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Impact of a workplace exercise program on neck and shoulder segments in office workers

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Received: November 30th, 2015. Received in revised form: March 07th, 2016. Accepted: March 11th, 2016.

Abstract
Work-related musculoskeletal disorders are a common problem among office workers. The purpose of this study is to evaluate the impact of a workplace exercise program on neck and shoulder pain and flexibility in office workers. The workstation assessment was performed using Rapid Office Strain Assessment. Workers were assessed for pain pre- and post-implementation of the workplace exercise program using the Nordic Questionnaire for Musculoskeletal Symptoms, and for flexibility. The program lasted 3 months and entailed twice weekly sessions. The sample consisted of an intervention group (n = 30) and a control group (n = 8). The results suggest improvements in pain reduction and increased flexibility. The workers had less musculoskeletal pain at the end of the evaluation. The increase in flexibility between the evaluations was significant in the intervention group, though there were slight improvements there too.

Keywords: work-related musculoskeletal disorders; workplace exercise; shoulder; neck; pain; flexibility.

Impacto de un programa de ejercicio en el trabajo en los segmentos de cuello y hombros en los trabajadores de oficina

Resumen
Trastornos musculoesqueléticos relacionados con el trabajo son un problema común entre los trabajadores de oficina. El propósito de este estudio es evaluar el impacto de un programa de gimnasia laboral en la dolor de cuello y hombro, y la flexibilidad en los trabajadores de oficina. La evaluación del puesto de trabajo se realizó a través de *Rapid Office Strain Assessment*. Los trabajadores fueron evaluados para el dolor pre y post-ejecución del programa de gimnasia utilizando el *Nordic Questionnaire for Musculoskeletal Symptoms*, y por la flexibilidad. El programa tuvo una duración de 3 meses y supuso sesiones dos veces por semana. La muestra está formada por un grupo de intervención (n = 30) y un grupo control (n = 8). Los resultados sugieren mejoras en la reducción del dolor y aumento de la flexibilidad. Los trabajadores tuvieron menos dolor musculoesquelético al final de la evaluación. El aumento de flexibilidad entre dos puntos de tiempo de la evaluación fue significativo en el grupo de intervención, aunque hubo una ligera mejora allí también.

Pal. Clave: trastornos musculoesqueléticos relacionados con el trabajo; programa de gimnasia laboral; hombro; cuello; dolor; flexibilidad

1. Introduction

Work-related musculoskeletal disorders (WRMSD) have increased among office workers in recent years, principally as a result of prolonged computer use [1,2]. Excessive use of computers has also been identified as the main reason for the increase in neck and upper limb problems [3]. About 45.5% to 63% of office workers surveyed have experienced neck pain during the previous 12 months [4,5]. Risk factors associated with computer use include prolonged sitting, fast and repetitive movements, lack of support for the upper limbs, non-neutral body position, inactivity, short or inexistent rest breaks, poor workstation ergonomics, mechanical stress concentrations (direct pressure on hard surfaces or sharp edges on soft tissues), static muscle loading, poor physical and mental condition, and others [6,7].

The relationship between sitting posture and cervical spine and shoulder changes have been extensively studied. Although it seems that there are no studies able to attest a clear relationship between posture, muscle motor activity and

WRMSD [2], some authors have shown that a sustained static posture for long periods of time is related to persistent muscular activity of the spine and shoulder stabilizers [8]. Others report that this muscle activity is higher in symptomatic workers compared to asymptomatic controls [9,10]. The development of upper extremity musculoskeletal disorders is associated with sustained muscle activity even at low loads[11].

Some authors suggest that there is a positive association between maintaining a sitting position for more than 95% of working time and neck pain [12]. Working in this position for long periods means the upper body must be kept in a static posture in which, anatomically, the neck supports the head, which accounts for nearly one-seventh of total body weight. In order to maintain a static posture, the muscles of the neck and shoulder overwork and become injured [13]. This condition produces a continuous static load on the neck and shoulder muscles, causing muscle tension that, in the long term, produces neck and shoulder pain and a restricted range of motion (RoM) [12]. The most frequently reported discomfort and pain among office workers is at the upper trapezius muscle [14], a problem caused by muscle tension; this pain usually radiates to the shoulder and involves muscle stiffness.

