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Determinants of occupational multisite musculoskeletal disorders: a cross sectional study among 254 patients

A. Mahfoudh, K. Fennani, M. Akrout, K. Taoufik

Department of Occupational Health & Ergonomics, Faculty of Medicine of Monastir, University of Monastir, Tunisia.

SUMMARY

The aim was to describe the profile of workers with occupational multi-site musculoskeletal disorders (MS-MSD) and study the relationship between these lesions and socio-professional factors.

This is a cross-sectional study involving 254 subjects with occupational musculoskeletal disorders (MSD), identified in the Department of Occupational Medicine at the University Hospital of Mahdia, in Tunisia, over a period of 10 years from 2005 to 2014. The study population was subdivided into two groups; mono-site MSD and multi-site (≥2 sites) groups. Data collection was based on a questionnaire prepared beforehand and covered the description of sociodemographic and professional characteristics. To study psychosocial constraints at work, we have used the Karasek questionnaire.

MS-MSD was correlated to the number of dependent children (p=0.02), job/place of work (p=0.00), qualification (p=0.02), taking a rest period (p=0.03), decision latitude (p=0.00), mental demands (p=0.002), social support (p=0.00) and job stress (p=0.04). After binary logistic regression, MS-MSD depended significantly on the number of dependent children (p=0.013; OR=0,33; IC=0,17-0,83), working spouse (p=0.05; OR=0.35; IC=0.12-0.99), job/place of work (p=0.00; OR=4.16; IC=1.95-8.88), qualification (p=0.008; OR=0.28; IC=0.11-0.72), taking a break during work (p=0.04; OR=3.10; IC=1.04-9.22) and social support (p=0.00; OR=7,1; IC=1,9-25,3).

When individual risk factors are fixed, the prevention of MS-MSD must target modifiable levers, related to the professional environment of the employees.

Key words: *Multisite; Musculoskeletal disorders; Occupational disease; Risk factor.*

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INTRODUCTION

MSD are the leading cause of morbidity and disability in the European Union and represent a work problem in different countries (1, 2). According to Eurostat, the Statistical Office of the European Community, MSD represent the most widespread and costly occupational health problems in Europe affecting about 45 million workers. In France, MSD are the principal cause of occupational diseases, with an annual increase of 18% over the past 10 years. In addition, claims for benefits increase from year to year and represent 76% of occupational illnesses compensated in 2015 (3).

In Tunisia, during the last decade, the number of MSD declared as occupational diseases has increased. Indeed, this number has augmented from 15 in 1995 to 155 in 2004 and 287 in 2011. The most affected sectors are electronics, confection and food industries (2).

These disorders constitute a major public health problem and an occupational health challenge. Consequently, a better understanding of the mechanisms responsible for the onset or progression of these lesions is required. Recent studies support a more comprehensive approach to musculoskeletal disorders, analyzing the extent of musculoskeletal symptoms and the number of symptomatic anatomical sites rather than a particular site (4, 5). This definition seems to be adopted by the American College of Rheumatology (6, 7).

Corresponding author:
Mahfoudh Aouatef
Department of Occupational Health & Ergonomics
Faculty of Medicine of Monastir,
University of Monastir, Tunisia
E-mail: mahfoudhaouatef@gmail.com

Although several teams have begun to describe the profile of subjects with MS-MSD (8-11), very few studies have targeted the working population.
These considerations led us to carry out this study, which aims to describe the profile of workers with MS-MSD and to study the relationship between the appearance of these lesions and socio-professional constraints at work.

MATERIALS AND METHODS

Patients

This is a cross-sectional study of subjects with occupational MS-MSD, identified at the Department of Occupational Medicine at the University Hospital of Mahdia in Tunisia over a period of 10 years from 2005 to 2014.
Included in this study were patients in professional activities who had benefited from a declaration of MS-MSD as an occupational disease; i.e. occupational exposure to biomechanical constraint had been assessed. Consequently, the anatomical sites studied were shoulders, arms, elbows, forearms, hands and wrists that had been compensated as occupational damage in conformity with Law No. 94-28 of 21 February 1994 according to Tunisian legislation (12).
A MS-MS disease is defined by the presence of symptoms affecting at least two different anatomical sites and a bilateral lesion is considered as a single pathology.
During the study period, 254 subjects were counted; subdivided into two groups. A first group was composed of patients with a single musculoskeletal lesion. The second group represented patients with at least two affected sites.

