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Comparison of musculoskeletal disorders development in Estonian office and garment industry workers

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Abstract. The aim of the paper was to investigate the structure of the factors influencing the development of the work-related musculoskeletal disorders (MSDs) in two different employee groups: office and garment industry workers. The work conditions in these two workplaces are different. The first group is mostly exposed to psychological distress and less to physiological risk factors. The second group is more affected by non-ergonomics factors. Several different research methods were used in the study: the work conditions were assessed using a flexible risk assessment method; the ergonomic risks were assessed with the ART-tool; the workers' musculoskeletal complaints were assessed using the Nordic Questionnaire; the intensity of pain was assessed by means of the Visual Analogue Scale (VAS). The number of investigated workers was 54 people from office and 49 from the garment industry. As a result, the garment workers' group had significantly more musculoskeletal complaints. Self-reported muscle pain and discomfort complaints showed that the office workers' left hand was less strained than the right one. It was confirmed by the studies determining the risk level using the ART tool at the workplace. The garment workers' both hands are usually strained at about the same level, only in the extreme conditions where the right hand is fulfilling special operations, the operating (right) hand is strained more. The results of the study make it possible to work out the means for prevention and rehabilitation of work-related musculoskeletal disorders.

Key words: work-related musculoskeletal disorders (WRMSD), office and garment industry workers, self-reported musculoskeletal disorders.

Abbreviations:
MSDs – musculoskeletal disorders,
WRMSDs – work-related musculoskeletal disorders,
OW – office workers,
GW – garment industry workers,
OCP – occupational disease patients,
VDU – visual display unit,
VAS – pain Visual Analogue Scale,
R – right; L – left,
N – number of workers.

INTRODUCTION

The majority of occupational diseases in Estonia are musculoskeletal disorders (MSDs) (National, 2015). They are mainly caused by long-time monotonous work or work in awkward postures. Both office and industrial workers are complaining of musculoskeletal disorders. Work-related musculoskeletal disorders (WRMSDs) of office workers are of shorter duration, especially specific hand diseases like carpal tunnel syndrome and epicondylitis (Leah, 2011; Mattoli et al., 2015). Manual workers, including garment workers, have a higher risk of developing an occupational disease. They are exposed to highly repetitive movements, awkward postures of hand, wrist, elbow, shoulder and neck. Usually, work intensity is high (Wang et al., 2009; Hagberg et al., 2012).

The occupational illnesses develop by stages. At the first stage, the rehabilitation is effective and the worker can return to work after a few weeks of treatment. At the next stage, treatment is possible, but it takes more time and sometimes the worker has to change the character of work in order not to be disabled in the future. In the case of occupational diseases, complaints and musculoskeletal changes are usually irreversible, but it is possible to use some rehabilitation methods to alleviate the sufferings of patients (Gawke et al., 2012; Pille et al., 2015). The MSDs are the common work-related diseases at the European level (Schneider et al., 2010). 25% of the workers in 27 of EU member countries complained of upper back pain and 23% of workers had neck, shoulder and hand complaints in 2007. Musculoskeletal disorders are the most common work-related diseases in the US and Australia, affecting millions of workers (Zheltoukhova et al, 2012; Summers et al., 2015). Middlesworth (2015) has estimated that MSDs are the single largest category of workplace injuries and are responsible for almost 30% of all worker's compensation costs in the US. At the same time, the work intensity and the information amount is increasing and it is followed by psychological stress of workers. The project's 'Fit for Work Europe' Estonian part was completed in 2011. The results showed that the health and ability to work of 50% of the Estonian workers are affected by MSDs. In 2009 the ability to work was limited due to long-lasting hand, leg, back or neck troubles in 59% of Estonian workers aged between 15 and 64 (Zheltoukhova et al., 2011).

Research conducted in different parts of the world has reported the problem of upper limb disorders among various occupations (Yassi, 1997; Bernaards et al., 2008; Borle et al., 2012). There are numerous names for the term work related upper limb disorders such as work-related musculoskeletal disorders, repetitive strain injuries, cumulative trauma disorders and occupational overuse syndrome (Yassi, 1997).