The shoulder is a complex joint that allows synchronized movement of the scapula and the humerus [15]. Simple movements such as shoulder flexion associate coordinated actions of many muscles in the neck, shoulder and trunk. Some authors have evaluated shoulder biomechanics in subjects with or without shoulder joint dysfunction [16,17]. These studies have shown that individuals with shoulder dysfunction display less tipping and upward rotation and more anterior tipping and elevation of the scapula during functional arm tasks, as well as greater activity of the upper trapezius muscle, which is associated with shoulder dysfunctions [15,17]. Studies of the interaction between posture and neck-shoulder dysfunctions also suggest that spinal misalignment allows them to occur [9,10]. Other authors have suggested that thoracic posture can affect scapula kinematics [18] because increased thoracic kyphosis, while a forward head posture can induce anterior tilt and protraction of the scapula, restricting the sub acromial space and shoulder RoM. Thus, it has been suggested that changes in shoulder biomechanics may be the cause of pain and of restricted RoM. Abnormal shoulder posture also leads to muscle imbalance and weakness, emphasizing the importance of strategies aimed at providing muscular training [19,20].

WRMSDs are a significant problem for companies in Europe, because they are a primary cause of work-related disability and loss of productivity.

In recent decades, exercise-oriented intervention has been widely used as a prevention strategy to reduce the impact of WRMSDs. Some studies have examined the benefits of exercise on work-related upper extremity disorders, but these have been based on limited evidence [21]. Certain authors have found exercise to have beneficial effects on musculoskeletal pain symptoms in several regions of the upper body, as well decreasing the number of additional pain regions, specifically in the neck. They have also concluded that neck pain is related to pain in other locations [22].

Most studies use strength exercise protocols to prevent WRMSDs [22,23]. These appear to be effective in the management of neck and shoulder pain. However, exercise with heavy loads in the presence of pain and/or of WRMSDs might be contraindicated, because overloading the neck and shoulder structures can lead to a risk of inflammation or increased pain [24].

The aim of this study was to evaluate the impact of a personalized workplace exercise program on neck and shoulder pain and flexibility in office workers.

2. Methods

2.1. Study sample

The study was conducted at the offices of an insurance brokers in Oporto, Portugal, between September and December 2013.

All workers generally perform their functions in a sitting posture and work with a range of office equipment such as computers (monitor, keyboard and mouse), telephones and documents.

The sample was intentionally composed of office workers who did and who did not participate in the workplace exercise (WEG) sessions. Participation was on a voluntary basis. There were 38 workers in the final sample, divided into two groups: the intervention group (IG) of 30, who participated in the WEG sessions, and a control group (CG) of 8 individuals who did not. The CG included workers who had undergone the entire evaluation process but who did not join the WEG sessions. An informed consent form, which briefly explained the study, its goals and the methods to be used, was distributed to all participants.

2.2. Study design

The evaluation of the workstations was carried out using Rapid Office Strain Assessment (ROSA) [25] with the goal of identifying risk factors related to discomfort at office workstations. This method allows the posture of workers and their interactions with their workstations to be examined in order to define the most appropriate exercises to be carried out during the WEG program. The method was designed to provide a rapid quantification of the risks associated with office work and was based on a set of scoring chart diagrams that included the subsections "Chair", "Monitor and Telephone" and "Keyboard and Mouse". The goal was to determine overall ROSA scores and the corresponding action level, in order to make changes to the workstations and to understand the interactions workers had with them. The workstations were not evaluated according to the group (IG or CG) to which each subject belonged, because the objective was simply to evaluate the risk associated with each workplace and not to compare the scores obtained by the two groups.

The evaluation of the workers' musculoskeletal pain symptoms was performed using an adaptation of the Portuguese version of the Nordic Questionnaire [26]. The segments evaluated were the neck and the right and left shoulders over the previous 12 months and within the previous 7 days. Each question was accompanied by a body diagram.

The measuring instrument used to gauge flexibility was the universal goniometer, model MSD EA-8161. All evaluations were carried out by the same evaluator, with the objective of improving the reliability of the measurements by eliminating inter-measurer variability. The tests were performed in a sitting posture, as described by Clarkson [27]. The movements evaluated were lateral flexion of the neck and flexion, abduction and external rotation of the shoulder, all performed for both sides of the body. Workers were asked to bring lightweight clothing to work.

