Open Access Research Journal - ONLINE **Medical and Health Science Journal, MHSJ**
www.mhsj.pradec.eu ISSN: 1804-5014 (ONLINE)
www.academicpublishingplatforms.com VOLUME 17, ISSUE 2, 2016, PP.23-30
The primary version of the journal is the online version DOI: http://dx.doi.org/10.15208/mhsj.2016.05

THE PREVALENCE OF WORK-RELATED MUSCULOSKELETAL DISORDERS IN COMPUTER WORKERS AND INDUSTRIAL WORKERS

Various work-related risk factors cause neck and upper extremity pains and disorders. The pain severity and the frequency of MSDs among workers are more dependent on the nature of work and physical workload than on the length of service. Office workers (N=192) and garment workers (N=48) were investigated. More muscular pains occurred in the latter group and, also, working ability was lower among the sewing machine operators. The condition of muscles was determined by using myotonometry. In the garment workers' group, it could be seen that the stiffness of m. adductor pollicis had increased in both hands. To prevent MSDs, it is necessary to pay attention to the work environment, muscular pain occurrences, pain severity, and muscle tone and stiffness. The myotonometric method could find more use in the occupational healthcare system.

VIIVE PILLE [1]
PIIA TINT [2]
JELENA HARTŠENKO [2]

[1] *Faculty of Mechanical Engineering, Tallinn University of Technology, Estonia*
[2] *Faculty of Economics, Tallinn University of Technology*

Keywords:	Professional upper limb overuse, work-related musculoskeletal disorders, musculoskeletal pain, work ability, myotonometry
Email:	piia(dot)tint[ats]ttu(dot)ee
Corresponding contact:	Tallinn University of Technology, Ehitajate tee 5, 19086 Tallinn, Estonia
Citation:	Pille, V., Tint, P., Hartsenko, E.., 2016. "The prevalence of work-related musculoskeletal disorders in computer workers and industrial workers", Medical and Health Science Journal, Vo.17(2), pp.23-30, DOI: http://dx.doi.org/10.15208/mhsj.2016.05

Introduction

Nowadays, many work tasks involve working in a sitting position, using forced hand positions or doing monotonous, repetitive movements. During their working years, many employees develop muscle tension, pains in the neck, shoulder or wrists. Also common are lower back pains. Health promotion and preventive measures are therefore becoming more important (Bevan 2015).

The aim of this study is to investigate and compare office workers' and sewing industry workers' work ability, health condition and the condition of shoulder and neck muscles, using the myotonometric method to evaluate muscle overload.

Office workers (N=192) were investigated within the framework of the Interreg 4A "Work Ability and Social Inclusion" project headed by Arcada University of Applied Life. Tallinn University of Technology and Riga Stradins University were also involved. The Work Ability Index questionnaire and the Nordic Musculoskeletal Questionnaire were used. The intensity of pain was assessed on the scale of 1 to 10 by means of the Visual Analogue Scale (VAS). The garment workers (N=48) were investigated separately, using the same questionnaires.

The work was carried out within the framework of the Interreg 4A "Work Ability and Social Inclusion" project headed by Arcada University of Applied Life of Finland. Tallinn University and Riga Stradins University were also involved. Permission for the research was obtained from the Medical Ethics Committee of National Institute for Health Development in 2011. The garment workers' investigation was carried out separately.

The majority of the registered occupational diseases and work-related diseases in Estonia have musculoskeletal diagnoses. Musculoskeletal disorders are expressed in pain in the neck, shoulders, elbows, wrist and back regions. Many investigations show that the number of musculoskeletal pain sites can predict work disability and they are found to be a threat to work ability. Pain at multiple sites occurs quite frequently among employees (H. Miranda et al, 2010, Y. Kamaleri et al, 2009).

MSDs are one of the major reasons for permanent work disability. Several recent studies have shown that single-site pain occurs less frequently than pain in several body sites concurrently. It has been determined that multiple-site pain has a risk of developing into permanent incapacity for work. Many researches have found a connection between widespread pain and everyday functioning and quality of life.