Methods

Data collection was based on a fact sheet prepared beforehand and completed by an investigating doctor. Clinical and paraclinical data were collected from records. Some information was collected during telephone contacts.
The questionnaire involved information under three headings; a description of sociodemographic data (gender, age, BMI, family situation, number of dependent children, medical and surgical history...), occupational data (labor market, job position, qualification, job tenure...) and psychosocial constraints. We therefore used the Karasek questionnaire. This questionnaire was conceived by the American sociologist and psychologist Robert Karasek in 1979. It is a questionnaire that evaluates for each employee the intensity of mental demands to which he is subject, the decisional latitude at his disposal and the social support he receives at his place of work. The questionnaire consists of 26 questions divided into three sections: Nine for decisional latitude, nine for mental requirements and eight for social support. The proposed answers are: *strongly disagree, disagree, agree perfectly, agree*, which allows them to be scored from 1 to 4 and to calculate a score for each of the three sections (13).
Job-stress is defined as a situation or score of mental demands greater than 20, decision latitude below 71 and a social support score of less than 24 (4).

Statistical study

We studied frequencies and percentages for qualitative variables and averages, medians, standard deviations and extremes for quantitative variables.
To compare averages, we used the *t* test of Student and the *f* test of ANOVA. For the comparison of frequencies, we performed the chi2 test.
To study predictive factors of multi-site occupational MSD, we performed a multiple binary regression. The inclusion of independent variables in the regression models was done when their degree of significance was less than 0.2. The threshold of significance p was set at 0.05.

RESULTS

General characteristics

Sociodemographic characteristics
The mean age of the study population was 42.8±8.4 years. A female predominance was noted with a sex ratio of 0.13. The

average of the BMI was 25±2.6 kg/m². Nearly half of the patients were overweight (136 patients).
Most patients were right-handed (88.2%). Married workers represented 73.6% and more than half of them had more than one dependent child (77.2%). The spouse worked in 63.4% of cases and 55.6% of these had temporary or occasional work.
In this study, 94.9% of the patients did not participate in leisure activities. The average distance to and from the work place was 4.17±3.36 km. 22.4% of these moved more than 5 km to get to work. The main pre-existing morbidities were metabolic diseases (18.5%), followed by hypertension (9.1%) and hypothyroidism (4.7%).

Table I - Influence of sociodemographic characteristics on MS-MSD, univariate analysis.

		1 site		≥2 sites		p
		N	%	N	%	
Gender	Male	26	12.2	4	9.8	0.85
	Female	187	87.8	37	90.2	
Age (years)	<35	39	18.3	7	17.1	0.22
	35-50	132	60	21	51.2	
	>50	42	19.7	13	31.7	
BMI (kg/m²)	< 20	1	0.5	0	0	0.55
	20-25	120	56.3	27	65.9	
	25-30	87	40.8	14	34.1	
	>30	5	2.3	0	0	
Dexterity	Right-handed	189	88.7	35	85.4	0.72
	Left-handed or ambidextrous	24	11.3	6	14.6	
Matrimonial status	Married	154	72.3	33	80.5	0.37
	Others	59	2.7	8	19.5	
Number of children in care	≤3	184	86.4	29	70.7	0.02
	>3	29	13.6	12	29.3	
Spouse's work	Stable	65	48.2	7	26.9	0,08
	Not stable	70	51.8	19	73.1	
Leisure activity	Yes	13	6.1	0	0	0.21
	No	200	93.9	41	100	
Distance of travel residence-workplace	≤5 km	163	76.5	34	82.9	0.48
	>5 km	50	23.5	7	17.1	
Means of travel	On foot	109	51.4	18	41.5	0.31
	Public or private transport means	103	48.6	24	58.5	
Medical history	Yes	83	39	20	48.8	0.31
	No	130	61	21	51.2	

Occupational characteristics
In this study, 78% of patients worked in the confection sector. The position of *worker on machine* was predominant with a percentage of 41.3%.
The average service length was 21.33±7.64 years. The studied population was characterized by the predominance of employees (83.9%), followed by state officials (15.4%).
The average of work hours per day were 8.15±1.3 hours with extremes ranging from 4 to 12 hours, and 39% of patients worked overtime for 80±60 min. Officeholders represented 85% of study population and 16.5% of patients had a work break period.

Psychosocial stress at work
The mean social support score was 17.4±8.5 and 42.4% subjects had a social support score of less than 24.
A score of mental requirements greater than 20 was noted in 87.9% with an average score of 24±2.69. The mean decisional latitude score was 31.18±3.6 and 99% had decision latitude of less than 71. Most patients were in a job-stress situation (90.4%).

Musculoskeletal disorders
MSD identified were rotator cuff tendonitis (34.3%), carpal tunnel syndrome (54.3%), epicondylitis (28.3%), De Quervain tendonitis (4.3%). In this study, 16.9% of patients had multi-sites pathologies.

Univariate analysis
In our study, MS-MSD was significantly associated with the number of dependent children (p=0.02), workplace (p=0.00), occupational qualification (p=0.02), work-related rest periods (p=0.03) and leaving the work place (p=0.05). Similarly, we found a statistically significant relationship between the different aspects of psychosocial stresses at work and MS-MSD (Tables I and II).