2.3. Intervention

The program lasted for 3 months, with 2 sessions per week with a duration of 15 minutes each. All the WEG sessions took place in the afternoon, with the intention of preventing fatigue, working unsolicited muscles and relaxing muscles that had been solicited for many hours at the computer.

The program was led by a physiotherapist specialized in WEG and took place in an open space near all the workers' workstations to ensure them quick access. The workers could use their normal work clothes during the sessions. The exercises performed were designed to mobilize and stretch several parts of the body, with an emphasis on the vertebral column and upper limbs, though some exercises were included for the legs because of the long hours worked in a sitting position. Sometimes, strength exercises were performed using low weights. Some sessions included playful and recreational activities such as massage, self-massage and games. The sessions were carried out with or without equipment (balloons, balls, sticks, paper) and were performed on an individual basis, as well as in pairs and in groups. All the sessions included background music to encourage wellbeing, joy and motivation. The WEG program was publicized using posters and emails sent by the Human Resources Department and which explained its objectives and raised awareness of the importance of participating.

2.4. Measurement

All participants underwent an evaluation of musculoskeletal pain symptoms and flexibility at the start of the program (M1), in order to establish a baseline, and again at the end, three months later (M2).

2.5. Statistical analysis

Data was analyzed using descriptive statistics (mean, standard deviation –SD- and percentages).

The McNemar test was used to compare differences in musculoskeletal pain symptoms between M1 and M2, while the Wilcoxon test was used to compare flexibility. The significance level was 0.05. The statistical data analysis was carried out using the SPSS program (version 22).

3. Results

3.1. Sample characterization

The study was conducted on 38 participants divided into two groups – the IG and the CG. The IG was 83.3% female and 16.7% male while the CG was 62.5% female and 37.5% male. Table 1 describes the characteristics of the sample at baseline (M1).

Table 1.
Sample characteristics at baseline.

	Intervention group	Control group
Age (years)	39.57 (7.66)	41.50 (7.75)
Weight (kg)	63.77 (10.48)	79.13 (15.29)
Height (m)	1.65 (0.06)	1.69 (0.09)
Body mass index (kg/m^2)	23.46 (3.12)	27.84 (5.23)
Smoking status	30.0%	25.0%
Physical activity status	50.0%	62.5%
Length of service (years)	8.59 (8.51)	10.43 (7.18)
Past history of illness	30.0%	50.0%

Data are expressed as mean (SD) or %
Source: The authors.

Table 2.
Pain perception in the previous 12 months. McNemar test results for difference analysis between evaluation moments.

Body region	Intervention group			Control group		
	M1	M2	*P* value	M1	M2	*P* value
Neck	60.0%	43.3%	0.180 (NS)	25.0%	37.5%	1.000 (NS)
Right shoulder	46.7%	43.3%	1.000 (NS)	12.5%	37.5%	0.500 (NS)
Left shoulder	36.7%	36.7%	1.000 (NS)	25.0%	37.5%	1.000 (NS)

Data are expressed as %. * $P < 0.05$, ** $P < 0.01$ and NS – Not significant.
Source: The authors.

3.2. Workstation evaluation

Most of the workers are seated in an open plan office environment. Their normal tasks are computer work, call answering, document-reading, writing, copy-making, and others. Of these, computer work and call answering occupy most time. The workstations are equipped with a desk, a chair, a computer (monitor, keyboard and mouse) and a telephone.

The mean final ROSA score for the 38 workstations was 3.61 (0.64) while the mean (SD) section scores were 3.45 (0.55), for the Chair, 3.11 (0.61) for the Monitor and Telephone and 2.11 (0.31) for the Mouse and Keyboard.

3.3. Musculoskeletal symptoms analysis

The workers in both groups experienced pain during their working hours. Table 2 shows worker perceptions of neck and shoulder pain, pre- and post the WEG program for the IG and for the CG during the previous 12 months.

As shown in Table 2, members of the IG experienced reduced musculoskeletal pain at M2 compared with M1, except for the left shoulder. For the CG, it was found that musculoskeletal pain increased for all body segments evaluated. However, the values of these differences are not significant.