The factors influencing the development of MSDs

There is a very large number of investigations of MSDs available in scientific literature. One group of the high incidence of WRMSDs are workers in the garment industry (Pun et al., 2004). Many studies indicated that female sewing machine operators as well as several other groups of women who are performing monotonous, highly repetitive tasks have a high occurrence of musculoskeletal complaints (Kaergaard & Anderson, 2000). The epidemiologic study divides the risk factors into two groups: A: socio-demographic factors (used for collection of detailed information on the history of disease), such as age, gender, ethnicity, level of education, type of job, and income; B: information on upper limb disorders, which assessed the musculoskeletal problems in some body regions (neck, shoulders, elbows, hands/wrists). A number of epidemiological studies regarding work-related satisfaction, monotonous work with MSDs, role of job control, low social support, low job satisfaction, as well as monotonous work with MSDs, and the role of psycho-social factors and stress in these disorders have received increased attention (van den Heuvel et al., 2005; Oha et al., 2010; Park & Jang, 2010). The upper limb disorders are a subgroup of MSDs and are ailments, which have an effect on the neck, shoulders, elbows, hands and arms (Leah, 2011).

Workers are exposed to psychosocial, occupational, personal risk factors, which are connected with the developing of MSDs. Bongers et al. (1993) divided the psychosocial factors into two groups: demand and control (monotonous work, time pressure, high concentration, high responsibilities, high work load, few opportunities to take breaks, lack of clarity, low control and little autonomy) and social support (poor social support from colleagues, poor social support from superiors). Skov et al. (1996) classified the psycho-social factors into four categories: demand (job demands, especially items like high demands for concentration and speed in the work; perception of competition), control (control over the content of the job, control over time aspects of the work, items like deciding working hours, holidays), support (social contact and support from colleagues, support from superiors, psychosocial work environment, (uncertainty of employment prospects (being concerned that one may become unemployed, transferred to another job, etc.), conflicts with colleagues, work role ambiguity, unclearly defined demands in the work, work role conflict, conflicting demands in the work, variation in the work).

At the present time 2–D and 3–D biomechanical models for controlling the MSDs have been worked out (Garg & Kapellusch, 2009). The application of the strain index, and threshold limit value have been first presented. The future developments of improved biomechanical applications are presented: improved estimates of tissue tolerance, estimating stress: complex jobs estimating stresses: job rotation, estimating stresses: use of multiple criteria to analyse jobs, improved instrumentation for data collection. Better instrumentation is needed for collecting and analysing data in industry, as well as better understanding of tissue tolerance under different loading conditions.

In today's economic context the input via productivity of highly skilled employees is a crucial asset in manufacturing. Employee performance and productivity are influenced by a number of factors including satisfaction, health, safety comfort and welfare (Kaare Kõrbe & Otto, 2014).

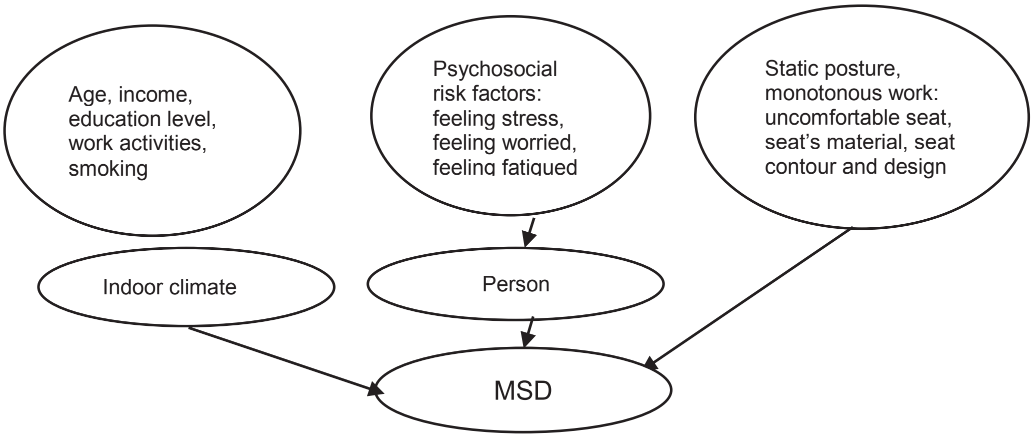

Figure 1. Development of musculoskeletal disorders.

The aim of the study was to investigate the risk factors contained in the work environment (the indoor air temperature) and how the workers complain about their health disorders resulting from continuous work in a forced position or in static posture (office and garment workers).