Multivariate study

Following a binary logistic regression, MS-MSD was significantly associated with a number of dependent children greater than three, instability of spouse's work, unqualified employees, clothing machine workers and lack of social support at work. Moreover, the possibility to take a period of rest during work was a protective factor against occupational MS-MSD (Table III).

DISCUSSION

Musculoskeletal disorders represent a widespread problem in the general population as well as in the workplace. In this study, we investigated individual and professional determinants in relation to multisite appearances of occupational MSD.

The population studied was characterized by a clear female predominance (88%). This prevalence is well described in the literature and may be explained by a difference in working conditions between the two genders (14, 8). Indeed, women are often involved in monotonous and detailed repetitive tasks, causing localized constraints on extremities (15). In addition, domestic responsibilities are mentioned as risk factors which worsen MSD, since they often lead to an inability of the subjects to take proper care of themselves (*e.g.*, inability to take rest due to domestic tasks) (16).

The mean age of the population studied was 42.8±8.4 years with a slight increase in the frequency of multi-site involvement in subjects older than 50 years. However, this variable is not associated with the risk of MS-MSD. These findings are contrary to those of the literature (10, 17). In fact, the increase of MS-MSD prevalence with age may be explained by wear of anatomical textures with age such as decreased muscle strength, bone fragility, loosening of joint ligaments and thinning of the cartilage (18). This may explain the increasing trend in the incidence of MS-MSD noted in the elderly in our study.

The association of musculoskeletal disorders and overweight is well documented in the literature (19, 7). Kim JH's study, for example, conducted among 189 cameramen, showed a significant correlation between MS-MSD with a high BMI (11). This association can be explained by premature mechanical wear of joints associated with additional forces caused by the weight excess exerted on these joints (20). The average body mass index of our population was 25±2.66 kg/m² and more than half of them were overweight. But his fac-

Table II - Influence of professional characteristics on MS-MSD, univariate analysis.

		1 site		≥ 2 sites		p
		N	%	N	%	
Industrial sector	Confection	162	76.1	36	87.8	0.14
	Others	51	23.9	5	12.2	
Job	Clothing machine worker	76	35.7	29	70.7	0.00
	Others	137	64.3	12	29.3	
Professional qualification	Qualified	132	62	17	41.5	0.02
	Unqualified	81	38	24	58.5	
Professional category	Salaried	183	85.9	32	78	0.29
	Official	30	14.1	9	22	
Professional seniority (years)	<5	2	0.9	1	2.4	0.63
	5-20	104	48.8	18	43.9	
	>20	107	50.2	22	53.7	
Duration of work (hours)	≤8	109	51.2	26	63.4	0.2
	>8	104	48.8	15	36.6	
Work schedule	Fixed work schedule	132	62	21	51.2	0.26
	Shift work	81	38	20	48.8	
Employment contract	Titular	183	85.9	33	80.5	0.51
	Contractual	30	14.1	8	19.5	
Taking a rest period during work	Yes	30	71.4	12	29.3	0.03
	No	183	85.9	29	70.7	
Period of rest	≤10 min	16	51.6	3	27.3	0.21
	>10 min	15	48.4	8	72.7	
Psychosocial constraints	Decisional latitude	-	-	-	-	0.004
	Mental requirements	-	-	-	-	0.002
	Social support	-	-	-	-	0.001
Job-stress	Yes	189	88.7	41	100	0.04
	No	24	11.3	0	0	

Table III - Determinants of MS-MSD after logistic regression.

		p	OR	IC
Sociodemographic characteristics	Number of dependent children	0.013	0.33	0.17-0.83
	Spouse at work	0.05	0.35	0.12-0.99
Professional characteristics	Post of work	0.00	4.16	1.95-8.88
	Professional qualification	0.008	0.28	0.11-0.72
	Tacking a rest during work	0.04	3.10	1.04-9.22
	Social Support	0.00	7.1	1.9-25.3

tor was not associated with the risk of MS-MSD in upper limbs.

Several published studies showed that the occurrence of MS-MSD was significantly correlated with the number of dependent children (6, 21), as in the case of Carvalho's study (22).

In our study, the number of dependent children was significantly associated with MS-MSD and this may be explained by an additional overload of domestic activities.

Apart from occupational exposure to MS-MSD, preexisting comorbidities may increase the risk of occurrence of these lesions (23).

Baillargeon and Patry explained in their book *Work-related upper limb musculoskeletal disorders* that people with rheumatic disease, neuromuscular diseases and psychiatric disorders are more likely to develop MSD when exposed to occupational risk factors. More specifically, they reported that hypothyroidism, diabetes mellitus and rheumatoid arthritis are factors that increase the risk of MS-MSD (24).

The main pre-existing conditions in our population were metabolic diseases in 18.5%, hypertension (9.1%), hypothyroidism (4.7%) and depression (1.8%).

