded as a high score (Costa and McCrae 1992).

For *extraversion* and *neuroticism*, the average scores are very close to the values of reference (11.2 for *extraversion* and 7.8 for *neuroticism*) for a working population (Eysenck and Eysenck 1981). The distributions are extremely broad, indicating again large differences among the operators.

As far as the psychosocial factors are concerned, it arises that:

- 37% feel fairly or very stressed.
- 58% are not at all or a little satisfied with their work.
- 14% have consulted a doctor or a psychologist for depression during the past 12 months.
- The score distribution for the questionnaire of Karasek is wide, and the lowest and highest values are close to the minimum and maximum scores.

With the number of people in the study (133), any association proves statistically significant as soon as the correlation coefficient is greater than 0.2. The highest correlation coefficients are observed in the following cases:

- Age is strongly related to seniority at the workplace ($R = 0.41$) but less with the other parameters.
- The *perception* of the work constraints is strongly correlated with the *appreciation* of these constraints ($R = 0.61$) and, to a lesser extent, with the score of *psychological demands* ($R = 0.41$).
- The score of *neuroticism* is also correlated with the score of *somatic disorders* ($R = 0.55$).

The results of the final logistic models of regression are given in Tables 4 (for the right wrist) and 5 (for the neck).

When the personal characteristics (A group) are considered alone, the probability of wrist-hand complaints appears higher ($OR = 3.05$, $P < 0.005$) for the smokers and lower for the people having hobbies ($OR = 2.5$, $P < 0.05$).

When the other parameters are included in the model, *extraversion* appears to be negatively related, as well as *life dissatisfaction*.

As for the occupational constraints, the probability of complaints is higher for the operators having fewer breaks and who judge their lifting efforts to be medium-heavy to heavy.

The model is similar when the psychosocial variables are not introduced, while the probability of MSDs increases with the *appreciation* of the constraints, when the personality characteristics are not taken into account.

When the personal characteristics (A group) are considered alone, the probability of neck complaints is negatively associated with the frequency of non-occupational activities ($OR = 0.27$). It is higher for the youngest people, the smallest ones, those judging their health as being bad, and those with hormonal problems.

As for the personality, only the characteristic of urgency of time appears in the final model.

The model is the same whether or not the psychosocial factors are considered. None of these factors is related to the MSDs of the neck when personality characteristics are taken into account. On the other hand, when these are not introduced into the model, a

Table 4 Multivariate logistic regressions between the wrist-hand complaints and the various parameters

Variables	OR	CI_{inf} 95%	CI_{sup} 95%	*P*
Model A + B + C + D				
All personal variables, questions relating to the working station, personality characteristics and psychosocial factors				
Smoking	9.03	2.29	35.59	0.002
Hobbies	0.18	0.06	0.57	0.003
Lifting efforts (average or heavy)	5.55	1.63	18.96	0.006
Duration of breaks (min)[a]	0.67	0.49	0.91	0.010
Extraversion[b]	0.28	0.10	0.76	0.012
Life dissatisfaction	0.31	0.10	0.92	0.035
Model A + B + C				
All variables except psychosocial factors				
Smoking	9.17	2.47	34.09	0.001
Hobbies	0.23	0.08	0.69	0.008
O' Connor test (number of holes filled)[b]	2.79	1.45	5.37	0.002
Lifting efforts (average or heavy)	5.75	1.74	19.02	0.004
Duration of breaks (min)[a]	0.71	0.55	0.92	0.010
Extraversion[b]	0.32	0.13	0.77	0.011
Model A + B + D				
All variables except personality characteristics				
Smoker	4.83	1.53	15.19	0.007
Hobbies	0.18	0.06	0.53	0.001
Lifting efforts (average or heavy)	4.03	1.33	12.20	0.013
Duration of breaks (min)[a]	0.73	0.59	0.92	0.007
Appreciation of the constraints[b]	3.57	1.42	8.95	0.006
Life dissatisfaction	0.30	0.10	0.89	0.030

[a]For a variation of 10 units
[b]For a variation of 25%

Table 5 Multivariate logistic regressions between neck complaints and the various parameters

Variables	OR	CI_{inf} 95%	CI_{sup} 95%	*P*
Model A + B + C + D				
All personal variables, questions relating to the working station, personality characteristics and psychosocial factors				
Age (years)[a]	0.37	0.16	0.87	0.022
Size (cm)[a]	0.42	0.19	0.93	0.031
Health (bad)	5.19	1.63	16.51	0.005
Hormonal problems	3.24	1.13	9.26	0.028
Hobbies	0.21	0.07	0.60	0.003
Urgency of time[b]	4.37	1.57	12.17	0.004
Model A + B + C				
All variables except the psychosocial factors				
Same model as above, none of the personality characteristics being statistically significant				
Model A + B + D				
All variables except the personality characteristics				
Age (years)[a]	0.48	0.24	0.99	0.046
Size (cm)[a]	0.37	0.17	0.82	0.014
Health (bad)	3.02	1.10	8.28	0.031
Hobbies	0.23	0.08	0.63	0.004
Constraints as seen by the supervisor[b]	0.10	0.02	0.47	0.004

[a]For a variation of 10 units
[b]For a variation of 25%

relationship is found with the constraints as seen by the direct supervisor.

