

ONE-YEAR PREVALENCE OF MUSCULOSKELETAL SYMPTOMS IN ALUMINIUM INDUSTRY POTROOM WORKERS

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Summary. Potroom workers in aluminium industry perform physically demanding jobs that include numerous risk factors such as awkward postures, static-load, and lifting and carrying of load. The aim of this study was to identify the most frequent musculoskeletal symptoms (MSS) among workers in an aluminium plant, as well as to examine a possible correlation between MSS incidence and the period of exposure to MSSs. The study population comprised 133 potroom workers who were asked to fill out a questionnaire, whereas 90 office workers served as controls. After a multivariate regression analysis for the parameters including age, duration of employment, height, smoking and alcohol consumption, the potroom workers showed a higher incidence of MSSs which significantly correlated with the age and duration of employment in nine out of the ten areas of the body (with the exception of the ankle and feet), when compared to controls. The results of the study suggest that the correlation between a high MSS incidence and the duration of employment can be due to the work environment.

Key words: Musculoskeletal symptoms (MSS), multivariate regression analysis, potroom workers

Introduction

Musculoskeletal symptoms (MSS) are multifactorial. They may develop due to occupational risk factors (1) and adverse psychosocial and physical factors such as decision latitude, job satisfaction, and social support, which may all influence the incidence of work-related MSSs (2,3). Given MSS multifactorial etiology, the exact proportion of work-related MSSs is most difficult to determine.

MSSs are very common in our working population. They not only present a problem to an individual worker who suffers a physical pain, but may also disturb everyday production activities of the industry (4,5,6). As work in the aluminum industry, particularly in potrooms and cast-houses, is highly physically demanding, women are rarely found at these workplaces. In Podgorica Aluminium Plant, where we performed our study, no female is employed. Exposure to physical risk factors such as awkward postures, static-load, lifting and carrying of load is well-known (7,8,9,10).

Age, height, weight, gender, smoking, alcohol consumption, physical activity, job satisfaction and motivation can be all significant for MSS incidence (1,7,11,12). Understanding how individual variables can alter the risk involved in a specific working environment can affect the selection of possible intervention measures (13). Prevention of MSS in a working population requires the evaluation of possible occupation-spe-

cific factors and individual characteristics, as well as determining their association with MSSs.

The aim of the study was to determine the prevalence of self-reported MSSs among electrolysis workers in aluminium factory and office workers with similar individual characteristics. In addition, we wanted to examine a possible correlation between MSSs and duration of employment (as exposure variable) and individual characteristics.

Participants and methods

Participants

The study group comprised a total of 133 potroom workers of Podgorica Aluminium Plant (Kombinat Aluminijuma Podgorica), Serbia & Montenegro, whereas 90 office workers of the same plant and of Podgorica Health Center served as controls. The two groups differed as to the level of physical demand necessary for job performance, socio-economic status and job satisfaction. The study group consisted of workers performing various types of manual jobs: manufacture, cleaning, repairing, etc. The office workers exerted various job-related characteristics, depending on the level of education. Both groups were asked to answer a self-administered questionnaire about MSSs.

The questionnaire

The participation in the questionnaire was voluntary. An informal consent was obtained from each participant prior to the questionnaire administration. The study group filled out the questionnaire following their regular periodical medical examinations in the local health center. Office workers completed the same questionnaire during the working hours at the workplace. The questionnaire was filled out anonymously, but a code for each individual worker was saved for future reference and survey.

The questionnaire comprised items related to the job title, occurrence of MSSs in the past 12 months (1-year prevalence), and duration of employment. Duration of employment was used to investigate the exposure-response association in the establishment of correlations between occupational hazards and diseases in several epidemiological studies (13,14). Duration of employment in the plant served as an indirect measure of the total work-related exposure to risk factors for MSSs. The occurrence of MSSs was registered using a modified version of the Standardized Nordic Questionnaire (SNQ) for MSS analysis (15). To the question: "Have you at any time during the last 12 months had trouble (ache, pain, discomfort) in: head, neck, shoulder, elbow, hand/wrist, upper back, lower back, hip, knee, ankle/foot?" five alternatives were offered on a five point scale ranging from "never" to "very often" (never, seldom, sometimes, often and very often).

Statistical analysis

Pearson's correlation coefficients were used to assess the association of MSSs with age, duration of employment, height, smoking and alcohol consumption. Since these variables correlated, a multivariate regression analysis was performed separately for each area of the body, with the MSS score as a dependent variable, and age, duration of employment, height, smoking and alcohol consumption as independent variables. The analyses were performed separately for potroom workers and office workers, using the Statistica 5.0 package. The significant limit was set at $p=0.05$. Significant values and values for null hypothesis rejection are marked in bold font.