The musculoskeletal system is affected by many factors besides static work posture and monotonous movements. Office workers and even more so industrial workers are under pressure, as increasing amounts of work have to be done within limited time. Stress is not only a sensation. It changes functions in the body: the release of a variety of hormones, increased breathing rate, quickened pulse and the production of more stomach acid. Distress often causes muscle tensions in the neck, shoulder and back regions (Kulin & Reaston, 2011). Symptoms of stress can be physiological (disturbed appetite, sleep disorders, headache, pain in the chest) and psychological (difficulty concentrating, anxiety, irritability, difficulty making decisions, burnout) (Tint et al., 2011). Stressors like time limits, bad relationships between co-workers or with the employer, too high workload are considered to be factors that can cause fatigue (Panari et al., 2011).

The use of electronic equipment in the work environment has increased in the recent decades. The result is that the complaints of unusual fatigue, headaches and eyestrain from individuals working with computers are likely to increase many times (Bako-Biro *et al.*, 2004; Uchino *et al.*, 2008).

Office workers and garment workers are both exposed to sedentary work in a static posture with an overload to neck, shoulder, hands and back. Garment workers work more intensively, using higher amplitudes and more strength.

Working in a static posture presents ergonomic risks due to the need to hold the body for a long time in the same position and using additional repetitive and sometimes forceful hand movements (Brauer *et al.*, 2010; Nag *et al.*, 2009; Šmite and Ancane, 2010; Zakerian and Subramaniam, 2009). The overuse syndrome caused by physical overload includes such common lesions as bursitis, carpal tunnel syndrome, epicondylitis etc. (Orsila *et al.*, 2011).

Material and methods

The number of investigated computer workers and garment workers was 192 and 53 respectively. As the basis for the questionnaire were taken: the Kiva questionnaire (Näsman, 2012; Tuomivaara *et al.*, 2012) and the Work Ability Index questionnaire (Tuomi, 1998).

The Kiva questionnaire characterizes the wellbeing of workers at work. The ratings were given on a scale of 1 to 10 (1- not at all, 10-yes, very much). The Kiva questionnaire has 7 questions concerning the meaningfulness of job, relationships with the employers and fellow workers etc.

The Work Ability Index (WAI) is determined on the basis of the answers to a series of questions, which take into consideration the demands of work, the worker's health status and resources. The worker completes the questionnaire before the interview with an occupational health professional, who rates the responses according to the instructions.

Measurement of the mechanical properties of muscles by the myometric method

Biophysical studies of the sarcomeric third filament system have become more focused on the conceptions of the role of passive tension in the muscle during contraction, relaxation, stretch, and in passive load-bearing properties. The giant titin (or connection) molecule with a molecular mass of approx. 3.5 MDa, the filamentous polypeptide, which forms spans between the Z- and M-lines of the sarcomere, possesses particularly stiffness and elasticity properties and maintains the integrity of the sarcomere has been proposed to have irnportant clinical implications stemming from its biomechanical role (Neagoe et al., 2003; Granzier et al., 2000; Viir et al., 2006). Skeletal muscle tone ensures normal contraction and work ability of muscles.

Clinically, the most common method for the assessment of muscle tone is muscle palpation. This subjective method gives an indication of muscle tone and helps to some extent objectivize muscle complaints. The myotonometric method allows an assessment based on objective measurements. Myotonometric method is a free oscillation technique for muscle stiffness and tone measurement, therefore it has been used in previous studies and has shown good reliability (Viir et al., 2006., Bailey et al., 2013., Pryn et al., 2015). Muscle stiffness (N / m) represents the characteristic of the muscle to resist changing its shape under an impact, characterized by the muscle tone frequency (Hz), and the characteristic logarithmic decay rate decrement expresses the muscular elasticity (Vain et al., 2002). The device allows measurements, which can easily be repeated, and at the same time to process the data and provide statistical estimates in real time.