Table 3 presents data on worker perceptions of neck and shoulder pain, pre- and post the WEG program for the IG and for the CG for the previous 7 days.

Table 3.
Pain perception in the previous 7 days. McNemar test results for difference analysis between evaluation moments.

Body region	Intervention group			Control group		
	M1	M2	*P* value	M1	M2	*P* value
Neck	33.3%	20.0%	0.125 (NS)	0.0%	12.5%	1.000 (NS)
Shoulders	26.7%	26.7%	1.000 (NS)	12.5%	37.5%	0.625 (NS)

Data are expressed as %. * $P < 0.05$, ** $P < 0.01$ and NS – Not significant.
Source: The authors.

During the previous 7 days, members of the IG perceived a reduction in musculoskeletal pain in the neck while there was no change for the shoulders. However, in the CG, pain perception increased in both segments. However, the values of these differences are not significant.

3.4 Analysis of Flexibility Levels

The results for flexibility levels are set out in Table 4. In terms of the movements analyzed, it may be observed that the RoM averages increased for the IG between the two evaluation moments. According to Table 4 these differences are significant.

Table 4.
Flexibility levels by group (in grades) and Wilcoxon test results for difference analysis between evaluation moments.

Joint	Movement	Side	Intervention group			Control group		
			M1	M2	*P* value	M1	M2	P value
Neck	Lateral Flexion	Right	35.50 (7.28)	38.97 (6.34)	<0.001**	37.75 (6.82)	38.50 (6.39)	0.098 (NS)
		Left	33.60 (7.27)	36.50 (7.53)	0.001**	38.63 (5.76)	37.50 (6.57)	0.655 (NS)
Shoulders	Flexion	Right	172.73 (9.22)	175.03 (9.15)	0.002**	177.50 (2.39)	177.88 (2.30)	0.257 (NS)
		Left	170.97 (10.78)	174.2 (9.37)	0.001**	175.75 (2.60)	176.63 (3.02)	0.038*
	Abduction	Right	172.57 (12.86)	175.97 (9.06)	0.003**	171.25 (14.26)	174.00 (8.05)	0.102 (NS)
		Left	170.67 (5.49)	174.63 (10.52)	0.002**	173.63 (8.07)	174.75 (6.45)	0.066 (NS)
	External Rotation	Right	81.30 (11.77)	85.13 (6.26)	0.007**	80.13 (14.36)	80.13 (14.36)	1.000 (NS)
		Left	79.40 (11.42)	85.20 (6.51)	<0.001**	81.63 (10.01)	81.63 (10.01)	1.000 (NS)

Data are expressed as mean (SD). * $P < 0.05$, ** $P < 0.01$ and NS – Not significant
Source: The authors.

The values remained relatively constant for the CG, while there was a slight increase in right lateral flexion of the neck and flexion and abduction of the shoulder on both sides, along with decreased left lateral flexion of the neck. Only left flexion of the shoulder presents a significant difference between the moments of evaluation.

4. Discussion

This study was intended to evaluate the effectiveness of a workplace exercise program in reducing musculoskeletal pain and improving the levels of flexibility in the neck and shoulders.

The workstation evaluation using the ROSA method found that workstations themselves can cause discomfort. Further investigation and modifications might be required here. The sitting posture adopted by workers using computers throughout the working day, as well as interactions with other elements in the workplace, can cause muscle tension in the neck and shoulder segments. Unilateral postures continue to occur too, as when workers hold their phones between the head and shoulder, causing muscle fatigue and decreased flexibility as a result of tension, which stops the muscles working at peak. The workplace exercise program was therefore planned to prioritize exercises designed to relax the musculature of the cervical spine and shoulders and decrease fatigue, reducing pain and increasing flexibility.

