

Prevention of MSDs and psychological stress at computer-equipped workplaces

Prevención de trastornos musculo-esqueléticos y estrés psicológico en los lugares de trabajo equipados con computadores

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ABSTRACT

Introduction: The human body responds to stress-factors through four systems – central nervous, autonomic nervous, endocrine and immune – which are constantly interacting as a complex network. The main stress-factor at the computer-equipped workplaces is a poorly designed workplace, specifically the positioning of equipment on and around the workstation. The number of occupational diseases among office workers is the specific indicator of influencing of existing hazards and risk factors on the worker in the work environment. **Objective:** To find out the health disturbances and to make the suggestions for health promotion for computer workers. **Methods:** Over 400 computer workers' working conditions were measured with subsequent measuring equipment; the fatigue of muscles was measured with myometer; the investigation of the workers' opinion on working conditions based on Nordic, Work ability index (WAI) and Kiva questionnaire was carried out. The workers were divided into different groups by the age (A: under 40 years and B: over 40 years). This paper investigates the satisfaction of computer workers with their working conditions. **Results:** According to the results of Nordic and WAI questionnaires, musculoskeletal disorders (MSDs) were observed by 53.6%; the cardiovascular disturbances by 20.4% and visual disturbances by 16.7% of the respondents in group A (under 40 years). In group B, MSDs were observed by 50.1%; cardiovascular disorders by 45.7% and visual disturbances by 23.2% of the respondents (over 40 years). Muscle and joint complaints were reported only by 19.7% of workers.

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The majority of the respondents declared the existence of two or more local pain points. Neck, shoulder, wrist and back pain were registered as the main complaints. **Conclusions:** The results of measurements of physical workplaces revealed that in some offices there are deficiencies in lighting, problems with stuffy air (high CO₂ value) and low relative humidity value on cold season. As muscle strain is often coming from the static posture, it may be influenced also by the psycho-emotional stress at workplace. The questionnaires, objective methods and environmental measurements are useful to plan prevention and early rehabilitation before the disability appears.

Keywords: Musculoskeletal diseases, psychological stress, computer terminals, workplace.

RESUMEN

Introducción: El cuerpo humano responde a los factores estresantes a través de cuatro sistemas – nervioso central, autónomo, endocrino e inmune- los cuales están constantemente interactuando como una red compleja. Los factores estresantes principales en los lugares de trabajo equipados con computadores son lugares de trabajo pobremente diseñados, específicamente el posicionamiento de los equipos en y alrededor de los puestos de trabajo. El número de enfermedades ocupacionales en los trabajadores de oficina es el indicador específico de la influencia de los peligros existentes y factores de riesgo sobre trabajador en el ambiente de trabajo. **Objetivo:** Encontrar los problemas en salud y realizar sugerencias para la promoción en salud para trabajadores con computadores. **Materiales y métodos:** Más de 400 condiciones en trabajadores con computadores fueron medidas con el equipo de medición pertinente; la fatiga muscular fue medida con el miometro, la opinión de los trabajadores sobre las condiciones de trabajo fueron registradas por medio de Nordic, el índice de habilidad de trabajo (WAI por sus siglas en ingles) y el cuestionario Kiva. Los trabajadores fueron divididos en diferentes grupos por edad (A: menores de 40 años y B: mayores de 40 años). En este artículo se investiga la satisfacción de los trabajadores de computadores con su condición de trabajo. **Resultados:** De acuerdo con los resultado de los cuestionarios Nordic y WAI, los trastornos musculo-esqueléticos (TME) fueron observadas en el 53.6%; los problemas cardiovasculares en un 20.4% y los problemas visuales en un 16.7% de los encuestados del grupo A (menores de 40 años). En grupo B, los TME fueron observados en un 50.1%; los problemas cardiovasculares en un 45.7% y los problemas visuales en un 23.2% de los encuestados (mayores de 40 años). Las quejas musculares y articulares fueron reportados solo en el 19.7% de los trabajadores. La mayoría de los encuestados reportaron la existencia de dos o más puntos locales de dolor. Los dolores de cuello, hombros, muñeca y espalda fueron registrados como las principales quejas. **Conclusiones:** Los resultados de las mediciones de los lugares de trabajo físicos revelaron que en algunas oficinas hay deficiencias en la iluminación, problemas con la contaminación del aire (altos niveles de CO₂) y el bajo valor de la humedad relativa en la estación fría. La tensión muscular es a menudo a causa de la postura estática, esta puede estar influenciada también por el estrés psico-emocional en lugar de trabajo. Los cuestionarios, métodos objetivos y mediciones ambientales son útiles para planificar la prevención y la rehabilitación temprana antes de que aparezca la discapacidad.