Results

A summary from the questionnaires

A total of 192 people working with personal computers (PC) answered the questionnaire. The main results are presented in Table 1. For the analysis, 181 correctly filled questionnaires were used. Among the respondents there were 69 men (average age 40.8) and 121 women (average age 45.6 years). The average length of working with PCs for respondents was 9.5 years. The workers were divided into two groups: 125 people working with PCs up to 10 (inclusive) years and 56 people working with computers over 10 years.

TABLE 1. THE MAIN HEALTH COMPLAINTS OF COMPUTER WORKERS' AND GARMENT WORKERS' GROUPS ACCORDING TO THE LENGTH OF SERVICE

Health complaint	Office workers (length of service with PC ≤ 10 years), % of respondents	Office workers (length of service with PC > 10 years), % of respondents	Garment workers (length of service ≤ 10 years), % of respondents	Garment workers (length of service > 10 years), % of respondents
Musculoskeletal disorders	53.6	50.0	42.1	70.0
Cardiovascular disturbances	20.0	45.0	5.3	35.0
Visual disturbances	16.0	23.0	10.5	15.0
The problem of overweight	20.0	25.0	15.7	35.0
Health status: good	55.0	43.0	78.9	60.0

Investigated were 48 employees from the garment workers' group, the length of service of 21 of whom was 10 years or less. All the employees were women. Their average length of service was 13.1 years and their average age was 43.6 years.

In the group of office workers (all workers), musculoskeletal disorders were observed in 95 (52.5%) people, among them, 82 diagnoses of MSDs were given by physicians. Cardiovascular disturbances were observed in 51 (28.2%) people, 23 people of those were diagnosed by physicians; visual disturbances occurred in 33 (18.2 %) people (22 of them physician-diagnosed). The problem of overweight occurred in 36 (21.5%) cases, 36 cases of those were diagnosed by a doctor. The problem of overweight occurred in 36 (21.5%) cases and all of them were diagnosed by a doctor. Diabetes occurred in two cases. In the group of garment workers, 39 filled out the WAI questionnaire correctly. Musculoskeletal disorders were observed in 23 (58.9%) people, to 15 of them, the diagnose of MSD was given by a physician; cardiovascular disorders were observed in 8 (20.5%) people, all of them also diagnosed by a physician; visual disturbances occurred in 5 (12.8%) people, none of those cases were diagnosed by a medical doctor. The number of overweight persons in this group was 10 (25.6%) and none of them had been diagnosed by a medical doctor, either.

Evaluation of the work ability index

In the office workers' group, the average work ability index was estimated to be 40 points; in the garment workers' group, the average work ability index was lower, approximately 37.3, and the result fluctuation was greater, the minimum and maximum work ability indexes were 23.5 and 49 respectively. Correspondingly, the office workers' work ability is higher and can be assessed as good. The garment workers' work ability can be placed on the boundary of being good, since good is assessed between 37 and 43. It also has to be noted that work ability was valued as moderate or bad in 16 workers. This has to be taken into consideration and employees should be given more freedom to change the work environment or be enabled rehabilitation, so that their work ability would not decrease even more. Among the office workers, there were no results that would have indicated low work ability.

Musculoskeletal pain complaints are represented in Table 2.

TABLE 2. PAIN COMPLAINTS BY BODY REGIONS AND SEVERITY OF PAIN IN OFFICE AND GARMENT WORKERS' GROUPS

Pain region	Office workers (N=53)	Severity of pain (0-10)	Garment workers (N=48)	Severity of pain (0-10)
Neck	30 (56%)	3.9	34 (70%)	4.9
Shoulder, right	19 (36%)	3.3	30 (63%)	6.0
Shoulder, left	15 (28%)		23 (48%)	
Elbow, right	4 (8%)	3.8	11 (23%)	5.3
Elbow, left	2 (4%)		14 (29%)	
Wrist, right	10 (19%)	3.9	24 (50%)	5.6
Wrist, left	1 (2%)		23 (48%)	
Back	20 (38%)	4.5	30 (62%)	6.2

In the office workers' group, there were 8 (15%) pain free workers, 10 (18%) workers who had pain in only one region, and 35 (66%) workers who had pain in more than one region. In the garment workers' group, there were 3 (6%) pain free workers, 6 (13%) workers, who had pain in one region and 39 (81%) workers, who had pain in more than one region.