The first improvement observed in the IG was related to a reduction in the prevalence of worker perceptions of musculoskeletal pain at 12 months and at 7 days, although the differences between these self-evaluations were not significant. These data may indicate that the WEG program influence this change in symptoms in the neck and right shoulder. However, the fact that there was less effect on the left shoulder may indicate that a longer intervention period would be necessary in order to obtain more significant results. Although the current study took place over a period of more than 10 weeks, other authors found that this period of workplace group gymnastics had no clear effects on pain [28]. A previous study that analyzed pain perception before and after a workplace fitness program obtained different results, finding that pain reduction was not significant for the CG but was for the IG [29]. Other studies that evaluated pain perception found that it is potentially possible to reduce subjective sensations of pain in office workers [23, 30]. On the other hand, another set of studies, in this case analyzing perceptions of musculoskeletal pain in cases where workers undertook an hour of exercise a week for a year, obtained similar results to those obtained here [22]. Waling et al. compared three different protocols, focused on strength, endurance and coordination exercises for a period of ten weeks, each session lasting one hour, and achieving similar results for pain reduction to those of the current study [31]. However, it was difficult to compare the current research with these earlier studies because the duration of the sessions was very different and –furthermore- in Waling et al. the sample was exclusively female. This is an important difference, as it is known that women have a higher risk of WRMSD than males [32], a difference that can be explained by the physical and functional differences between the sexes [33]. Thus, a WEG program could have beneficial effects, decreasing muscle fatigue and, consequently, reduce the perception of pain.

The results were similar for flexibility: neck and shoulder RoM in the movements evaluated improved in the IG following the WEG program. It is known that a lack of exercise influences the levels of flexibility and that sedentary people tend to be less flexible than their active counterparts. Thus, it can be said that exercise improves flexibility [34]. Other studies focused on office workers found similar results, with improvements in the flexibility levels of the shoulder in flexion, abduction and external rotation, though the results were non-significant [35]. On the other hand, a study of metalworkers registered an increase in flexibility levels in shoulder movements [36]. Restricted RoM can also be affected by factors such as postural misalignment and muscle imbalance. The literature suggests that there is some evidence that exercise may improve posture in the upper thoracic area, helping improve mobilization of the shoulder muscles, and consequently leading to an increase in RoM [20]. An appropriate posture at the workstation, either sitting or standing, allowed subjects to reduce muscle stress and tension, as the muscles are able to work in balance and, therefore, more efficiently. The decrease in trapezius muscle tension may have influenced the increased RoM in the assessed tasks (especially in lateral neck flexion) as well as a decrease in fatigue levels in the shoulder muscles, leading, in turn, to increased external rotation RoM of the shoulder [15]. On the other hand, the exercises performed during the program were accompanied by stimuli administered by the physiotherapist with the aim of raising awareness of the importance of maintaining correct posture of the neck and upper limbs, not just during the sessions but at all times. This might be one explanation of the significant improvements in the flexibility levels in this study as compared to others, in which the workers were responsible for their own exercise routines [37].

The improvements observed in the CG may have been the result of recommendations to perform specific exercises designed for specific body parts that were formulated during assessments. These improvements may be associated with the impossibility of evaluating the IG and the CG separately. WEG sessions were held in an open space, in full view of other workers. This may have influenced CG members to engage in some of the proposed exercises.

4.1. Limitations of the study

The first recognized limitation of this study is the reduced sample size, both for the IG and the CG. Increased sample size would have permitted some sample stratification, for instance by gender, allowing analysis and comparison by group. It would also have been beneficial to have been able to exert more control over some variables, such as subject lifestyle routines, clinical history and others, in order to obtain more accurate results.

5. Conclusions

This study was designed to evaluate the effectiveness of a workplace exercise program, with the intention of reducing musculoskeletal pain and improving the levels of flexibility in neck and shoulders. The results obtained show that IG members experienced reduced musculoskeletal pain in the neck and shoulders, although the results were not statistically significant. They also demonstrated improved RoM in lateral flexion of the neck and flexion, abduction and external rotation of the shoulder, for both sides of the body. According to these results, then, the implementation of a WEG program could be beneficial to office workers.

Acknowledgments

This study received financial support from the Portuguese Foundation for Science and Technology, under project ID/CEC/00319/2013.

References

[1] Buckle, P. and Devereux, J., The nature of work-related neck and upper limb musculoskeletal disorders. Applied Ergonomics, 33, pp. 207-217, 2002. DOI: 10.1016/S0003-6870(02)00014-5

[2] Tittiranonda, P., Burastero, S., and Rempel, D., Risk factors for musculoskeletal disorders amog computer users. Occupational Medicine, 14, pp. 17-38, 1999.

