Musculoskeletal disorders caused by the static posture of office and garment workers

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***Abstract*—**The work-related musculoskeletal disorders were studied in three groups of persons: office workers (N=54), garment industry workers (49) and patients of occupational disease (34). The methods used were the Nordic Questionnaire, the pain VAS scale, myotonometric measurement of muscles. The study was supported by the statistics using SPSS methods. The result is a model of relationships between the three stages of musculoskeletal disorders and the workers' age and occupation. This model could be considered for prevention of musculoskeletal disorders and for starting rehabilitation at an early stage, when the worker is not yet disabled. It is useful for employers and occupational health doctors.

Keywords—Monotonous work, static posture, musculoskeletal disorders, office, garment workers and patients with occupational disease.

I. Introduction

The majority of occupational diseases in Estonia are related to musculoskeletal disorders (MSDs). These are caused mainly by the long-time monotonous work or a forced position. Both computer-workers and industrial workers are affected [1].

The Global Burden of Diseases 2010 Study (GBD 2010 Study) is the most comprehensive effort to date for estimating the global burden of musculoskeletal diseases. The results of the GBD 2010 Study show that the prevalence of and burden from musculoskeletal disease conditions are exceptionally high throughout the world. MSDs as a group cause 21.0% of the total years lived with disability in the world, second only to mental and behavioural problems (23.2%) [2].

Work-related musculoskeletal disorders (WRMSDs) in the arm, shoulder and neck region often occur in workers who work in forced postures and make highly repetitive movements (e.g. garment workers) [3-4]. Numerous cross-sectional epidemiological studies provide support for an association between workplace physical and psychosocial exposure to both upper extremity and back musculoskeletal disorders. WRMSDs and occupational diseases affect industrial workers more than office workers [5-7]. Repetitious high-force work may increase physical stress on muscles and tendons, as well as decrease blood flow to these structures. Repetitiveness may be a reason for fatigue and shorter time for recovery, which induces metabolic changes that, in turn, lead to inflammation and injury. Tendons and muscles are therefore likely to be more at risk of tears and micro tears; ultimately, it may transfer to an individual level into pain and disability for a worker [8-9].

The WRMSDs develop gradually, stage by stage. The stages may reflect on the symptoms' severity and depend on the intensity of the workload and the possibilities for recovery. At an early stage of the symptoms, workplace preventive ergonomic interventions and rehabilitation are effective, and the worker can return to work after a short treatment [10]. A part-time sick leave may also be useful. At the next stage, treatment will take more time and sometimes the job character has to be changed in order for the worker not to be disabled in future [11]-[12]. The Criteria document for evaluating the work-relatedness of upper-extremity MSDs indicates that very few clinical studies report the frequency or duration of symptoms as a part of their case definitions. A physician´s diagnosis may be different for the patient who comes to the office with mild symptoms shortly after the symptoms begin. Therefore, a patient has to wait many months and seek help when the symptoms have come severe [11].

WRMSDs describe a wide range of inflammatory and degenerative diseases and disorders. These conditions result in pain and functional impairment and may affect the neck, shoulders, elbows, forearms, wrists and hands [12]. The need for standardized diagnostic methods for assessment of neck and upper limb MSDs are obvious. The pathomechanisms of MSDs affecting tendons, ligaments, nerves, muscles, circulation, as well as pain perception and the pathogenesis of MSDs affecting the neck and upper limbs are presented. It is evident that there is a relationship between work performance and the occurrence of neck and upper limb MSDs. Intervention strategies in the workplace for the reduction of both exposure and effect should focus upon factors within the work organization as well as actively involve the individual factor. Already in 2002 [12], it was suggested that the future research has to be directed to societal, organizational and individual

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levels. Prevention is effective if the individual characteristics are taken into account [13].

The diagnostics of MSDs is complicated; especially because the first musculoskeletal complaints are nonspecific: pain, muscle fatigue, which cannot be diagnosed under a specific diagnostic unit. There are few easily used objective diagnostic methods to assessing upper extremity or the neck and back muscles fatigue and overload. The development of WRMSDs is individual and therefore it is important to assess working conditions, workers' state of health and off-hour factors' rate [14]-[9]. Occupational musculoskeletal disease lesion localization, stages, pathogenesis, symptoms, influence on work performance, treatment efficiency and other characteristics of these diseases vary largely, making diagnosing complicated. For this reason, every suggestion of how to make diagnosing of physical overload diseases easier should be taken into consideration. The risk factors in the work environment which can cause MSDs are investigated by the authors of the current paper [15]-[16]-[17], and the risk levels of office work and garment industry workers have been determined. The physicist Arved Vain, who is also a doctor of biology in Tartu University, constructed an original, non-invasive myotonometer, which allows examining superficial skeletal muscles that are palpable with exertion [18].

II. Methods

In the present study, the workers' musculoskeletal complaints were assessed by means of the Standardized Nordic Questionnaire for Analysis of Musculoskeletal Symptoms [19], the intensity of pain was assessed on the pain Visual Analogue Scale (VAS). The workers filled out the questionnaire forms. Myotonometry [18] was carried out in thumb muscles and m. trapezius middle part.