TABLE 3. INVESTIGATED WORKERS' GROUPS

	I group office workers, length of service ≤ 10 years N =33; 18 M; 15 F		II group office workers, length of service >10 years N = 20; 5M; 15F		III group garment workers, length of service ≤ 10 years N=28; 28 F		IV group garment workers, length of service > 10 years N=20; 20 F	
	Mean	SD	Mean	SD	Mean	SD	Mean	SD
Age	33.8	8.3	50.5	8.4	40.6	11.3	46.7	8.1
BMI (kg/m^2)	23	2.2	23.7	2.9	24.7	2.7	24.8	2.8
Length of service (years)	3.5	2.7	18.2	6.7	5.1	3.0	19.3	6.8

Note: M-male persons, F-female persons.

Overview of the results of myotonometric measurements

The myotonometric method is based on creating mechanical impulses in the examined muscle and determining muscle stiffness and flexibility according to the mechanical response of the muscles. The MYOTON-3 device 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. trapezius med,* both sides of the spine) were measured in the sitting position.

Univariate analysis, correlation analysis, parametric and nonparametric tests were applied in SPSS. The Shapiro-Wilk test (more appropriate for small samples) was used as the numerical means of assessing normality. If the p-value in the Shapiro-Wilk test was below 0.05, the data significantly deviated from the normal distribution. For checking the hypothesis, Pearson's Chi-Square test, Likelihood Ratio, Fisher's Exact test, Linear-by-Linear association were used. The p-value <0.05 was taken to be significant.

TABLE 4. DIFFERENCES IN MEASURED FREQUENCIES BETWEEN MUSCLE GROUPS OF OFFICE AND GARMENT WORKERS BASED ON LENGTH OF SERVICE

		I group OW		II group OW			III group GW		IV group GW		
		Freq. (Hz)		Freq. (Hz)		p-value	Freq. (Hz)		Freq. (Hz)		p-value
Muscle site	Side	Mean	SD	Mean	SD		Mean	SD	Mean	SD	
Add poll	left	15.6	2.2	16.2	2.2	0.46	15.7	1.8	16.4	2.5	0.44
	right	16.4	2.7	16.8	2.4	0.34	15.8	2.1	16.3	1.6	0.97
Trapez med.	left	17.5	2.5	17.1	3.0	0.52	16.8	2.8	17.8	3.3	0.28
	right	16.8	2.5	16.7	3.2	0.70	16.9	2.5	16.6	3.1	0.90

TABLE 5. DIFFERENCES IN MEASURED MUSCLE STIFFNESS BETWEEN MUSCLE GROUPS OF OFFICE AND GARMENT WORKERS BASED ON LENGTH OF SERVICE

		I group OW		II group OW			III group GW		IV group GW		
		Stiffness (Nm^{-1})		Stiffness (Nm^{-1})		p-value	Stiffness (Nm^{-1})		Stiffness (Nm^{-1})		p-value
Muscle site	Side	Mean	SD	Mean	SD		Mean	SD	Mean	SD	
Add poll	left	263.2	37.5	265.9	41.6	0.76	289.7	32.2	283.3	31.6	0.47
	right	266	38.6	277.6	47.0	0.22	285.4	34.5	274.8	19.4	0.32
Trapez med.	left	340	43.7	333.3	66.9	0.80	339.3	61.1	344.3	73.9	0.80
	right	324	46.6	319.8	72.5	0.80	305.8	95.5	214.3	73.2	0. 97

TABLE 6. DIFFERENCES IN MEASURED MUSCLE FREQUENCY AND STIFFNESS BETWEEN MUSCLE GROUPS OF OFFICE AND GARMENT WORKERS

		Office workers		Garment workers			Office workers		Garment workers		
		Freq (Hz)		Freq (Hz)		p-value	Stiffness (Nm^{-1})		Stiffness (Nm^{-1})		p-value
Muscle site	Side	Mean	SD	Mean	SD		Mean	SD	Mean	SD	
Add poll	left	15.8	2.1	16.1	2.2	0.507	263	38.7	286.1	31.7	**0.000***
	right	16.5	2.6	15.9	1.8	0.737	266.0	42.8	279.4	27.2	**0.023***
Trapez med.	left	17.4	2.9	17.4	3.1	0.682	337.1	52.7	342.1	67.9	0.960
	right	16.8	2.8	16.4	2.8	0.406	322.4	56.6	310.6	82.8	0.413

Note: *$p < 0.05$ = significant difference.