The novelty of the study lies in the complexity of the investigated risk factors in the workplace and the clarification of the strength of the same workers' health disorders.

MATERIAL AND METHODS

The prevention of MSDs begins with the assessment of risks in the work environment as the basic data.

1. The microclimate measurements in office-rooms and in the garment industry are based on ISO, EN and EVS standards: ISO 7726 'Thermal environments – Instruments and methods for measuring physical quantities'; EN 15251 'Indoor environmental input parameters for design and assessment of energy performance of buildings addressing indoor air quality, thermal environment, lighting and acoustics'. The measuring equipment used for microclimate was TESTO 435.

The standard EVS-EN 15251:2007 gives the room temperature in three categories of the buildings: in office rooms the 1st category from 21–25.5 degrees; the 2nd category from 20 to 26.0 degrees and the third category from 18 to 27.0 degrees, in department scores 1st category from 17.5 to 24.0 degrees, the 2nd category from 16.0 to 25.0 degrees, and the third category from 15.0 to25.0 categories. The manufacturing space (e.g. garment industry) is not regulated with EVs-EN 15251.

2. The development of MSDs in both investigated activities is very much dependent of the ergonomics of the workplaces. In the current study, the risk level of office-workers and sewers was assessed using the ART tool (HSE, 2007). In 2007, the Health and Safety Executive (HSE) presented the prototype of a tool for risk assessment of repetitive tasks of the upper limbs. The technical content of the ART tool draws upon earlier work to develop the occupational repetitive actions methods (Colombini et al., 2002) and Quick Exposure Check (David et al., 2008). As a result, the ART tool examines twelve risk factors that have been grouped into four stages: (1) frequency and repetition of movements; (2) force; (3) awkward postures (of the neck, back, shoulder/arm, wrist and hand); (4) additional factors (which include the aspect of task duration, recovery, perceived work pace and other object and work environment factors). The result is the sum of the four stages: stages A, B, C and D (Eq. 1). These stages are divided into sub-stages: $A1$, $A2$, B, C1, $C2$, $C3$, $C4$, $C5$, $D1$, $D2$, $D3$. The body postures (in graphical mode) and conditions (by time) are given.

$$Task\ score = A1 + A2 + B + C1 + C2 + C3 + C4 + C5 + D1 + D2 + D3, \quad (1)$$

where: $A1$ – arm movements; $A2$ – repetition; B – force; $C1$ – head/neck posture; $C2$ – back posture; $C3$ – arm posture; $C4$ – wrist posture; $C5$ – hand/finger grip; $D1$ – breaks; $D2$ – work pace; $D3$ − other factors.

If you assess both arms, the scores for the left arm and right arm should be kept separate and not combined.

The calculation of the exposure score (risk level) is achieved when the task score is multiplied by the duration multiplier.

$$Exposure\ score\ (Risk\ level) = Task\ score\ x\ D4, \qquad (2)$$

where: $Task\ score -$ calculated by the formula 1; $D4 -$ Duration multiplier depends on the duration of the activity.

Task scores and exposure help prioritise tasks that need most urgent attention and help check the effectiveness of any improvements.

The system for interpreting the exposure score is proposed in Table 1.

Table 1. Risk levels depending from the scores

Exposure score	Proposed risk level	Action needed
0–11	low	Consider individual circumstances
12–21	medium	Further investigation required
22 or more	high	Further investigation required urgently

3. The assessment of musculoskeletal pain.

The workers' musculoskeletal complaints were assessed based on the Nordic Questionnaire (Kuorinka et al., 1987). The intensity of pain was assessed using the Visual Analogue Scale (VAS, a scale from one to ten). The workers filled the questionnaire forms.

4. The statistical analysis

The mean and standard deviation (SD) were calculated in the course of the measurements. The student t test was used. The statistical significance of the t test was $p = 0.05$.

103 workers were investigated (office-workers: 54; garment industry workers: 49). The industrial workers were from one enterprise; investigated office workers were from three different workplaces (Table 2). The study groups were chosen basing on the previous studies (Pille et al., 2014) which have concluded that the MSDs development in office workers have different character than in garment industry workers.