[3] Punnett, L. and Wegman, D.H., Work-related musculoskeletal disorders: The epidemiologic evidence and the debate, in: J Electromyogr Kinesiol, University of Massachusetts Lowell, USA. 2004, pp. 13-23. DOI: 10.1016/j.jelekin.2003.09.015

[4] Sillanpää, J., Huikko, S., Nyberg, M., Kivi, P., Laippala, P., and Uitti, J., Effect of work with visual display units on musculo-skeletal disorders in the office environment. Occupational Medicine, 53, pp. 443-451, 2003. DOI: 10.1093/occmed/kqg120

[5] Cagnie, B., Danneels, L., Van Tiggelen, D., De Loose, V., and Cambier, D., Individual and work related risk factors for neck pain among office workers: a cross sectional study. European Spine Journal, 16, pp. 679-686, 2007. DOI: 10.1007/s00586-006-0269-7

[6] Ming, Z., Närhi, M., and Siivola, J., Neck and shoulder pain related to computer use. Pathophysiology : The Official Journal of the International Society for Pathophysiology / ISP, 11, pp. 51-56, 2004.

[7] Punnett, L. and Bergqvist, U., Visual display unit work and upper extremity musculoskeletal disorders. A Review of Epidemiological Findings. National Institute for Working Life, 16, 1997.

[8] Hägg, G.M. and Aström, A., Load pattern and pressure pain threshold in the upper trapezius muscle and psychosocial factors in medical secretaries with and without shoulder/neck disorders. International Archives of Occupational and Environmental Health, 69, pp. 423-32, 1997. DOI: 10.1007/s004200050170

[9] Szeto, G., Straker, L. and O'Sullivan, P., A comparison of symptomatic and asymptomatic office workers performing monotonous keyboard work-2: Neck and shoulder kinematics. Manual Therapy, 10, pp. 281-291, 2005. DOI: 10.1016/j.math.2005.01.004 DOI: 10.1016/j.math.2005.01.005

[10] Szeto, G., Straker, L., and O'Sullivan, P., A comparison of symptomatic and asymptomatic office workers performing monotonous keyboard work-1: Neck and shoulder muscle recruitment patterns. Manual Therapy, 10, pp. 270-280, 2005. DOI: 10.1016/j.math.2005.01.004 DOI: 10.1016/j.math.2005.01.005

[11] Visser, B. and Van Dieën, J.H., Pathophysiology of upper extremity muscle disorders. Journal of Electromyography and Kinesiology, 16, pp. 1-16, 2006. DOI: 10.1016/j.jelekin.2005.06.005

[12] Ariëns, G., Bongers, P., Douwes, M., Miedema, M., Hoogendoorn, W., van der Wal, G., et al., Are neck flexion, neck rotation, and sitting at work risk factors for neck pain? Results of a prospective cohort study. Occupational and Environmental Medicine, 58, pp. 200-207, 2001. DOI: 10.1136/oem.58.3.200

[13] Ming, Z. and Zaproudina, N., Computer use related upper limb musculoskeletal (ComRULM) disorders. Pathophysiology, 9, pp. 155-160, 2003. DOI: 10.1016/S0928-4680(03)00004-X

[14] Jensen, C., Finsen, L., Hansen, K., and Christensen, H., Upper trapezius muscle activity patterns during repetitive manual material