Results

The questionnaire was completed by a total of 223 persons (age range 26-60 years). Of these, 133 were potroom workers and 90 were office workers. All the workers were male. The main statistical parameters of independent variables (age, duration of employment, and height) are given in Table 1. Using the t-test, hypotheses were tested for the equal mean value for age, duration of employment and height in both the potroom group and the office group. For age and height the hypotheses were rejected. The results of the t-test are given in Table 1. Frequency of smoking and alcohol consumption are given in Table 2. Smoking status was defined as "currently smoking" (score 3), "formerly smoking" (score 2) and "not smoking" (score 1). Alcohol consumption status was referred to as "drinking every day" (score 3), "drinking frequently" (score 2), and "never or seldom drinking" (score 1). The Mann-Whitney test showed that smoking and drinking status are unevenly distributed among potroom workers and office workers in the aluminium plant.

One-year prevalence of MSSs

Totally 93% potroom workers and 85% office workers experienced pain, ache, discomfort in one or more of the ten defined areas of the body within the past 12 months. 78% potroom workers and 71% office workers answered that they suffer from MSS often or very often in one or more areas of the body.

The incidence rates of MSSs in potroom workers and office workers are shown in Table 3. Odds ratios were calculated by categorizing MSSs into "often", "very often" vs "never", "seldom", "sometimes". Symptoms in the upper back, hands, elbows, knees and feet were reported significantly more often by potroom workers than office workers. Symptoms in the neck and head pain were more frequently reported by office workers than potroom workers.

A correlation analysis showed that the prevalence of MSSs in all areas of the body except feet increased with age among potroom workers. The same analysis showed that office workers suffer from MSSs that increase with age in all areas of the body except feet and elbows. The areas with the strongest correlation with age among potroom workers included the upper back ($r=0.29$), neck ($r=0.28$) and elbows ($r=0.26$). The areas with the

Table 1. Age, duration of employment and height in potroom workers (Op) and office workers (Of)

	Mean Op	Mean Of	Range Op	Range Of	SD Op	SD Of	T-value	Df	p
Age	39.73	43.06	26-58	27-60	6.43	8.32	-3.361	221	0.0009
Dur of em.	17.17	16.38	1-35	1-33	5.78	7.97	0.863	221	0.389
Height	175.78	183.47	157-194	167-202	6.62	7.40	-8.105	221	0.001

Abbreviations: SD-standard deviation, Df-degree of freedom

Table 2. Smoking and alcohol consumption in potroom workers (Op) and office workers (Of)

Smoking	Op, No s, 33	Op, ex s, 17	Op, s, 83	Of, No s, 39	Of, ex s, 16	Of, s, 35
Alcohol	Op, NS 41	Op, Often, 57	Op, Ed, 35	Of, NS 28	Of, Often, 33	Of, Ed, 29

Abbreviations: No s-not smoking, ex s-formerly smoking, s-smoking, Ed- drinking every day, NS-never and seldom drinking.

strongest correlation with age among office workers included the neck ($r=0.46$) and hips ($r=0.33$). The prevalence also increased with duration of employment. As age and duration of employment showed a strong correlation ($r=0.85$ and $r=0.95$), a multivariate analysis was performed.

Risk factors for MSS

The multivariate regression analysis was performed in the forward stepwise module. The results of the analysis are shown in Tables 6 and 7. First, we comment the results obtained for potroom workers. Age correlated with MSSs in the head, hands, lower back, hips and knees. Duration of employment correlated with MSSs in the neck, shoulders, elbows and upper back. Height correlated negatively with MSSs in the head, neck, elbows and upper back. Height correlated with MSSs in the hips, knees and feet. Smoking correlated with MSSs in the neck, shoulder, upper and lower back. Alcohol consumption correlated negatively with MSSs in the elbows and hips. Among office workers alcohol consumption significantly correlated with MSSs in the head, neck, shoulder, elbows, hands and lower back. The P-level in our analysis is convenient. In the multivariate analysis of MSSs and individual factors, the variance explained (adjusted r^2) was relatively low (among potrooms workers, between 0.01 in the feet and 0.11 in the head). The causes of MSSs are highly multifactorial, and the present analysis reflects only a few.

Discussion

The results of the study demonstrate a higher one-year prevalence of MSSs among potroom workers than among office workers. As potroom workers are more exposed to physical risk factors, and the prevalence of MSS among them is correlated with duration of employment, the findings suggest a relation between MSSs and specific job demands. One-year prevalence of MSSs in our study is higher than or similar to those registered in other studies. In a cross-sectional study in Norway the aluminium plants prevalence was the same, that is, 93% (13). A study among construction workers in Sweden found a prevalence of 92% (16). In population surveys, the rate of prevalence of MSSs was 85% in Norway (4) and 69% in Denmark (17). Comparison was difficult to make due to different "cut-off" points for determining the frequency, intensity and duration of symptoms. Medical examination may diagnose part of this prevalence as disease. Some variations of normal conditions may be included in self-reported MSSs based on this questionnaire (18). Studies support the observation that MSSs are most frequent in the neck, shoulders and lower back (4,13,17).