Table 2. The characterization of workers groups investigated

	Office workers group	Garment workers group
Subjects	54	49
Age (years)	40.6 (SD 12,14)	44.8 (SD 9,9)
BMI (kg m^{-2})	23.4 (SD 2.51)	24.7 (SD 2.75)
Working time (hours)	7.1 (SD 1.7)	8.0 (SD 1.3)
Seniority (years)	8.8 (SD 8.4)	13.2 (SD 9.0)

Fig. 2 depicts an office workplace where there is no direct contact with natural light or outdoor air. These conditions are not allowed by the standard EVS-EN 15251. Fig. 3 depicts a workplace in an atrium-type building, where natural lighting is not the best. The windows can be opened, the room is opposite the atrium, so in very hot summer days, and the conditions are good. In winter, it is not possible to use natural light as the opposite workrooms inside the atrium are very close and this disturbs the scientific work in the room shown in Fig. 3.

Figure 2. Office room without natural lighting.

Figure 3. Office room in atrium-type building.

The workplaces depicted in Fig. 4 (gore machine) and Fig. 5 (universal sewing machine) are from the garment industry. Working with the core machine, the right hand of the worker is moving up and down hundreds of times during the workday. The right hand is under big stress. The factory has been looking for better work solutions for a long time, but there is no other machine available. Working by the universal sewing machine, the worker is working in the forced position for 8 hours a day (excluding the rest periods, 10 minutes per hour, and the lunch break). The static posture over a long period of time is a clear risk factor for developing MSDs in the neck, upper or lower back.

Figure 4. Workstation (gore machine) with sewing continuous one-sided dynamic movement.

Figure 5. Workstation (universal machine) with continuous static spine curve.

RESULTS

The characterization of the study groups

Two study groups were selected: office workers and garment workers. Employees in both groups worked in seating position. Garment workers are more influenced by static hand postures and repetitive movements. People who had chronic inflammatory disease of the joints, used nonsteroid anti-inflammatory drugs or BMI >30 kg m^{-2} were excluded from the study. The patients with occupational disease, the chronic arthritis's patients etc. were excluded.

Assessment of the work conditions in the workplace

The air temperature, velocity and humidity in the investigated offices and garment industry rooms are given in Table 3.

Table 3. The assessment of indoor climate at workplaces

Company	Risk level	Air temperature, °C, U* = 0.6 °C	Air velocity M s^{-1} U* = 0.01m s^{-1}	Air humidity, % U* = 2.0%
The limit	< 4	20–26 °C	< 0.3 m s^{-1}	30–60%
Office-room (Fig. 2)	1–2	22–22.4	0.1	34–42
Atrium-type office-room (Fig. 3)	2–3	22.0–22.8	0	22–26
Gore machine (Fig. 4)	2	19–22	0.03	40–50
Universal sewing machine (Fig. 5)	2	18–22	0.1–0.3	36–48

(Abbreviation: *U – uncertainty of measurements, k = 2).

The seasons studied, were summer and winter. The conditions are different. The only justified risk in summer is usually the air humidity. If the air temperature is > 30 °C (which happens very seldom, for one to two weeks), then the effective ventilation has to be switched on. Connected with the very strong ventilation, the problem is that airflow may blow upon people and cause colds. If the windows are opened during very hot days and drafts are formed, then the same result is possible. The bad ergonomics is the same risk factor both in summer and in winter.

In winter in office rooms, the risk factor is low humidity of the air (< 20%), that may cause dryness of mucous membranes. Other risk factors are badly organized lighting and office workers' insufficient knowledge of the lighting requirements during computer work. Not only the monitor has to be lighted, but also the backlighting has to be used. This demand is not always fulfilled in the rooms where IT specialists are working. They like to work in the dark (without general lighting). The air temperature in the investigated office rooms was good (22–23 °C).

The office workers were not aware of the scientific design principles of workplace ergonomics, but they were interested in having a good chair or an adjustable table if the person was short or tall.

In the garment industry, the air temperature is good both in winter and in summer (18–22 °C). The indoor climate conditions in winter change regarding humidity, seeing that during the heating period, humidity is usually below the norm (< 40%).

Assessment of the ergonomic situation in workplaces

The assessment of the workplaces in offices and in the garment industry was carried out on site in co-operation with the workers working in these workplaces (Figs 2–5). The assessment was carried out using the ART tool (Table 4). It is expected that the workers doing general office work and in the garment industry are engaged for 8 hours per day, while computer workers at high schools (Fig. 3) work for 10 hours per day (they work on at home).