The VAS scale description: the Visual Analogue Scale (VAS) is an instrument for measuring the characteristics or attitudes that are believed to range across a continuum of values and cannot easily be measured directly, e.g. the amount of pain. The pain a patient feels ranges across a continuum from none to an extreme amount of pain [20]. The VAS scale consists of a 10 cm horizontal line with written descriptions at either end (not at all; very much); the subjects were asked to mark on the line the point that they felt represented their perception of their current state of pain in the respective body region.

The patients were asked about the pain duration, letting them fill out the Nordic questionnaire's four duration groups**:** pain lasting for 1-7 days, 8-30 days, more than 30 days or pain felt every day.

Myotonometric method is based on creating the mechanical impulses in the examined muscle and determining muscle stiffness and flexibility according to the muscles mechanical response. Muscle stiffness (N/m) reflects the ability of a muscle to resist external force, natural frequency (Hz) shows tone and the logarithmic decrement that expresses the character of the damping of its oscillation related to muscle elasticity**.** The device "MYOTON-3" enables easy repetition of measurement, processes the data at the same time and gives statistical ratings in real time.

The thumb muscles (*M. add pollicis* left and right hand; *M. abd pollicis brevis* left and right hand*; M. flexor capri* right and left; *M. extensor digit*, right and left; *M. trapezius med*, both sides of the bine) were measured in sitting and lying position.

Univariate analysis, correlation analysis, parametric and nonparametric tests were applied in SPSS. Shapiro-Wilk test (more appropriate for small samples) was used for the numerical means of assessing normality. The last is the prerequisite for many other statistical tests. If the Shapiro-Wilk test p-value is greater than 0.05 we can reject the alternative hypothesis and conclude that the data come from a normal distribution. To compare the significant mean difference between two groups, the Student's t-test was used; to compare the significant mean difference between three groups, ANOVA test was used. If the Shapiro-Wilk test p-value was below 0.05, the data significantly deviate from a normal distribution. For checking the hypothesis, Pearson's Chi-Square test, Likelihood Ratio, Fisher's Exact test, Linear-by-Linear association [21] were used. P-value <0.05 ($p<0.1$ in some dependences) was taken to be significant.

III. Study design

The study was carried out during the years 2012-2014. The medical ethics committee of the National Institute for Health Development of Estonia approved the study, and the written informed consent was obtained from all the participants.

The research subjects fell into three groups: office workers (OW, N=54), garment industry workers (GW, N=49) and patient with occupational disease (ODP, N=34). The office-workers selected randomly from three offices, 13 of them were completely free from muscle and joint complaints, 41 persons complained of pain in the region of neck and arms. The office workers' MSDs had low levels of pain intensity, so there was no permanent incapacity of work in this group (OW). The garment workers (GW) were selected from West of Estonian factories with a long business history. The GW group had the most varied health complaints in various, and often several, regions of the body. The patients with occupational disease (ODP) were construction workers, woodworkers, workers from retail trade, forestry, agriculture and clothing industry. In 24 people of the third group (ODP), the permanent incapacity for work was diagnosed and verified. The average (ODP) loss of working capacity was 40%. Disability expertise was performed by specialists of the Estonian Social Insurance Board specialists based on the Barema method [22].

The characterization of the study groups is given in Table 1. For evaluating the OW length of service, the time of working with computers was analysed with questionnaires. It turned out that the work with computers is much more intense in the present time than it was, for example, eight years ago.

The office and garment industry workers had passed their occupational medical check-ups There was no permanent incapacity among office workers (OW), but there was some in the garment industry workers' group (GW). The third group (ODP) also passed occupational medical examinations, comorbidities were identified. To diagnose musculoskeletal diseases, following examinations were carried out: ENMG, Xray hands and elbow, USG of shoulder joints, and MRT of the wrist region in some cases.

The aim of the study was to investigate the three groups of persons (office and garment industry workers and patients with occupational diseases) by means of questionnaires on the pain location and intensity, and to draw a conclusion regarding the relationship between the stages of MSDs and the pain occurrence and duration. The myotonometric tests were used as a supportive measure. The stages of MSDs are as follows:
Stage 1: a worker has up to three different pain locations;
Stage 2: a worker has 4 to 5 different pain locations and the pain duration is over 30 days, as a rule;
Stage 3: a person has 5 or more pain locations and the pain duration is over 30 days or every day.

The study consisted of the following parts:

1. The statistical conclusion regarding the differences in pain duration in OW, GW and ODP and (based on the questionnaires).
2. Postulating of five hypothesis for determining the relationship between the three stages of MSDs, the workers' age and occupation.
3. Myotonometric measurements of muscles to explain muscle condition and the relationship with muscle strain and aches and different groups of occupations (OW, GW, ODP).
4. Working out of a model for prevention of the occupational diseases.
5. In the conclusion, the prevention possibilities are presented.