Palabras clave: Enfermedades osteomusculares, estrés psicológico, terminales de computador, lugar de trabajo.

INTRODUCTION

The human body responds to stress-factors through four systems – central nervous, autonomic nervous, endocrine and immune – which are constantly interacting as a complex network. The main stress-factor at the computer-equipped workplaces is poorly designed workplace, specifically the positioning of equipment on and around the workstation. The number of occupational diseases among office workers is the specific indicator of influencing of existing hazards and risk factors on the worker in the work environment. The occupational diseases in Estonia are usually

diagnosed in the late stage when the worker is already disabled. The main part of these diseases is connected with musculoskeletal disorders (MSD) as well as the diseases caused by the mental stress at workplace¹. Employees working with computers are mentally under pressure due to high amount of work to be done within limited time. This can lead to work-related stress, which is not only a feeling, but can cause functional changes in the body: release of different hormones, increased breathing, the production of more stomach acid etc. Besides, computer-workers' stressors like time limits, high work demands, high responsibilities are likely to cause fatigue in upper extremities^{2,3}.

The understanding of workers' stress in the workplace is attracting growing interest in occupational health psychology. Increased levels of stress compromise the immune system and increase of risk of accidents. Psychological risk factors have been defined as aspects related to the planning, organization and management of the job, social contexts, physical, social or psychological damage⁴. Previous studies^{5, 6} have shown that musculoskeletal disorders among computer-workers contain pain in the neck and shoulders, elbows, back and in the wrist as the most common work operations are typing, reading from the screen, using a computer mouse. Intensive use of computers may cause major other health problems like tissue damages, imbalance in blood flow, formation of the carpal tunnel syndrome⁵. The objectives of the study were to investigate the satisfaction of computer workers with their working conditions, to find out the health disturbances, and to make suggestions for health promotion.

MATERIAL AND METHODS

Participants (N=423) in the study were selected from various office-rooms from different institutions. All of them used a computer-equipped workplace more than 6 hours per day. The workers were divided into different groups by the age (A: under 40 years and B: over 40 years). Selected workers had been working in the same occupation on the average for 4.81 years (group A) and 17.38 years (group B). The investigation of the workers' opinion on working conditions was based on Nordic Work ability index (WAI) and Kiva questionnaire^{7, 8, 9} which was forwarded to the participants either by e-mail or in paper.

Nordic questionnaire is designed to use as an instrument for studying psychological, social and organizational working conditions. WAI is determined on the basis of the answers to a series of questions that take into consideration the demands before the interview with an occupational health professional who rates the responses according to the instructions. Kiva questionnaire characterizes the wellbeing of workers at work. The ratings were given in a 10-point scale (1 - not at all, 10 - very much so, certain or well). The Kiva questionnaire was composed of seven statements: I have enjoyed coming to work in the last weeks; I regard my job meaningful; I feel in control of my work; I get on with my fellow-workers; my immediate superior performs as superior; I'm certain that I will keep the job with my current employer, I can influence factors concerning your job. For statistical data processing (except working environment hazards measurements),

the computing programme SPSS.13 (Windows) was used. The arithmetic mean and standard deviation (SD) were calculated.