In our study, there was no significant relationship between the pre-existence of comorbidities and the majority of MSD, which is inconsistent with some studies (25, 26).

According to some authors, and extending beyond the organic pathologies considered to be at risk of MS-MSD, personality type may interfere with the appearance of these lesions. Subjects with a high neuroticism score tend to introspection and somatic complaints (27). They would have an increased vulnerability to stress and a tendency towards job dissatisfaction, factors that appear associated with MSD of the neck and shoulders (27, 28).

In this study, 78% of the people worked in the confection sector. These results could be explained by a predominance of this sector in the study area. It represents 34% of all manufacturing industries in Tunisia (29). In these activities, employees are exposed to repeated and rapid movements, often requiring a localized group of muscles and tendons, to maintain certain constraining postures that constitute risk factors for MSD (30-32).

However, in this study, the industrial sector was not correlated with MS-MSD involvement, which is inconsistent with the findings of Parot Schinckel E, which reported a higher prevalence of MS-MSD among food and manufacturing industries (33).

Further studies with a well-structured methodology will be required to identify the industrial sector most at risk of multiple MSD.

The post of *clothing machine-worker* was predominant (41.3%) and it was retained among determinants of multifocal MSD. Similarly, Andersen JH et al. reported in their study of 424 machine workers that this workstation is significantly related to the onset and persistence of MSD-MS (34).

According to some studies, occupational seniority increases the risk of MS-MSD. Reddy EM et al. reported in their study of 220 workers that occupational seniority had a significant influence on the occurrence of MS-MSD (35). Similarly, Liu. J et al. has noted among a large sample of workers that the onset of musculoskeletal disorders increases after more than ten years' professional tenure (36).

In this study, the frequency of subjects suffering from MS-MSD increases clearly with occupational seniority and the risk of this pathology was significantly lower among skilled workers (p=0.016, OR=0.43 (CI=0.22-0.85), explained by a better knowledge of preventive means and methods of carrying out tasks in qualified employees. These results are also noted in

some studies (1, 37). Sérazin et al. reported in their study among 2287 employees that the occupational category influenced significantly the occurrence of musculoskeletal disorders (38).

Several scientific studies have found significant relationships between the occurrence of MSD and the lack of rest periods during labor (39, 40). Kim JH *et al.* reported in a study of 189 cameramen that 63.4% of them took a duration break ≤30 min with a significant association of this factor with the risk of MS-MSD in a univariate study (11).

These findings were consistent with our results where the pause is a significant factor in the majority of musculoskeletal disorders (p=0.04, OR=3.10, IC=1.04-9.22).

Rest periods during work are a fundamental means of preventing MSD-MS, since they allow better recovery after strain (41). In addition, short and frequent breaks reduce muscle fatigue and static loads on the musculoskeletal system and reduce mood disturbances associated with long periods of labor.

In our study, the category of employee is more exposed to the risk of unilateral or multi-focal musculoskeletal involvement, which could reflect an unequal distribution of occupational risks between the different professional categories, documented by the DARES study. According to this study, employees are more exposed to physical constraints than public servants (39.1 *vs* 31.2%) (42).

The status of employee or official is not associated with the occurrence of MS-MSD. These findings make it possible to conclude that, apart from biomechanical constraints, multifocal involvement of MSD is linked to other occupational factors, in particular psychosocial factors.

In this study, 90% of patients were in job stress situations significantly correlated with MS-MSD involvement. Similar findings have been described by some authors (25, 43). Sommer TG et al. reported in their study of 34,254 employees that the psychological state of job stress is significantly related to the majority of musculoskeletal disorders (44). Similarly, Neupane S et al. reported in a study of 734 employees that physical factors such as repetitive movements in association with psychosocial factors are significantly related to the multi-site involvement of MSD (45).

The complexity of explanatory models makes it difficult to determine occupational risk factors for MSD. Some authors also lead us to think that this distinction is hard to define methodologically. Bernard A and Guignon N noted, for example, that it is virtually impossible to distinguish precisely the relative importance of psychosocial and physical factors (46). However, psychosocial stresses are found in many work situations, which seems to suggest that they are general risk factors for MSD.

Consequently, other high-quality methodological studies with stronger evidence will be needed to distinguish better the causal relationship between occupational risk factors for MSDs, in particular in its multi-site locations.

CONCLUSIONS

According to this study, multi-site involvement of MSD depends on individual, occupational and psychosocial factors. So preventive actions against MSD in companies cannot focus solely on physical or biomechanical exposure of operators as a means of confronting this problem.

When individual risk factors are fixed, the prevention of multi-site MSD-MS must target the modifiable levers that constitute the employee's professional environment. This approach must follow a well-structured occupational risk management policy.

Conflict of interest: The authors declare that they have no conflict of interest in relation to this article.

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