Table 1. The characteristics of the study groups

	Total number of investigated computer workers (OW) N_{OW}= 54; 22M; 32F		Total number of garment industry workers (GW), N_{GW}=49; 49N		Total number of patients with occupational diseases (ODP), N_{ODP} =34; 13M; 21F	
	Mean	SD±	Mean	SD±	Mean	SD±
Age (years)	40.61	12.14	44.08	8.6	54.32	6.60
BMI (kg/m^3)	23.4	8.4	24.95	2.7	27.34	4.50
Length of service (years)	8.8	8.4	13.9	9.0	25.53	13.2
Working time per week (h)	7.1	1.7	8.09	1.3	6.74	3.6

IV. Results

A. Pain intensity and pain duration

The pain intensity in different body regions based on the investigated groups (OW, GW or ODP) is presented in Table 2. It is evident that the intensity is dependent on the workers' group and, accordingly, on the character of work. The patients with occupational disease (ODP) feel the severest pain (~7.0-8.0 on the 10-point scale). The pain duration in the four duration groups (1-7 days, 8-30 days, more than 30 days, but not every day, and every day) for OW, GW and ODP is presented in Fig. 1, 2 and 3 and Table 3. The pain duration is the longest in the ODP group (Fig. 3). For the office workers, the pain in the neck, shoulders, back and wrists can be treated mostly within 1-7 days (Fig. 1). Daily pain in different body regions is felt by the garment industry workers, from 4.1% to 18.4% and from 17.6% to 41.2% of the patient with occupational diseases (Table 3). Fig. 2 illustrates the variety of pain duration in different body regions for garment industry workers; however, we cannot conclude the same for the patients with occupational diseases: the duration in all regions is in the 3rd or 4th pain duration zone (Fig. 3). Rehabilitation takes a long time and is continuous. In some regions (like back), the illness for GW is more serious and the treatment takes often 30 days or more (Fig. 2).

Table 2. Pain intensity in different body regions of according to the VAS-scale

Anatomical region	Office workers Group (N_{OW}=54)	Garment workers Group (N_{GW}=49)	Patients with occupational diseases (N_{DP}=34)
	Mean pain intensity (VAS scale)		
Neck (N=96)	4.1 (SD 1.8)	5.0 (SD 2.0)	7.04 (SD 2.2)
Shoulders (N=81)	3.3 (SD 1.4)	6.0 (SD 1.7)	7.35 (SD 2.1)
Elbows (N=50)	3.8 (SD 1.6)	5.3 (SD 2.0)	6.69 (SD 1.9)
Wrist/hand (N=72)	3.9 (SD 1.8)	5.7 (SD 2.0)	7.45 (SD 1.9)
Back (N=80)	4.4 (SD 2.1)	6.1 (SD 1.8)	7.97 (SD 2.3)

Table 3. Pain duration for different workers' groups and body regions (Nordic Questionnaire)

Workers' group, pain region	Pain duration			
	1-7 days/ % of total group number*	8-30 days/ % of total group number	More than 30 days, but not every day/ % of total group number	Every day/ % of total group number
OW* neck	21/38.9	8/14.8	2/3.7	0
OW shoulder	13/24.0	2/3.7	5/9.3	0
OW elbow	2/3.7	2/3.7	0	0
OW wrist/hand	7/13.0	4/7.4	0	0
OW low back	12/22.2	2/3.7	4/7.4	0
GR neck	10/20.4	4/8.2	13/26.5	7/14.3
GR shoulder	7/14.3	6/12.2	8/16.3	7/14.3
GR elbow	2/4.1	4/8.2	9/18.4	2/4.1
GR wrist/hand	7/14.3	7/14.3	9/18.4	5/10.2
GR low back	4/8.2	8/16.3	8/16.3	9/18.4
ODP neck	4/11.7	4/11.7	13/38.2	7/20.5
ODP shoulder	5/14.7	3/8.8	8/23.5	10/29.4
ODP elbow	4/11.7	6/17.6	12/35.2	6/17.6
ODP wrist/hand	2/5.7	2/5.7	15/44.1	12/35.2
ODP low back	2/5.7	2/5.7	12/35.2	14/41.2

*OW - office workers' group=**54**, GR - garment workers' group=**49**, ODP- patients with occupational diseases=**34**

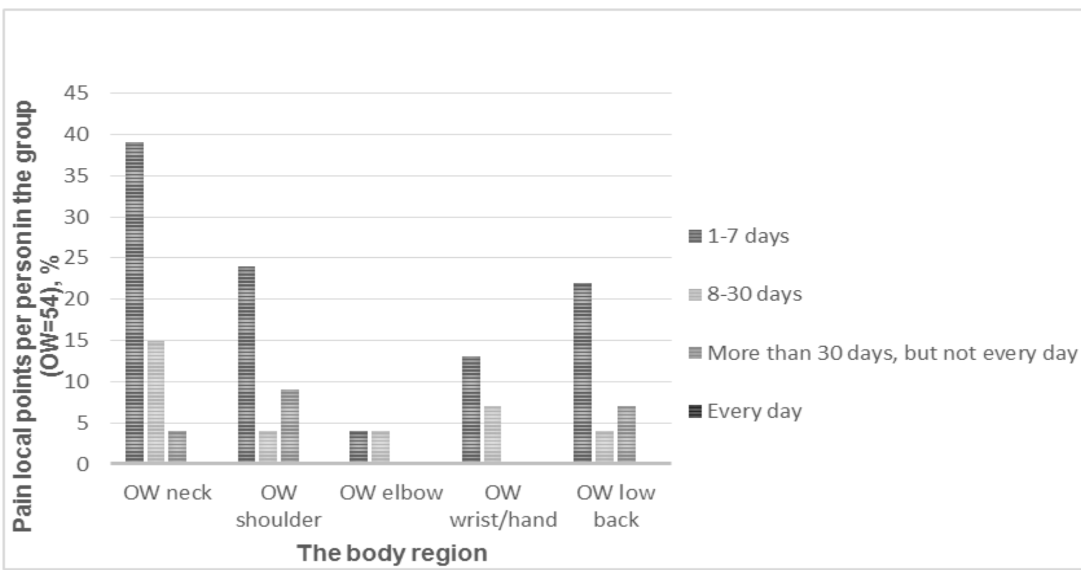

Figure 1. Pain location and duration in office workers (OW)