Table 4. Assessment of monotonous work and/or in static posture by means of the ART tool (presented in Table 1) in offices and garment industry

Work-place	Lef/right (L/R)	*A*1/*A*2	*B*	*C*1/*C*2	*C*3/ *C*4	*C*5/*D*1	*D*2/*D*3	*D*4	Risk** level
Fig. 2	L	1/2	4	1/1	0/1	0/1	1/2	1	14–medium
	R	3/3	4	1/1	0/1	0/1	1/2	1	18–medium
Fig. 3	L	1/2	4	1/1	0/1	0/0	1/2	1.2	15.6*–medium
	R	3/3	4	1/1	0/1	0/0	1/2	1.2	19.2*–medium
Fig. 4	L	6/3	6	1/1	1/1	4/4	2/2	1	24**–high
	R	6/6	12	2/2	2/2	4/4	2/2	1	41**–high
Fig. 5	L	3/3	6	1/1	2/2	2/6	2/2	1	30 –high
	R	3/3	6	1/1	2/2	2/6	2/2	1	30 –high

Risk level: 0–11= low risk; 12–21: medium risk; 22 or more: high risk level;
*Right hand: RL= (3+3+4+1+1+0+1+0+0+1+2) x 1.2=19.2; risk level: medium;
*Left hand: RL= (1+2+4+1+1+0+1+0+0+1+2) x 1.2=15.6; risk level: medium;
**Right hand: RL= (6+6+12+2+2+1+2+2+4+2+2) x 1=41; risk level: high;
**Left hand: RL= (3+3+6+1+1+1+1+2+4+2+2) x 1=24; risk level: medium.

The results of the assessment (Table 4) show that office workers' risk level is medium (14–19.2); while garment workers' ergonomic risk is on a high level (24–41). There is a difference in the risk level of the left and right hand for the office-workers. There is no difference in the risk level of a garment worker, who works with two hands at the same physical level (universal sewing machine). The highest risk for developing the MSDs was stated for the worker's (gore machine) right hand, i.e. 41 points (Table 4).

The health complaints of office and garment workers

The data characterizing the age, working hours and seniority, is presented in Table 2. The health complaints of office workers (OW) and garment workers (GW) are presented in Table 5, and the pain duration in Table 6.

The workers, who declared the presence of pain, assessed the following durations of pain: 1–7 days, 8–30 days, more than 30 days, every day. The results show that the pain in the muscles of office workers (OW) is less frequent and the duration of pain is shorter. Garment industry (GR) workers have more frequently pain in their muscles and it lasts longer.

We can see from Table 5, that the right hand muscles are more painful in office workers (OW). Only two of the office workers (OW = 54) had pain in the left wrist (VAS scale = 3–4 (10 max)). The other 11 office workers had pain in the right wrist (VAS scale, mean = 3.9). The pain occurrence in the garment workers (GW)' both hands was similar and the pain intensity was 5.7 in 10-point scale.

The difference between the office and garment workers' painful regions also lies in the neck area. The neck is more damaged in garment industry workers (71.3%) and less in computer workers (55.6%). The low back pain data have the same numbers.

Pain duration is the longest in the neck region (Table 6), both in the office and the garment industry workers. Office workers have less long-term pains that last over 30 days and they do not have daily pains. Remarkable group of workers are people who have severe pain, which means 5 points in VAS scale and pains duration is over 30 days over or continuous. Workers with this kind of complaints should have been treated actively, because chronic myalgia syndrome may lead to chronic musculoskeletal disease, occupation disease and cause permanent incapacity. It is necessary to check the job management.

Table 5. Health complaints according to the Nordic Questionnaire and VAS: pain strength