In our study potroom workers had a higher prevalence of MSSs compared to office workers. This finding corresponds with the results by other authors (19,20,21). Duration of employment was a measure of duration for work-related exposure to psychosocial and physical factors. It was not possible to differentiate between their importance.

Table 3. Odds ratio for musculoskeletal symptoms among potroom workers (OP) versus office workers (OF)

Head OP	Head OF	Odds ratio	Neck OP	Neck OF	Odds ratio	Shoulder OP	Shoulder OF	Odds ratio	Elbow OP	Elbow OF	Odds ratio	Hands OP	Hands OF	Odds ratio
38.3	46.7	0.8	36.8	47.7	0.8	30.1	18.8	1.6	24	13.3	1.8	26.3	11.1	2.4
Upper back OP	Upper back OF	Odds ratio	Lower back OP	Lower back OF	Odds ratio	Hips OP	Hips OF	Odds ratio	Knees OP	Knees OF	Odds ratio	Feet OP	Feet OF	Odds ratio
32.3	12.2	2.6	51.9	33.3	1.6	30.1	18.8	1.6	24	13.3	1.8	30	11.1	2.7

Table 4. Correlation matrix for musculoskeletal symptoms among potroom workers

	Age	Dur	Heig	Smo	Alc	Head	Neck	Shou	Elbo	Hand	U b	L b	Hips	Knee	Feet
Age	1	0.85	-0.21	-0.14	-0.19	0.24	0.28	0.23	0.26	0.25	0.29	0.21	0.19	0.15	0.02
Dur of em.	0.85	1	-0.29	-0.13	-0.14	0.33	0.29	0.23	0.26	0.23	0.3	0.19	0.12	0.14	-0.05
Height	-0.21	-0.29	1	0.07	0.06	-0.2	-0.21	-0.14	-0.25	-0.11	-0.21	0	0.11	0.11	0.14
Smookin	-0.14	-0.13	0.07	1	-0.05	0.1	0.13	0.13	0.03	-0.03	0.16	0.12	0.08	0.08	-0.05
Alcohol	-0.19	-0.14	0.06	-0.05	1	-0	-0.03	-0.09	-0.23	-0.05	0.03	0.02	-0.15	-0.02	-0.02

Table 5. Correlation matrix for musculoskeletal symptoms among office workers

	Age	Dur	Heig	Smo	Alc	Head	Neck	Shou	Elbo	Hand	U b	L b	Hips	Knee	Feet
Age	1	0.95	0.02	0.26	0.45	0.3	0.46	0.27	0.08	0.03	0.23	0.3	0.33	0.26	0.14
Dur of em.	0.95	1	0.05	0.22	0.44	0.27	0.46	0.28	0.14	0.09	0.25	0.31	0.27	0.22	0.13
Height	0.02	0.05	1	0.09	0.11	0.09	0.15	0.14	0.05	0.01	0.11	0.15	0	0.13	0.2
Smookin	0.26	0.22	0.09	1	0.39	0.06	0.25	0.22	0.06	0.08	0.16	0.12	0.17	0.13	0.1
Alcohol	0.45	0.44	0.11	0.39	1	0.33	0.56	0.38	0.2	0.19	0.17	0.33	0.12	0.12	-0.09

Table 6. Association between musculoskeletal symptoms and age, duration of employment, height, smoking and alcohol consumption among potroom workers; multiple regression analyses with body part as a dependent variable (n=133)

Area of the body	Age		Dur of empl		Height		Smoking		Alcohol		B	Adj r^2
	β	p	β	p	β	p	β	p	β	p		
Head	0.29	0.00			-0.11	0.19					3.14	0.11
Neck			0.24	0.01	-0.13	0.13	0.09	0.30			4.19	0.09
Shoulder			0.22	0.01			0.10	0.24			0.61	0.05
Elbows			0.18	0.03	-0.18	0.04			-0.19	0.02	5.38	0.12
Hands	0.25	0.01									-0.74	0.06
Upper back			0.24	0.01	-0.13	0.13	0.12	0.17			4.15	0.10
Lower back	0.20	0.02					0.09	0.29			0.46	0.04
Hips	0.20	0.03			0.16	0.07			-0.12	0.17	-4.27	0.05
Knees	0.18	0.04			0.15	0.10					-4.32	0.03
Feet					0.14	0.10					-3.13	0.01