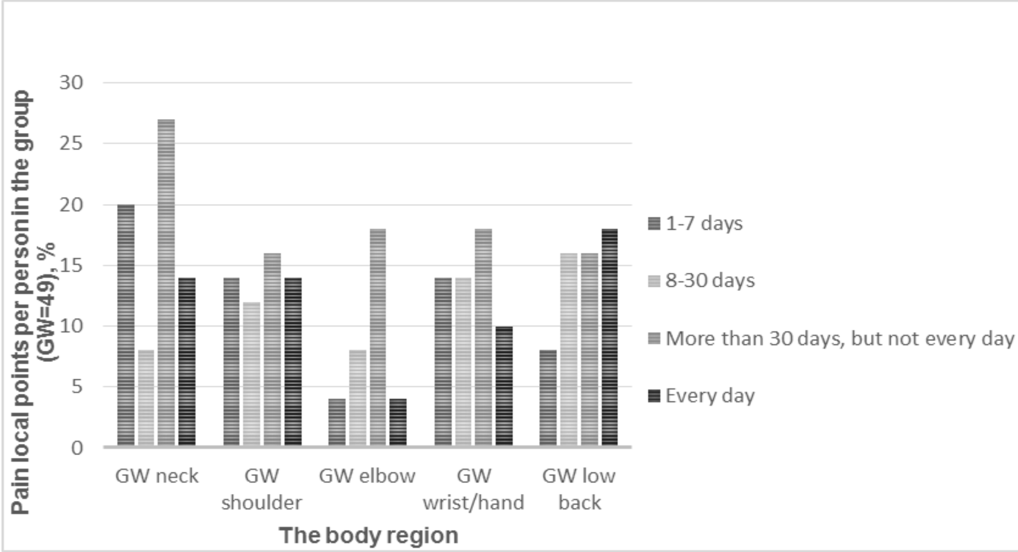

Figure 2. Pain location and duration in garment industry workers (GW)

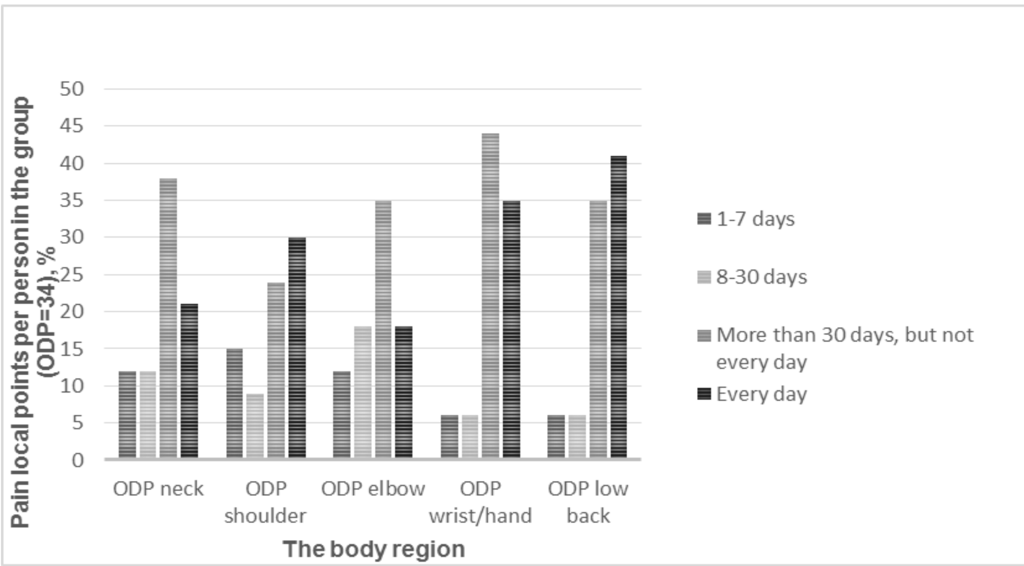

Figure 3. Pain location and duration in patients with occupational diseases (ODP)

B. The results of the myotonometric studies

The results of the myotonometric measurements are presented for two muscles: *M.* a*dductor pollicis* (Table 4A, 4B) and *M. trapezius med* (Table 4C, 4D), measured in patients in the lying and sitting position. The results of the measurements of *M.* a*dductor pollicis* show that the frequency and the stiffness of the muscles are increasing from office workers to the direction of the patients with occupational diseases; it means that the muscles loose their elasticity as a result of great physical overload and working in a static posture (GW and ODP). In the case of *M. trapezius med* measurements, the stiffness and frequency have higher values for OW compared with GW, this means that GW work more with hands, but the *M. trapezius med* is exposed to a greater load in computer work. The mytonometric study revealed differences in the tone and muscle stiffness between the three groups: office-workers (OW), garment workers (GW) and persons with occupational diseases (ODP). The statistics is given in Table 4E.