Discussion

The effect of a parameter can be determined only if the values of this parameter vary from one person to another. Thus, a limitation of the study is the fact that all the participants in the study are women: no gender effect can be expected. It would be the same for other effects if all subjects had roughly the same profile. It is therefore necessary to discuss the interindividual variability within the sample.

The descriptive statistics demonstrate that, whatever the parameter considered, the distribution is broad, the interindividual variations are significant and that the data can make it possible to highlight certain effects, if they exist.

Smoking is associated positively with the probability of wrist-hand complaints in all the models: the ORs are indeed very high, 4.8 to 9.2 according to models. Paradoxically, no relationship is found for the MSDs of the neck.

The importance of these ORs suggests a direct relationship between smoking and wrist-hand complaints. Smoking is recognized as being a risk factor for low back pain (Leboeuf 1999). Heliövaara et al. (1987) suggested that smoking constitutes a factor of exposure with an etiologic fraction of the risk of 51%.

The relationship between smoking and MSDs of the wrists is less clear. As we showed in a recent review of the literature relating to the MSDs (Malchaire et al. 2001), smoking was taken into account as a confounding factor in 20 studies, but a relationship was found with neck problems in three studies only (Ekberg et al. 1994; Skov et al. 1996; Zetterberg et al. 1997), and with wrists problems in only one (Zetterberg and Öfverholm 1999).

Several publications suggested a possible relationship between smoking and tingling of the hand at night and pain in the wrists (Hagberg et al. 1995). Nathan et al. (1996) studied particularly the relationships between individual characteristics and carpal tunnel syndrome (CTS) and reported a relationship between smoking and a decrease in the conduction velocity of the median nerve. However, smoking explained only a small fraction of the CTS cases.

Non-occupational activities are sometimes taken as being responsible for certain cases of MSDs. The literature provides little information supporting this assumption (Malchaire et al. 2001), although this relationship was investigated in at least 17 studies. Indeed, respectively, ten out of 11 studies and 12 out of 13 studies did not find any association with the wrist-hand and neck MSDs.

The study of individual data suggests that the non-occupational activities that might be responsible for the development of MSDs are unusual sports or domestic activities superimposed on the occupational activity. However, the majority of the epidemiological studies takes only into account the usual secondary activities and neglects these unusual activities for methodological reasons. This could explain the absence of relationship found in the large majority of the studies.

In the present study, the associations between wrist/hand and neck complaints and non-occupational activities involving biomechanical constraints of the upper limbs are both negative. This seems a priori in opposition with an assumption that the musculoskeletal loads of the occupation and the domestic and leisure activities are adding up. This relationship could be due to the fact that the operators with MSDs stopped the hobbies that were demanding for the wrists, such as sewing, knitting

or gardening. This would suggest that the operators manage their physical activity by taking account of the total occupational and non-occupational musculoskeletal load. The operators with MSDs start by limiting their non-occupational activities, for lack of being able to reduce their occupational load and in order to be able "to hold out" with their work. This type of regulation was observed in hospital nurses suffering from low back pain (Fanello et al. 1999) where they reduced their leisure activities in order to avoid their problems becoming chronic and to remain able to perform their work.

The study highlights two characteristics of the work situation in relation to MSDs of the wrists: lifting effort and duration of breaks, as evaluated by the operators.

The increase in the risk of MSDs in association with intense physical efforts is recognized by many studies (Brusco and Malchaire 1993; Chiang et al. 1993; Fransson-Hall et al. 1995; Roquelaure et al. 1997; Burdorf et al. 1997; Silverstein et al. 1986, 1987; Silverstein and Hughes 1996). Generally, the main factor is the grip strength (Silverstein et al. 1987; Wieslander et al. 1989) or the weight of the objects handled. The absence of significant association with the wrist and hand efforts is probably due to the fact that all seven work situations had approximately the same force requirements. It is the same for repetitiveness of movement.

The study shows a negative relationship between the duration of breaks and wrist-hand complaints: the longer the breaks, the lower the frequency of MSDs. This result is in agreement with a study on CTS (Roquelaure et al. 1997) that showed a decreased risk of CTS when the subject was able to change activity during the day and/or take breaks during at least 15% of the working time. It is also in agreement with work showing a positive relationship between working hours and the existence of wrist-hand MSDs (Harber et al. 1993; Ingelgard et al. 1996; Margolis and Kraus 1987).

Contrary to the study by Fransson-Hall et al. (1995), no relationship was observed between wrist-hand complaints and type-A behavior.

It was the same for *conscientiousness* and *neuroticism*, and this is in agreement with the results of Kasl and Amick (1996).