Study limitations

The myotonometric study field in occupational health needs to evolve. More people should be involved and different professions should be compared, in addition to studying people who already have work-related musculoskeletal pathologies. It is suggested that the standard value of muscles should be included.

Conclusion

The office workers' group valued their work ability higher than did the garment workers. Less neck, shoulder and hand muscle pains occurred in the office workers' group. Multiple-site musculoskeletal pain occurred more often in the garment workers' group, also the pain intensity was higher according to the VAS scale, the tone and stiffness of the trapezius muscles and hand muscles were increased. Connections of muscle stiffness differences with length of service were not found, but differences between office workers' and garment workers' groups were identified.

The muscle load of office workers does not usually exceed the limits of physiological endurance; muscle pains in the neck, shoulder girdle and hands do not usually last long and are self-limiting. The office workers' pain complaints were mostly found to last 1-7 days. The garment workers had declared longer lasting pain periods. In both the studied groups of workers, no length of service-related differences was measured regarding the frequency and stiffness of hand and trapezius muscles. It can be assumed that even long-term work with a computer monitor is not as harmful to the musculoskeletal system as the work of industrial workers.

In the office and garment workers' groups, there was no length of service-related difference in the thumb or shoulder girdle muscle frequency or stiffness. However, when comparing office workers to the group of garment workers, the people working with computer monitors had lower muscle stiffness indices than the people in the comparison group. It can be concluded that garment workers experience a greater overload in the hand region than office workers. Also, the sewing industry employees had more wrist pain complaints.

Therefore, more myotonometric studies in the occupational health field should be conducted in the future. Based on this survey, it can be concluded that myotonometrically measured muscle parameters are persistent and can thus be used to establish muscle overload signs.

For a wider application of myotonometry in occupational health, further studies with larger groups of workers, developing of recommendatory norms and more specific measurement method manuals will be necessary. One may also assume that the average indices of muscle stiffness and frequency are rather stable parameters, while fast and noticeable changes in muscles are caused by very great loads, e.g. in sports. In the ordinary working environment, probably no great or fast changes occur in hand muscle parameters. Noticeable changes in muscle frequency are more likely to occur as a result of workers' long-term disregard of the limits of physiological muscle recovery. The myotonometric method should be investigated more thoroughly and could find more use in the occupational healthcare system.

References

Bako-Biro, Z., Wargocki, P., Weschler, C.J., Fanger, P.O., 2004. Effects of pollution from personal computers on perceived air quality, SBS symptoms and productivity in office. Indoor air, 14, 178-187.

Baley, L., Samuel, D., Warner, M., Stokes, M., 2013. Parameters representing muscle tone, elasticity and stiffness of biceps brachii in healthy older males: symmetry and within-session reliability using the MyotonPro. Journal Neurol Disord. http://dx.doi.org/10.4172/jnd.1000116

Bevan, S. (2015). Economic impact of musculoskeletal disorders (MSDs) on work in Europe. Best Practice & Research Clinical Rheumatology 29 (2015) 356-373.

Brauer, C., Mikkelson, S., 2010. The influence of individual and contextual psychological work factors on the perception of the indoor environment at work: a multilevel analysis. Int Arch Occup Environ Health, 83, 639-651.

Granzier, H., Helmes, M., Cazorla, O., McNabb, M., Labeit, D., Wu, Y., Yamasaki, R., Redkar, A., Kellermayer, M., Labeit, S., Trombitas, K., 2000. Mechanical properties of tintin isoforms. Adv Exp Med Biol, 481:283-300.