Table 4A. Office and garment workers, patients with occupational diseases: M. *adductor pollicis*, in a lying position, myotonometric data

	Adductor pollicis, left (±SD)			*Adductor pollicis, right* (±SD)		
Workers' group	Frequency	Decrement	Stiffness	Frequency	Decrement	Stiffness
Office workers (OW)	15.0 (2.0)	1.9 (0.3)	243 (28)	15.2 (2.5)	2.0 (0.3)	193 (43)
Garment workers (GW)	16.3 (2.5)	2.2 (0.3)	281 (35)	16.6 (1.8)	2.0 (0.3)	277 (48)
Patients with OD	16.1 (0.3)	1.25 (0.0)	318 (29)	15.6 (0.3)	1.3 (0.0)	313 (56)

Table 4B. Office and garment workers, patients with occupational diseases: M. *adductor pollicis*, in a sitting position, myotonometric data

	Adductor pollicis, left (±SD)			*Adductor pollicis, right* (±SD)		
Workers' group	Frequency	Decrement	Stiffness	Frequency	Decrement	Stiffness
Office workers (OW)	15.8 (2.2)	1.7 (0.3)	264 (39)	16.5 (2.6)	1.8 (0.3)	267 (42)
Garment workers (GW)	16.1 (2.2)	2.2 (0.5)	287 (32)	15.9 (1.7)	2.2 (0.4)	279 (27)
Patients with OD	18.6 (2.9)	1.8 (0.3)	294 (50)	20.6 (4.4)	1.9 (0.4)	311 (60)

Table 4C. Office and garment workers, patients with occupational diseases: M. *trapezius med*, in a lying position, myotonometric data

	Trapezius med, left (SD)			*Trapezius med, right* (SD)		
Workers' group	Frequency	Decrement	Stiffness	Frequency	Decrement	Stiffness
Office workers (OW)	11.4 (1.6)	1.4 (0.3)	193 (25)	11 (2.1)	1.4 (0.3)	192 (25)
Garment workers (GW)	12.4 (3.1)	1.3 (0.5)	175 (59)	11.7 (3.0)	1.4 (0.5)	187 (51)
Patients with OD	11.23 (1.9)	1.5 (0.1)	213 (46)	11.8 (2.3)	1.5 (0.2)	207 (70)

Table 4D. Office and garment workers, patients with occupational diseases: M. *trapezius med*, in a sitting position, myotonometric data

	Trapezius med, left (SD)			*Trapezius med, right* (SD)		
Workers' group	Frequency	Decrement	Stiffness	Frequency	Decrement	Stiffness
Office workers (OW)	17.4 (2.7)	1.3 (0.2)	337 (53)	16.8 (2.8)	1.3 (0.3)	323 (57)
Garment workers (GW)	17.3 (3.1)	1.4 (0.2)	342 (69)	16.4 (2.9)	1.5 (0.3)	318 (69)
Patients with OD	15.2 (3)	1.5 (0.2)	283 (56)	15 (2.7)	1,5 (0,3)	280 (53)

Table 4E. Office and garment workers, patients with occupational diseases (OW, GW, ODP): differences between the groups

The muscle	Kruskal Wallis Test (Square values), *Anova test		
	Frequency (p-value)	Decrement (p-value)	Stiffness (p-value)
Adductor pollicis, left	23.998 (0.0)	36.366 (0.0)	15.302 (0.0)
Adductor pollicis, right	31.032 (0.0)	21.072 (0.0)	13.626 (0.001)
Trapezius med, left	58.88 (0.002)*	0.28 (0.015)*	39821.18 (0.0)*
Trapezius med, right	7.145 (0.028)	16.04 (0.0)*	10.21 (0.01)*

C. The correlation between the pain location, intensity and MSDs stages

The total number of sufferers of pain in different regions was: neck: 96, shoulders: 81, elbows: 50, wrist: 72, back: 80 persons. Total number of persons investigated was 137. Several persons had pain in more than one region.

To clarify the connections between the pain duration in different regions of the body, considering the occupation, the age and the stages of WRMSDs development, five hypothesis were postulated:

H1 – The pain duration in different anatomical regions of the body is dependent upon the occupation (garment and office workers and patients with occupational disease (as a control group))

In Table 5, the durations of pain (four different ranges: 1-7 days, 8-30 days, more than 30 days but not every day; every day) are given (Column 2-5). Columns 6, 7, 8 give the ratio in per cent between the days with various pain durations (in OW, GW and ODP group) to the total days of pain in this region of the body. So we can see that the short duration (1-7 days) is predominant in OW, the last pain duration group (every day) is recorded in GW and patients with ODP.

The statistical analysis (Table 5, Column 10) confirm that there is a significant difference between the duration of pain between OW, GW and ODP in the following pain locations: neck, shoulder, wrist and back ($p=0.000-0.001$). We could not confirm the clear difference in elbow pain, as the correlation is $p=0.086$. If we take the level of significance to be 0.05, the correlation is not very weak ($p<0.1$).