The working conditions of computer-equipped workplaces were objectively measured. The indoor air conditions were measured with TESTO 435 using the following standards: EVS-EN-ISO 7726:2003 "Thermal environments- Instruments and methods for measuring physical quantities"; EVS-EN 15251:2007 "Indoor environmental input parameters for design and assessment of energy performance of buildings addressing indoor air quality, thermal environment, lighting and acoustics". Workplaces lighting and screens were measured using the light-metre TES 1332 following the standards EVS 891:2008 "Measurement and evaluation of electrical lighting in working places" and EVS-EN 12464-1:2011 "Light and lighting-Lighting of workplaces- part 1: Indoor work places". Dust was measured with HazDust EPAM-5000 following the WCB method 1150:1998" Particulate (total) in air". Equipment used for the measurements met the requirements set in the standards cited above and calibrated as required by Estonian Metrology Act¹⁰. Myometer "MYOTON-3" was used to diagnose the functional state of the skeletal muscles of office workers. Myoton-3 exerts a local impact on the biological tissue by means of a brief mechanical impulse. The impact force is small enough so that it causes no changes in the neurological reaction of the biological tissue. The tissue responds to the mechanical impact with damping or oscillation which is registered by an acceleration sensor located on the measuring tip of the device.

RESULTS

Occurrence, measurements and analysis of occupational hazards

The table 1 shows the results of measurements in the selected office rooms where the participants worked. Offices 1, 2 and 5 were situated on either new or renovated buildings where good ventilation system had been installed. However, office 1 had big glass walls without any shields which meant high temperatures in summer-time. Offices 3 and 4 were situated in older buildings which lacked an effective heating system to keep warmth in cold winter days and had no sufficient ventilation which meant high CO₂ values from time to time (e.g. in the end of the working day). All offices were cleaned regularly and no problems with dust were detected. In winter time, relative humidity posed a problem when the air dried due to heating system and no

conditioner system existed to balance it (e.g. 15...25% in office 1). The lighting of workplaces equipped with computers was measured in most places according to the norms (300...500 lx or more); but some workers

preferred working without electrical lighting to get a better contrast of the screen. However, this situation must be avoided as it may favour uncomfortable working postures and give rise to MSDs.

Table 1. Measurements of working environment, selected office rooms

Room type	T, °C Cold/warm season U=0.6°C	R, % Cold/warm season U=2.0%	L, lx U=10.4%	CO ₂ , ppm U=10%	Dust, mg/m ³ U=10%
Office 1	20...22/28...30	15...25/35...65	495..890	537..698	0.030
Office 2	20...22/24...26	19...25/35...75	400..650	500..750	0.020
Office 3	18...22/20...24	20...30/40...74	350..600	550...1200	0.015
Office 4	17...20/22...28	15...30/40...70	690...1209	678...1152	0.011
Office 5	21...23/24...25	26...35/46...65	246...780	555...654	0.032

Abbreviations: U - the uncertainty of measurements; T- temperature of the air; R - relative humidity; L - lighting; CO₂ - concentration of carbon dioxide in the air; Dust - dust concentration in the air

Response and analysis of questionnaires

Table 2 presents the results of the survey involving 423 computer workers. In group A (participants under 40 years, N=251), MSDs were observed by 53.6% of the respondents; the cardiovascular disturbances were observed by 20.4% of the respondents (A); visual disturbances occurred in 16.7% of persons (A). The problem of overweight in group A occurred in 20.2% of the respondents. The diabetes occurred in two people. In group B (participants over 40 years, N=172), MSDs were observed by 50.1% of the respondents; cardiovascular disorders by 45.7% of the respondents; visual disturbances occurred in 23.2% of the respondents. Considering the fact that people begin

to work with computers at ever younger age and using the computer also during their free time, according to the current investigation, slightly more MSDs are observed by young people (<40 years of age) than by older workers (>40 years of age). The results from the questionnaire showed that the computer workers assess their health status considerably high – in group A, more than half of people were satisfied with their health; in group B, 43.1% of people assessed their health good. They were also relatively optimistic about static postures they are experiencing during their working days and are hoping that their health status in the future will stay on the same level using the steadily enhancing rehabilitation means.