Anatomical region		Office workers' Group, OW	Garment workers' Group, GW	p-value
Pain occurrence during the past 12 months				
Neck N (%)		30 (55.6%) SD 0.5	35 (71.4%) SD 0.4	0.06
Shoulder N (%)		23 (42.6%)	33 (67.3%)	
	Right	20 (37%) SD 0.5	30 (61.2%) SD 0.5	0.00*
	Left	16 (29.6%) SD 0.5	24 (48.9%) SD 0.5	0.03*
Elbow N (%)		5 (9.26%)	19 (38.8%)	
	Right	4 (7.41%) SD 0.3	11 (22.4%) SD 0.4	0.03*
	Left	2 (3.7%) SD 0.2	14 (28.6%) SD 0.5	0.00*
Wrist/hand N (%)		12 (22.2%)	26 (53.1%)	
	Right	11 (20.4%) SD 0.4	25 (51.0%) SD 0.5	0.00*
	Left	2 (3.70%) SD 0.2	24 (48.9%) SD 0.5	0.00*
Back N (%)		21 (38.9%) SD 0.5	29 (59.1%) SD 0.5	0.01*
Pain intensity (VAS)				
Neck		4.1 (SD 1.8)	5.0 (SD 2.0)	0.03*
Shoulders		3.3 (SD 1.4)	6.0 (SD 1.7)	0.00*
Elbows		3.8 (SD 1.6)	5.3 (SD 2.0)	0.13
Wrist/hand		3.9 (SD 1.8)	5.7 (SD 2.0)	0.01*
Back		4.4 (SD 2.1)	6.1 (SD 1.8)	0.00*

*p <0.05 = significant difference between workers' groups.

Table 6. Pain duration

Worker group/ pain region	Pain duration				Total
	1–7 days	8–30 days	More than 30 days, but not every day	Every day	
W* neck	21	8	2	0	31
OW shoulder	13	2	5	0	23
OW elbow	2	2	0	0	4
OW wrist/hand	7	4	0	0	11
OW low back	12	2	4	0	18
Total	55	18	11	0	87
GR neck	10	4	13	7	34
GR shoulder	7	6	8	7	28
GR elbow	2	4	9	2	17
GR wrist/hand	7	7	9	5	28
GR low back	4	8	8	9	29
Total	30	29	47	30	136

*OW –office workers group, GR –garment workers group.

Different hazardous factors (indoor climate, psychosocial factors, static posture etc.) are influencing the workers (Figs 1, 2). If improvement methods in the working environment are implemented, the level of stress of workers could be decreased.

Workers feeling pain in several regions of the body were directed to therapy. The medical surveillance in the investigated firms was very good. In both investigated groups (office and garment workers), the therapy helped workers and most of the workers were rehabilitated in a week time.

In the schematic drawing (Fig. 6), the development of MSDs is presented. The presented factors could be taken as a basis for elaborating a prevention and rehabilitations model and for performance of work ability and quality of life of people. At the first stage of health disorders (1st stage of MSDs), the subjective data on fatigue and pain in overloaded muscles was noticed by the workers; at the 2nd stage of MSDs, the pain was over 5 points by the VAS scale and muscle fatigue was more intense. The objective symptoms are more pronounced and can be diagnosed for clinical syndromes. The ability to work has decreased. At the last stage, if the rehabilitation has not begun in time, the illness might continue developing until the patient is disabled.

The model for the prevention and rehabilitation of MSDs has to include:

1) Risk analysis data (the level and effectiveness of lighting, indoor climate, ergonomics etc.) in a workplace;

2) Health status data of workers using the questionnaires (work ability index –WAI; the Nordic questionnaire for MSD s, psychological tests).

3) The results of measurements of muscle strain (myotonometry).

There is a good correlation between the ergonomic risk level (determined by ART-tool) and the pain regions (R = 0.9), but the correlation between the temperature in the workroom and the pain groups of workers was not high (R = 0.4). The microclimate conditions in garment industry are usually normal, therefore we cannot consider the room temperature as the risk factor in garment industry, but it good be the risk factor during outdoor activities, like driving an agriculture machine or at construction work etc.