H2 – The duration of pain is dependent on the MSD stage (early stage, stage 2, chronic WRMSDs: stage 3)

Table 5. Correlation between the occupation and the pain duration in different body regions

Pain location	Duration of pain, OW/GW/ODP				Total pain duration,% of total number of persons in the group			Square test *	Asymp. Sig. (2-sided) p-value
	1-7 days	8-30 days	>30 days	Every day	OW=54	GW=49	ODP=34		
1	*2*	*3*	*4*	*5*	*6*	*7*	*8*	*9*	*10*
Neck (96)	21/10/4	8/4/4	2/14/13	0/8/7	20.8	82.4	73.5	32.355[1]	0.000
Shoulder (81)	15/7/5	2/6/3	578/8	0/12/10	40.7	67.3	76.4	21.583[2]	0.001*
Elbow (50)	3/2/4	2/4/6	0/9/12	0/2/6	9.2	34.7	82.4	11.127[3]	0.086
Wrist (72)	7/7/2	4/7/2	0/10/15	1/5/12	22.2	59.2	91.1	28.972[3]	0.000
Back (80)	13/4/2	4/8/2	4/8/12	0/9/14	38.9	59.2	88.2	32.831[1]	0.000

[1]Pearson Chi-Square, [2] Fisher's Exact Test, [3] Likelihood Ratio, *(Exact Sig. (2-sided)

Table 6. Correlation between the stages of illnesses and the duration of pain in different locations

Pain location	Duration of pain				The complaints in the stages of the disease/ total number of complaints in the region (Column 1)			Square test	Asymp. Sig. (2-sided) p-value
	1-7 days	8-30 days	>30 days, but not every day	Every day	1st stage	2nd stage	3rd stage		
1	*2*	*3*	*4*	*5*	*6*	*7*	*8*	*9*	*10*
Neck (96)	36	16	29	15	34.4	26.0	39.6	30.240[1]	0.000
Shoulder (81)	27	11	21	22	27.1	27.1	45.7	24.332[1]	0.000
Elbow (50)	9	12	21	8	12.0	28.0	60.0	12.448[2]	0.053
Wrist (72)	16	13	25	18	19.4	26.4	54.1	19.709[2]	0.003
Back (80)	19	14	24	23	28.8	23.8	47.5	33.345[2]	0.000

[1]Pearson Chi-Square, [2] Fisher's Exact Test

The statistical analysis (Table 6, Column 10) confirm that there is a significant difference between the stages of ailment and the occurrence of pain in different regions of the body (p=0.000-0.003), in the elbow region, the p-value is also under 0.1 (p=0.053). Stage 3 is more obvious in case of elbow pains (Table 6, Column 8). Based on pain duration, the neck and back pains require the longest rehabilitation (Table 6, Column 6).

H3 – The occurrence of pain is dependent on workers' age (the workers were divided into four groups: ≤ 25, 26…40, 41-55 and ≥55 years of age).

Table 7. Correlation between the duration of pain and the workers' age

Pain location	The age of the person				Square test: Likehood ratio	Asymp. Sig. (2-sided) p-value
	≤25 years	26-40	41-55	≥55		
	The pain occurrence, % of all sufferers from the region pain					
1	*2*	*3*	*4*	*5*	*6*	*7*
Neck (96)	-	29.1	42.7	28.1	26.590	0.000
Shoulder (81)	2.5	24.7	43.2	29.6	13.600	0.137
Elbow (50)	4.0	8.0	58.0	30.0	6.897	0.648
Wrist (72)	2.8	20.0	45.8	29.2	22.880	0.006
Back (80)	1.25	23.8	50.0	25.0	18.997	0.025

The statistical analysis (Table 7, Column 6, 7) showed that there was a correlation between the intensity of pain in the neck, wrist and the back regions (p=0.000-0.0025) and the workers age. There was no correlation of pain in the shoulder and elbow regions. The persons suffering most belong to the age group 41-55. The age group >55 is already disabled or not working, the fact decreases the number of sufferers in these groups (GW, ODP).

H4 – Duration of pain is dependent on the age of workers in various occupations

Table 8. Correlation between the duration of pain and the age of workers in different occupations

Pain location	Occupation	Age groups	Square test: Likelihood ratio	Asymp. Sig. (2-sided) P-value
1	*2*	*3*	*4*	*5*
	Workers mean age: OW=40.61; GW=44.08; DP=54.32	<25/26-40/ 41-55/>55		
Neck (N=96)	Office workers	- / 17.7 / 8.3 / 7.3	8.275	0.082
	Garment workers	- / 11.5 / 20.8 / 5.2	16.55	0.011
	Patients with OD	- / - / 13.5 / 15.6	1.745	0.627
Shoulder (81)	Office workers	1.2 / 12.0 / 4.9 / 8.6	1.983	0.921
	Garment workers	1.2 / 12.0 / 21.0 / 6.2	12.827	0.171
	Patients with OD	- / - / 17.2 / 14.8	2.538	0.468
Elbow (50)	Office workers	2.0 / 4.0 / 4.0 / -	3.958	0.138
	Garment workers	2.0 / 4.0 / 26.0 / 2.0	6.046	0.735
	Patients with OD	- / - / 28.0 / 28.0	1.726	0.631
Wrist (72)	Office workers	1.4 / 9.7 / 2.8 / 2.8	8.971	0.175
	Garment workers	1.4 / 12.5 / 22.2 / 4.2	10.175	0.337
	Patients with OD	- / - / 20.8 / 22.2	3.344	0.034
Back (80)	Office workers	1.3/ 13.0 / 8.8 / 3.8	8.847	0.182
	Garment workers	- / 11.3 / 23.8 / 1.3	7.476	0.279
	Patients with OD	- / - / 17.6 / 20.0	0.153	0.985