On the other hand, some logistic models show a negative relationship between *extraversion* and wrist-hand complaints. The likely explanation is that *extraversion* is associated with lower exteriorization and summarization of the musculoskeletal constraints.

All in all, the study suggests that personality characteristics are not strongly associated with wrist-hand MSDs and that personality tests do not make it possible to identify the people most susceptible to developing MSDs. In addition to the ethical problems that it would raise, the use of personality tests to select operators with the lowest personal risk of MSDs is thus likely to fail.

The literature reports six studies interested in the possible relationship between personality and neck complaints. Three found a relationship with type-A behavior, two with *neuroticism* and none with *extraversion* (Malchaire et al. 2001). Our results corroborate those results for *urgency of time* (type-A behavior) and *extraversion*.

Psychological and organizational factors were approached in a complementary and original way, starting from the *perception* and the *appreciation* by the operators. The 12 items used for these scales of *perception* and *appreciation* were those usually used by other authors (Malchaire et al. 2001). *Job* and *life satisfaction*, stress perception and human relations were considered in addition.

These factors were taken into consideration in many studies (Zetterberg et al. 1997; Silverstein and Hughes 1996; Bernard et al. 1994; Hales et al. 1994; Jensen et al. 1998; Toomingas et al. 1997). Very few, however, showed an association with MSDs (Bernard et al. 1994).

This is also the case for the present study, which found a relationship only with *life satisfaction*. About half (47%) of the operators declared themselves little or not satisfied with their life. However, this *dissatisfaction* appears to be related negatively to the MSDs. It must also be underlined that 14% of the people consulted a physician for depression.

On the other hand, *job satisfaction* does not appear in the model, thus corroborating the literature data where only one study (Kasl and Amick 1996) out of some ten found an association. This could be explained by defense mechanisms in the operators with MSDs to bear situations that are sources of suffering. As shown by Dejours (1993), when it is not possible to modify the origins of the suffering – in life or in working conditions – the defense mechanism consists of avoiding establishing a cause-effect relationship between the suffering and these origins. Conversely, the unharmed operators would not hesitate to underline their *dissatisfaction* with their living conditions.

This remark shows the limits of investigations that use questionnaires, which cannot encompass the unconscious psychological mechanisms intervening in the phenomena of stress (Theorell et al. 1991) or psychodynamics at work (Dejours 1993), according to the theory to which one refers.

The total scores of *perception* and *appreciation* of the psychosocial constraints are associated positively with MSDs, with high prevalence ORs. However, only *appreciation* remains in the final logistic model, suggesting that the *appreciation* of the constraints plays a more significant role than the constraints themselves.

It is surprising to note that the individual psychosocial variables are not associated with the neck MSDs, while reviews of the literature (Bongers et al. 1993; Malchaire et al. 2001) show the report of many associations, in particular with work-related psychosocial factors (not the human-related factors), stress symptoms and mental stress.

Some items of the *perception* and *appreciation* scores match up the dimensions of *psychological demands* and *decision latitude* of the Karasek and Theorell (1990)

stress model. However, when the parameters of both approaches are introduced simultaneously into the logistic regression, the final model proves a stronger relationship with the *appreciation* of the work situation. This approach thus appears to explain the differences in MSDs better than the Karasek approach does.

The final model is in agreement with the so-called *equilibrium model* of the stress factors proposed by Smith and Sainfort (1989). According to this model, the working conditions and the other characteristics of the environment produce a *stress load* that can trigger physiological or psychological reactions, such as a discharge of adrenaline or a feeling of sadness. This stress load is influenced, on the one hand, by the objective properties of the working conditions, and on the other hand, by the perception of the conditions by the individual. This *equilibrium model* places the individual, together with the individual's physical characteristics, perceptions, personality and behavior, in the center of the work system. The advantage of this model is its dynamic character that weighs, one against the others, the various sources of stress in the working environment. It shows that it is possible to decrease the stress level by carrying out a dynamic balance between the various sources of stressors, one compensating for the others (Hagberg et al. 1995).

As a final remark it must be realized, however, that in this study, as in probably all such studies, the subjects came from companies that allowed the study to be carried out. Many other companies refused for various reasons: reorganization, overload or for no reason. One can wonder about this selection bias. The participating companies had problems with stress. However, they had an open-mindedness without any doubt better than some other employers. The scores used here cannot, thus, be regarded as representative of this type of company. It is likely to be impossible to determine how this influences the conclusions. On the other hand, the interindividual differences were perhaps larger, if it is admitted that the companies concerned were not in a critical situation where the individual scores would tend to be similar.

In conclusion, the present study confirms the multifactorial character of the MSDs. Factors playing a direct or indirect role are biomechanical factors, individual characteristics and the *appreciation* of the working conditions. Psychosocial factors play a significant role in the expression of wrist-hand MSDs and must be taken into account besides the more objective constraint factors.

The study clearly shows the absence of relationship between personality characteristics, functional capacities and the risk of MSDs.

This multifactorial character again underlines the need for a global – ergonomic – approach to the work situations, taking account of all their physical, psychological and social components.

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