Kamaleri, Y., Natvig, B., Ihlebaek, C., Bruusgaard, D., 2009. Does the number of musculoskeletal pain sites predict work ability. European Journal of Pain. 13: 426-430.

Kulin, J., Reaston MR., 2010. Musculoskeletal disorders early diagnosis: A retrospective study in the occupational medicine setting. Journal of Occupational Medicine and Toxicology. DOI: 10.1186/1745-6673-6-1

Miranda, H., Kaila-Kangas L., Heliövaara, M., Leino-Arjas, P., Haukka, E., Liira, J., Viikari-Juntura, 2007. E. Musculoskeletal pain at multiple sites its effects on work ability in general working population. Journal of Occupational and Environment Medicine 67:449-455.

Nag, P.K., Pal, S., Nag, A., Vyas, H., 2009. Influence of arm and wrist support on forearm and back muscle activity in computer keyboard operation. Applied Ergonomics, 40(2), 286-291.

Neagoe, C., Optiz, CA., Makarenko, I., Linke WA., 2003. Gigant variety: expression patterns of tintin isoforms in striated muscles and cosenquences for myofibrillar passive stiffness. Journal Muscle Res Cell Motil; 24(2-3):175-89

Orsila, R., Luukkaala, T., Manka, M.-L., Nygard, C.-H., 2011. A new approach to measuring work-related well-being. International Journal of Occupational Safety and Ergonomics (JOSE), 17(4), 341-359.

Panari, C., Guglielmi, D., Ricci, A., Tabanelli, M.C. Violante, F.C., 2012. Assessing and improving health in the workplace: an integration of subjective and objective measures with the Stress Assessment and Research Toolkit (St.A.R.T) method. Journal of Occupational Medicine and Toxicology, 2012, 7:18. DOI: 10.1186/1745-6673-7-18

Pruyn, C. E., Watsford, L. M., Murphy J. A., 2015. Validity and realibility of three methods of stiffness assessment. Journal of Sport and Health Science. http://dx.doi.org/10.1016/j.jshs.2015.12.001

Šmite, D., Ancane, G., 2010. Psychosomatic aspects of chronic low back pain syndrome. Proc. Latvian Acad. Sci., Section B, 64(5/6), 202-208.

Tanabe, S., Nishihara, N., 2004. Productivity and fatigue. Indoor Air, 14(Suppl 7): 126-133.

Tint, P. Traumann, A., Pille, V., Tuulik-Leisi, V.-R., Tuulik, V., 2011. Computer users' health risks caused by the simultaneous influence of inadequate indoor climate and monotonous work. Agronomy Research, Biosystems Engineering, 10 (1), 261-268.

Tuomi, K., Ilmarinen, J., Jahkola, A., Katajarinne, L., Tulkki, A., 1998. Work Ability Index. Helsinki: Finnish Institute of Occupational Health.

Tuomivaara, S., Ketola, R., Huuhtanen, P., Toivonen, R., 2008. Perceived competence in computer use as a moderator of musculoskeletal strain in VDU work: An ergonomics intervention case. Ergonomics, 51(2), 125-139.

Uchino, M., Schaumberg, D.A., Dorgu, M., Uchino, Y., Fukagawa, K., Shimmura, S., Satoh, T., Takebayashi, T., Tsubota, K., 2008. Prevalence of dry eye disease among Japanese visual display terminal users. Ophthalmology, 115(11), 1982-1988.

Vain, A., Kums, T., 2002. Criteria for preventing overtraining of the musculoskeletal system of gymnasts. Biol. Sport, 19(4), 329-345.

Viir, R., Laiho, K., Karmarenko, J., Mikkelson, M., 2006. Repeatability of trapezius muscle tone assessment bu myometric method. Journal of Mechanics in Medicine and Biology, 6 (2), 215-228.

Zakerian, S.A., Subramaniam, I.D., 2009. The relationship between psychological work factors, work stress and computer-related musculoskeletal discomforts among computer users in Malasia. International Journal of Occupational Safety and Ergonomics (JOSE), 15(4), 425-434.