Patients (Table 8) suffering most from neck pain fall into the age group 41-55 (GW); as do patients with occupational diseases (age groups 41-55 and >55). As regards the office-workers, neck pain was the most prevalent in the age group 26-40. Most GW suffering from shoulder pain belonged to the age group 41-55. Pain in the elbows was reported mostly by the patients with occupational diseases in the age groups 41-55 and >55 and by the garment workers (age group 41-55). Patients suffering from wrist pain were mostly the garment workers (age group 41-55) and the patients with occupational diseases (age groups 41-55 and >55). Most patients suffering from back pain were the garment workers in the age group 41-55 and the patients with OD in the age groups of 41-55 and >55.

The relationship between the body regions (Table 8, Column 5) and the occupation was confirmed as follows: in the neck region of OW (p=0.082) and more severely in the neck region of GW (p=0.01). For ODP and in all other body regions, pain occurrence is not dependent on the age of the worker.

Therefore, we can conclude that the pain occurrence caused by a static posture and monotonous work, is not dependent on the age of the person. In addition, the MSDs may develop in younger workers.

H5 – Duration of pain is dependent on the stages of illness in different occupations

The statistics on the relationship of the occurrence of pain and the stages of illnesses (three stages) was confirmed only regarding shoulder pain in garment workers (Table 9, Column 7). It confirms again that garment workers' shoulders are a weak body region and suffer from overload.

Thus it can be stated that the pain occurrence and duration (as the occurrence of MSDs) is not dependent on age. MSDs may occur in workers of any age. Everything depends on workload and the character of work (i.e. which body regions suffer more continuously from stress).

As can be seen from Table 8, the back and wrists of ODP are the most painful; as are the elbows of GW and the neck of OW. Office workers do not develop stage 3 of the illness.

The model (based on the above statistics) for the prevention of MSDs at an early stage is presented in Fig. 4.

Table 9. Duration of pain is dependent on the stages of illness in workers in different occupations

Pain location	Occupation	The stages of the illnesses			Square test: Likelihood ratio	Asymp. Sig. (2-sided) p-value
		1st stage of MSDs	**2nd stage of MSDs**	**3rd stage of MSDs**		
		Duration of pain, % of all sufferers (54+49+34)				
1	*2*	*3*	*4*	*5*	*6*	*7*
Neck	Office workers	18.2	5.1	-	1.810	0.404
	Garment workers	5.1	10.2	10.9	8.356	0.213
	Patients with OD	0.7	2.9	16.8	5.671	0.461
Shoulder	Office workers	10.9	5.1	-	2.327	0.312
	Garment workers	5.1	8.8	10.2	23.98	0.001
	Patients with OD	-	2.1	16.8	2.248	0.523
Elbow	Office workers	2.2	1.5	-	2.911	0.088
	Garment workers	1.5	5.1	5.8	7.861	0.248
	Patients with OD	0.7	3.6	16.1	6.146	0.407
Wrist	Office workers	5.1	3.6	-	2.241	0.326
	Garment workers	4.4	6.6	10.2	11.28	0.080
	Patients with OD	0.7	3.6	18.2	4.498	0.610
Back	Office workers	10.2	5.1	-	0.641	0.726
	Garment workers	5.8	5.8	9.5	3.848	0.697
	Patients with OD	0.7	2.9	18.2	12.99	0.043

V. Discussion and conclusion

The development of chronic WRMSDs (work-related musculoskeletal diseases) is usually preceded by years of muscular pain and other complaints of the musculoskeletal system. For the purpose of prevention of musculoskeletal complaints, it is essential to determine the niduses of early complaints and pain either on the course of medical anamnesis or by means of the relevant questionnaires. Attention should be paid to the duration and recurrence of the complaints, and the possible relationship of the complaints with the nature of work should be determined. A significant place is occupied by differential diagnostics.

Based on the study, it may be concluded that, in case of a MSD, pain complaints develop significantly sooner than muscle soreness or elevated muscle tone, which is usually determined by palpation. Myotonometry is a readily available and non-invasive tool for early detection of changes in muscle tone. The measuring of muscles is not a procedure requiring much time or conditions differing from a regular visit to a doctor or a nurse. As a result of a myotonometric study, we can assess the muscle condition and symptoms of an effect of physical overload in a particular worker. Myotonometric study can also be used for assessing muscle state under dynamic conditions, e.g. after a treatment or a change in the working order, as well as during physical examinations over a number of years. When conducting the study, it is also necessary that the person conducting the study has passed previous training, has a good knowledge of musculature and can choose the muscles subjected to a larger load in the given work process.