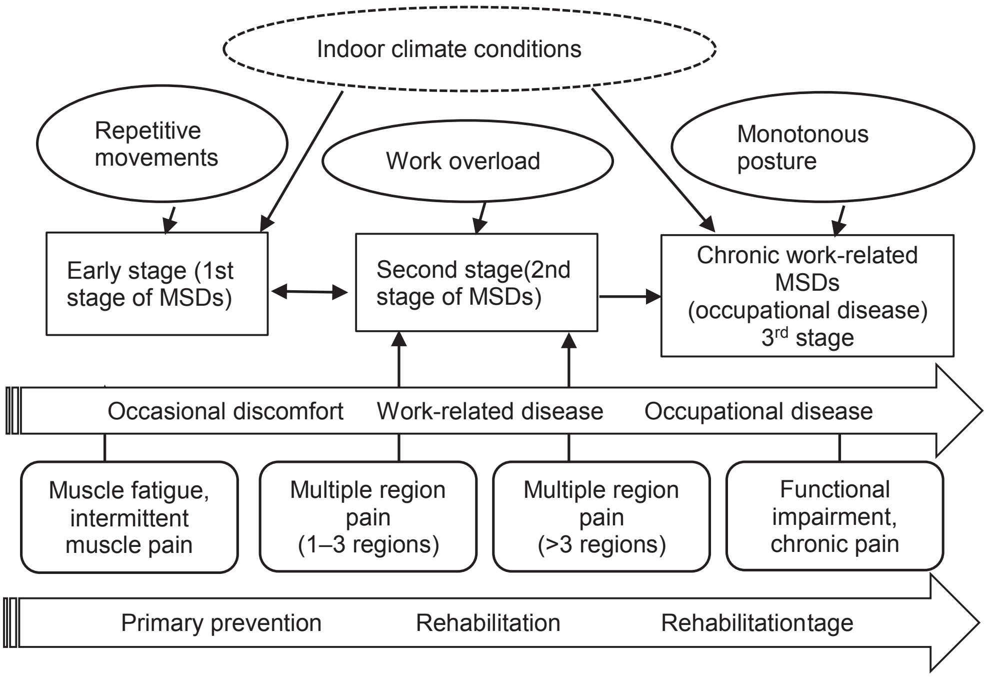

Figure 6. The factors influencing the development of MSDs as an occupational disease.

These data are the basis for the developing of the model and a subsequent IT program for designing computer-equipped and industrial workplaces for different age groups in order to prevent decreased work ability and development of an occupational disease. These recommendations could be followed by the occupational health and family doctors in their treatment work.

DISCUSSION

The novelty of the present study lies in the statement that the right hand of office workers is more painful than the left one (as proved by the questionnaires) due to a greater load affecting the right hand. Garment workers' both hands are painful to the same extent. The other authors' papers dedicated to garment workers' MSDs show the same tendency.

Although neck pain is mentioned as the most prevalent musculoskeletal complaint of office workers (Blagsted et al., 2008), pain symptoms in other body regions are reported as well (Juul-Kristensen et al., 2008). The number of workers studied by Andersen et al. (2010) was 544. The areas of pain were as follows: neck 53% of the people studied, lower back 43%, R shoulder 36%, upper back 33%, knees 20 %, R hand 22%, L shoulder 24%, feet 18%, R elbow 16%, hips 15%, L hand 10% and L elbow 10%. Pain intensity was rather unvaried: 4.18…4.93 on the scale of 0 to 9.

Neck pain is very common among office workers (Sihawong, et al., 2010). Approximately 43% to 69% of the office workers experienced neck pain in the preceding 12 months. A survey of MSDs among visual display unit (VDU) users in a bank showed the prevalence of complaints in various body parts as follows: neck 31.4%, shoulder 16.5%, hand and wrist 14.9% and arm 6.6%. Frequent users of VDU had significantly more musculoskeletal problems in the neck and shoulder regions than infrequent users (Yu & Wong, 1996). Modification of the workstation design and improvement of work organization should be able to reduce the prevalence of these disorders.

The corresponding results (OW) obtained by the authors of this paper were 55.6% in the neck, 42.6% in the shoulders, 38.9% in the back, 5.96% in the elbows and 22.2% in the wrist (the percentage of people suffering from pain of all the people studied). Pain intensity was from 3.3 to 4.4 in the present study (Table 5).

The results of the assessment (Table 3) show that office workers' risk level is medium (14–19.2); while garment workers' ergonomic risk is on a high level (24–41).

We have to conclude that the results derived from this study are similar to or higher when compared to the other authors. New data are derived from a comprehensive study of wrist pains.

In the garment workers' group (230 people, Reinhold et al., 2008) the incidence of pain in different areas of the body were rather variable: the pain in the shoulders was felt by 27% of the workers studied, lower back pain by 46%, pain in the neck area by 21%, headache and brain fatigue by 15%, carpal channel syndrome –moderate stadium by 18%, back pain in the pectoral region by 8%, fatigue of hands and disturbances in the sensitiveness by 16%, pain in hip by 2%, pain in the leg muscles by 7%, knee pains by 6%, pain in thigh muscles by 2% and back pain by 8% of the workers.