Table 2. Health complaints (Nordic and WAI questionnaires)

Health complaint	Group A (persons <40- included; years of age), % of all investigated	Group B (persons >40 years of age), % of all investigated
Musculoskeletal disorders	53.6	50.1
Cardiovascular disturbances	20.4	45.7
Visual disturbances	16.7	23.2
The problem of overweight	20.2	25.0
The health status good	55.6	43.1

Kiva questionnaire (scale 1-10) revealed that people in group A enjoyed coming to work less than in group B (6.7 and 7.3 points, respectively). There were no differences in assessing the importance of work which both groups agreed (8.2 and 8.5 points respectively). The ability to control the work process was evaluated with 8.0 points by participants in group A and with 8.5 points by participants in group B. Both groups were satisfied with the relationships with their co-workers (8.5 points) while the relationships with employer were assessed lower (7.4 and 7.1 points, respectively). The possibility to influence participants' own work was evaluated with 6.8 points in group A and 6.2 points in group B.

Determination of fatigue in muscles

Muscle and joint complaints were reported only by 19.7% of workers. From those, 34 participants were selected whose MSDs were examined profoundly (Table 3). Nordic questionnaire was used beforehand to find out the persons who might have MSDs with the aim to diagnose the disease in the early stage. Myoton allows pohlde abductors muscle tone and muscle stiffness to be measured. Pain intensity was evaluated on a 10-point scale. The body mass index was assessed, average being 25.0 (SD 5.0).

The majority of the respondents declared the existence of two or more local pain points. Neck pain complaints occurred in 22 respondents (64.7%), and the severity of pain was assessed at an average of 4.18. Right shoulder pain occurred in 15 patients (44.0%) and left shoulder pain in 14 (41.0%) of the respondents. Pain in shoulders was assessed with 3.80 (right) and 2.80 (left) balls. Wrist pain in the right arm was declared in 7 cases (20.6% of all) and the left wrist pain only in two cases (4.5%); the severity of 4.57 (right) and 4.01 (left). Back pain was complained by 16 (47.0%) persons with severity of 4.28 balls (Table 3). The presence of pain was generally of short-term duration, mostly for 1-7 days. Myometric study revealed differences in the pain severity of complaints from employees with muscle pain and trapeze muscle pain in tonus and muscle stiffness. As muscle strain is coming from the static posture, it can be influenced by the work psycho-emotional stress.

Table 3. The results of measurements of fatigue in muscles with myoton

Pain region	Number of workers (% from all 34 respondents)	Severity of pain (0-10)
Neck	22 (64.7%)	4.18
Shoulder, right	15 (44.0 %)	3.80
Shoulder, left	14 (41.0%)	2.80
Elbow, right	2 (5.9%)	4.71
Elbow, left	2 (5.9%)	2.12
Wrist, right	7 (20.6%)	4.57
Wrist, left	2 (5.9%)	4.01
Back	16 (47.0%)	4.28

Thus, it might be concluded that static muscle tension causes increased muscle tone. Loaded in front of the screen is mostly the guiding hand. It is important to find the organizational measures that would ensure regular breaks and exercises, possibly combining them.

DISCUSSION AND CONCLUSIONS

The most interesting finding in the study was that different conditions for younger workers and for older workers were often provided or preferred. When the conditions were the same, the two groups of workers often experienced them in different way. In addition, the age and sex of the employer and the employees have their influence on the questionnaire results. As the problems were defined in quite different ways by workers, then an individual approach for every workplace has to be implemented considering the anthropological and other features of the worker. The main conclusion from the investigation is that MSDs and stressful situations at workplace can be prevented by use of the proper intervention programmes.

The authors of the present study suggest active and passive methods of physiotherapy for rehabilitation^{2, 11, 12} systematic application of physical education, exercise therapy improves the functional capacity of the organism to physical stress. The active part is organized by the physiotherapist whose role 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^{13,14,15}. Physical therapies which influence the tissues metabolic activity and have positive influence on the repairing process are available as well. These include massage, physical agents therapies and water immersion therapy.

Additionally, the proposals were given for ergonomic improvements at workplaces. It is well-known, that best results for intervention are obtained when both organizational and technical measures are implemented together in order to prevent MSDs.

The data derived from this study are valuable for the early diagnosis of possible health disturbances caused by work and for planning the rehabilitation treatment in an early stage of overload caused MSDs. The questionnaires, objective methods and environmental measurements are useful to plan prevention and intervention before the disability appears.

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