Abbreviations: B-intercept coefficient

Table 7. Association between musculoskeletal symptoms and age, duration of employment, height, smoking and alcohol consumption among office workers; multiple regression analyses with body part as a dependent variable (n=90)

Area of the body	Age		Dur of empl		Height		Smoking		Alcohol		B	Adj r^2
	β	p	β	p	β	p	β	p	β	p		
Head	0.19	0.09							0.25	0.03	0.15	0.12
Neck			0.26	0.01	-0.09	0.29			0.43	0.01	-1.96	0.36
Shoulder			0.14	0.20	-0.08	0.17			0.32	0.01	-0.26	0.14
Elbows									0.20	0.05	0.07	0.03
Hands									0.19	0.07	0.03	0.03
Upper back			0.23	0.03			0.11	0.29			0.23	0.06
Lower back			0.21	0.05	0.11	0.27			0.22	0.05	-2.19	0.13
Hips	0.83	0.03									-2.23	0.12
Knees	0.58	0.09			0.14	0.18					-4.91	0.06
Feet	0.22	0.06			0.21	0.04	0.13	0.26	-0.26	0.03	-4	0.07

Abbreviations: B-intercept coefficient

Age was strongly correlated with duration of employment and with increasing prevalence of MSSs, which is supportive of the findings in other studies (3, 4, 19, 20, 21). Multivariate regression analysis when adjusted for age, MSSs and duration of employment remained significant for all areas of the body, except for feet, according to the findings of other studies (22). Other authors showed different relationships (16,23,24).

The causes of MSSs are highly multifactorial, which is the reason for a relatively low explained variance (adjusted r^2) in multivariate analysis of MSSs and individual factors. The association between smoking and MSSs in the neck, shoulders and upper and lower back pain is found in the present study and corresponds with the findings by other authors (25-28). Being of short stature seems to be the risk factor for MSSs in the neck, elbows and upper back. This is in accordance with the results of other studies (29,30). We also found an association between height and MSSs in the shoulder and neck of office workers. It suggests that the workplace design was ergonomically better adapted for taller workers.

As this study was focused on the improvement of musculoskeletal health among employees in the aluminium industry, the workers may have over-reported MSSs, being themselves interested in a better-designed work environment. The results of prevalence must therefore be interpreted with caution. Other authors found

that workers tended to under-report lower back pain in questionnaire surveys (31). Some of non-responders in this study were employees who were on sick-leave at the time of the questionnaire-based study. Some of these were probably absent due to MSSs, the fact that might have contributed to the under-reporting of MSSs.

This study was designed as cross-sectional with an aim to develop into a baseline for an intervention study. The default is a cross-sectional design and indirect measure of exposure, which makes it difficult to interpret the findings as evidence for causal relationships. The dependent and independent variables are both measured at the same time. The cause-effect relationship will be investigated in our follow-up study in the same population after an intervention of possible risk factors on the workers health.

Conclusion

The study found that potroom workers have more MSSs than office workers. MSSs among potroom workers affect most areas of the body and depends on the duration of employment. This suggests that the higher risk of MSS is related to the work environment. Further epidemiological studies are needed to identify specific risk factors in the work environment of the aluminium industry.

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JEDNOGODIŠNJA PREVALENCA MIŠIĆNOKOŠTANIH SIMPTOMA KOD RADNIKA U ELEKTROLIZI INDUSTRIJE ALUMINIJUMA

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Kratka sadržaj: *Rad u elektrolizi industrije aluminijuma fizički je zahtjevan, sa mnogim faktorima rizika koji podrazumijevaju prinudni položaj tijela, statički napor, dizanje i nošenje tereta. Ovom studijom željeli smo da odredimo koji su najčešći mišićnokoštani simptomi (MSS) među radnicima u elektrolizi i da ispitamo povezanost*

između MSS i dužine ekspozicije ovoj vrsti rada. 133 radnika elektrolize odgovarali su na pitanja iz upitnika i iskazali veću učestalost MSS nego 90 kancelarijskih radnika (službenika) iz naše komparativne grupe. Među radnicima elektrolize, nakon sprovedene multifaktorijalne regresivne analize u kojoj su kontrolisani parametri: životna dob, broj godina radnog staža, visina, pušenje i konzumiranje alkohola, konstatovano je da životna dob i dužina ekspozicionog radnog staža značajno koreliraju sa MSS u svim dijelovima tijela (osim u člancima i stopalima). Kod kancelarijskih radnika ta korelacija je slabija. Na osnovu naših rezultata možemo da zaključimo da je prevalenca MSS među radnicima elektrolize visoka i da je njihova pojava povezana sa dužinom radnog staža, što znači da učestalost MSS može biti povezana sa uslovima radne sredine.

Ključne reči: *Mišićnokoštani simptomi, multivarijantna regresiona analiza, radnici u elektrolizi*