Wang et al., (2009) report about pain in the neck/shoulder region (12.9% of garment workers), in hands/wrists (6.9%) and in arms/forearms (3.7%). The most frequent physical signs observed in the neck/shoulder region were rotator cuff tendonitis (7.3%), somatic pain syndrome (6.9%), radicular pain syndrome (6.0%) and thoracic outlet syndrome (4.6%).

Herbert et al. (2001) observed the areas and frequency of pain among garment workers as follows: neck in 47% of the people studied, R shoulder 66%, L shoulder 36%, L elbow 26%, R elbow 29%, R forearm 29%, L forearm 24%, R wrist 25%, L wrist 19%, R hand 42% and L hand 36%.

Thus the data are variable, but the problem is actual and several researchers are looking for ways of decreasing the risk factors in the garment workers' work environment and also for the best means of rehabilitation.

The results of the present study of garment workers correspond to the previous data regarding back pain (59.1%). The frequency of pain occurrence in the neck area (71.4% of all GW), in the shoulders (67.3% of all GW), wrist/hand region (53.1% of all GW) is higher when compared to the study of Reinhold et al. (2008).

In the study of Friedrich et al. (2000), the proportion of sewing industry workers suffering from neck, upper back and lower back pain was much higher: 52.4%, 54.8% and 72.8% respectively of all the workers studied, which is in better conformity with the results of the present study.

The work is repetitive both for workers (in the garment industry and in offices), but the movements, made by the right hand, are different. The probability of developing the carpal-syndrome disease is higher for office workers who use the mouse. Number of musculoskeletal disorders has risen, caused by the work with computers; therefore, the rehabilitation methods are very important. The authors of the present study suggest the following: the complex treatments of these syndromes include active and passive methods of physiotherapy. The active part is organized by the physiotherapist. Systematic application of physical education, exercise therapy improves the functional capacity of the organism to physical stress. The role of the physical therapist in the occupational health team is to ensure that an optimum work environment exists for the prevention of injury and for the rehabilitation of work-related impairment, activity limitation, and participation restrictions. There are also physical therapies which influence the tissues metabolic activity and have positive influence on the repairing process. These are massage, physical agents' therapies and water immersion therapy. The most important is the workplace ergonomic design (Figs 4–5) to prevent the health damages.

The microclimate measurements are in the accordance with our previous measurements Reinhold et al. (2008) & Tint et al. (2012).

Thus, the intensity of pain and the frequency of its occurrence in certain areas of the body are closely linked to the risk factors in the work environment. They have to be determined on the individual level.

CONCLUSIONS

The studied office and garment workers' groups had a significant difference in the presence of shoulder, elbow and wrist pains. There was no great difference in the incidence of neck pain; back pain was also observed quite often in both groups. The office workers had characteristically short-term muscle pains, usually lasting from one to 7 days. The average duration of pain in the garment workers' group was 8 to 30 days, in fewer cases over 30 days. From the results it can be concluded that the studied industrial workers were not sufficiently protected against physiological risks. Continuing to work in the same working conditions may lead to chronic MSDs, and the development of permanent incapacity might occur. The threat to office workers does not seem to be so high, but considering the high incidence of neck and back pain, it is necessary to monitor workplace ergonomics, the intensity of work and other indicators of working conditions. However, it is certainly important for the workers themselves to ensure adequate physical activity, since both studied groups had a sedentary job, and static muscle strain dominated the muscles throughout the body. It can be pointed out that for the occupational health personnel it is important to collect detailed work anamnesis and complaints, and let the workers themselves to fill out the complaints in the muscle mapping questionnaire. Based on articles listed in the *References* part of the present paper, it is desirable that the employees participate in suitable rehabilitation programs.

The results of the risk assessment of the workplaces in office and garment industry (using ART-tool) are corresponding to the data derived from the questioning of the persons in the current study (VAS-scale and Nordic Questionnaire).

The amount and intensity of the work environment risk factors are in correlation with the development of musculoskeletal complaints. The time during which the workers have been subjected to the non-ergonomic risk factors in the workplace is in correlation with the development of musculoskeletal disorders. There are different stages of the disease which can be clearly detected.

Future research: preventive programs/models will have to be worked out on the basis of the structure of risk factors in the workplace and the complaints of workers, considering the measurement results of musculoskeletal pain and muscle strain. The design of workplaces will have to be based on the individual features of workers. The prevention methods for different age groups for computer and industrial workers will have to be investigated.

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