A further study of larger groups of workers by means of the myotonometric method would also be expedient. The models for determination of the relationship between the musculoskeletal pain and age or occupation are not readily available in the scientific literature, seeing that the development of the disease is very much dependent on a person and the persons' general health status. The models mostly deal with the problem of how to return to work after musculoskeletal disorders [23]. However, it is concluded that the future development of models that are truly transdisciplinary and address temporal and multidimensional aspects of occupational disability remains a goal [24]. In literature, the following models are also available: connecting the biomechanical factors and MSDs [25], psychosocial factors, stress and MSDs, work demands and MSDs [26], chronic musculoskeletal pain and motor function [27]. The epidemiology of chronic musculoskeletal pain is investigated by several authors [28]-[29]-[30]. The group and individual risk factors for musculoskeletal pain in adult population are well documented; however, the mechanisms which underlie these associations are inadequately understood and require further research. Individual and workplace psychosocial factors are strongly associated with musculoskeletal pain, interventions targeting these factors should form part of an effective treatment programme. Physical and psychosocial risk factors are at work in the development of chronic widespread pain and in the determination of its outcome. The risk factors for developing pain in muscles associated with work are gender and age, familial aggregation and genetic susceptibility; stressful life events, pain-prone lifestyle, physical trauma and recurrent pain episodes [30]-[31]-[32]-[33]. The current study did not show the MSDs development dependence with the age. According to results of this investigation the incidence of WRMSDs is correlated with exposure to physical load in a person's professional work and length of service. For preventing WRMSDs is important an individual approach.

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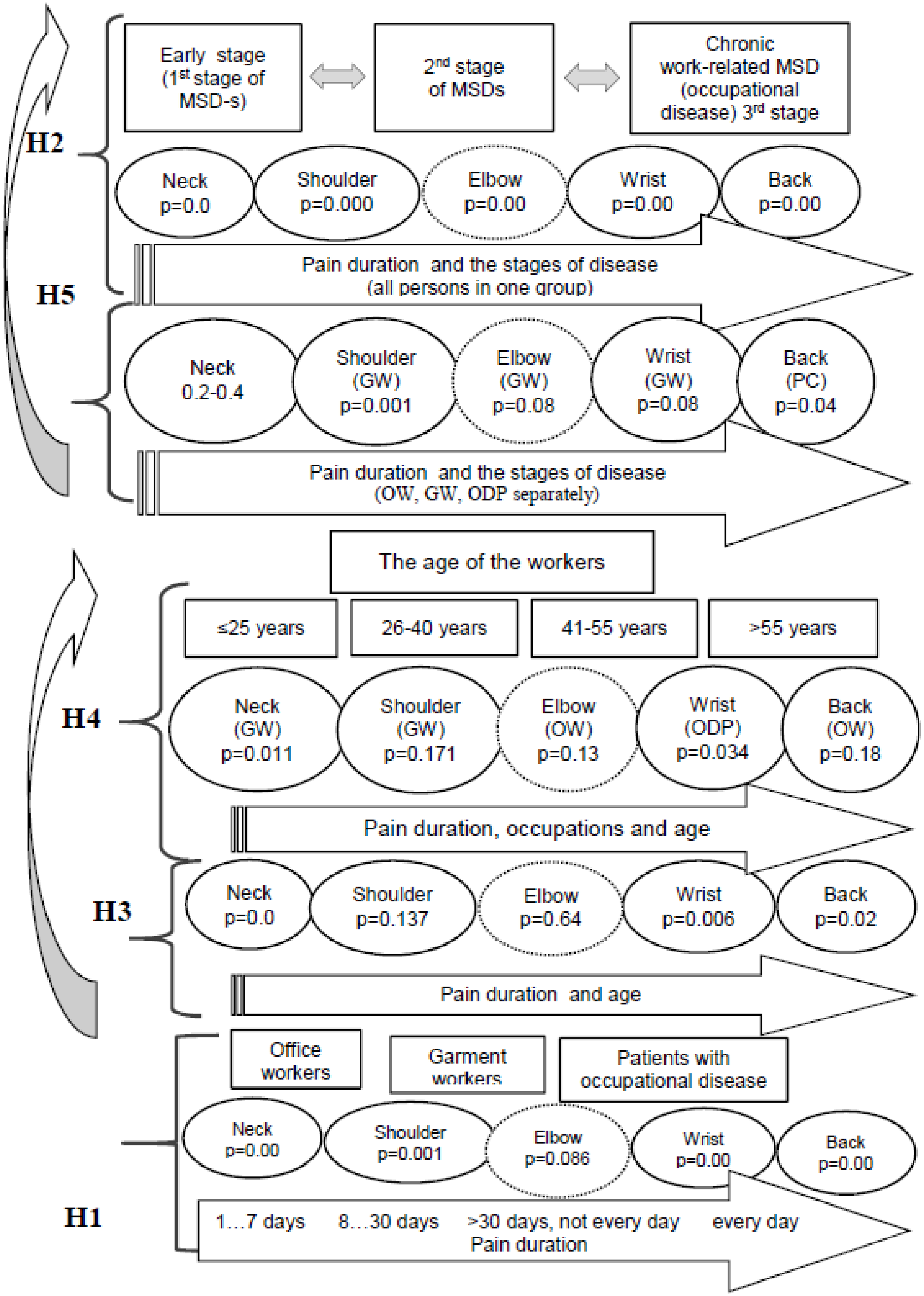

Figure 4. The dependences of the pain duration in different locations and at different stages of MSDs (office workers, garment industry workers, patients with occupational diseases)