handling and work with a computer mouse. Journal of Electromyography and Kinesiology : Official Journal of the International Society of Electrophysiological Kinesiology, 9, pp. 317-325, 1999. DOI: 10.1016/S1050-6411(99)00007-3
[15] Ebaugh, D.D., McClure, P.W. and Karduna, A.R., Effects of shoulder muscle fatigue caused by repetitive overhead activities on scapulothoracic and glenohumeral kinematics. Journal of Electromyography and Kinesiology: Official Journal of the International Society of Electrophysiological Kinesiology, 16, pp. 224-235, 2006. DOI: 10.1016/j.jelekin.2005.06.015
[16] Klopcar, N. and Lenarcic, J., Bilateral and unilateral shoulder girdle kinematics during humeral elevation. Clinical Biomechanics Bristol, Avon, 21(Suppl 1), pp. S20-S26, 2006. DOI: 10.1016/j.clinbiomech.2005.09.009
[17] Lin, J., Hanten, W.P., Olson, S.L., Roddey, T.S., Soto-quijano, D.A, Lim, H.K., et al., Functional activity characteristics of individuals with shoulder dysfunctions. Journal of Electromyography and Kinesiology, Official Journal of the International Society of Electrophysiological Kinesiology, 15, pp. 576-586, 2005. DOI: 10.1016/j.jelekin.2005.01.006
[18] Finley, M.A. and Lee, R.Y., Effect of sitting posture on 3-dimensional scapular kinematics measured by skin-mounted electromagnetic tracking sensors. Archives of Physical Medicine and Rehabilitation, 84, pp. 563-568, 2003. DOI: 10.1053/apmr.2003.50087
[19] Kebaetse, M., McClure, P., and Pratt, N.A., Thoracic position effect on shoulder range of motion, strength, and three-dimensional scapular kinematics. Archives of Physical Medicine and Rehabilitation, 80, pp. 945-950, 1999. DOI: 10.1016/S0003-9993(99)90088-6
[20] Wang, C., Mcclure, P., Pratt, N.E. and Nobilini, R., Stretching and strengthening exercises: Their effect on three-dimensional scapular kinematics. Arch Phys Med Rehabil, 80, pp. 923-929, 1999. DOI: 10.1016/S0003-9993(99)90084-9
[21] Staal, J.B., de Bie, R.A. and Hendriks, E.J.M., Aetiology and management of work-related upper extremity disorders. Best Practice and Research: Clinical Rheumatology, 21, pp. 123-133, 2007. DOI: 10.1016/j.berh.2006.09.001
[22] Andersen, L.L., Christensen, K.B., Holtermann, A., Poulsen, O.M., Sjøgaard, G., Pedersen, M.T., et al., Effect of physical exercise interventions on musculoskeletal pain in all body regions among office workers: A one-year randomized controlled trial. Manual Therapy, 15, pp. 100-104, 2010. DOI: 10.1016/j.math.2009.08.004
[23] Sjögren, T., Nissinen, K.J., Järvenpää, S.K., Ojanen, M.T., Vanharanta, H. and Mälkiä, E.A., Effects of a workplace physical exercise intervention on the intensity of headache and neck and shoulder symptoms and upper extremity muscular strength of office workers: A cluster randomized controlled cross-over trial. Pain, 116, pp. 119-128, 2005. DOI: 10.1016/j.pain.2005.03.031
[24] Kisner, C. and Colby, L.A., Therapeutic exercise: Foundations and techniques, 5th ed., F.A. Davis Company, Philadelphia, PA, 2007.
[25] Sonne, M., Villalta, D.L. and Andrews, D.M., Development and evaluation of an office ergonomic risk checklist: ROSA-rapid office strain assessment. Appl Ergon, 43, pp. 98-108, 2012. DOI: 10.1016/j.apergo.2011.03.008
[26] Kuorinka, I., Jonsson, B., Kilbom, A., Vinterberg, H., Biering-Sorensen, F., Andersson, G., et al., Standardised Nordic questionnaires for the analysis of musculoskeletal symptoms, in: Appl Erg., Institute of Occupational Health, Department of Physiology, Helsinki, Finland., 1987: pp. 233-237. DOI: 10.1016/0003-6870(87)90010-x
[27] Clarkson, H., Musculoskeletal assessment. Joint motion and muscle testing., 3rd Ed., Lippincott Williams & Wilkins, Philadelphia, PA, 2013.
[28] Takala, E.P., Viikari-Juntura, E. and Tynkkynen, E.-M., Does group gymnastics at the workplace help in neck pain? Scand J Rehab Med, 26, pp. 17-20, 1994.
[29] Macedo, A., Trindade, C., Brito, A. and Socorro-Dantas, M., On the effects of a workplace fitness program upon pain perception: A case study encompassing office workers in a portuguese context. Journal of Occupational Rehabilitation, 21, pp. 228-233, 2011. DOI: 10.1007/s10926-010-9264-2
[30] Garganta, R., Prufer, C., Guerreiro, F., Soares, P. and Pereira, H., Effect of an exercise program in work environment on musculoskeletal disorders. Report of an experience in administrative workers., In: Proc. Int. Symp. Occup. Saf. Hyg. - SHO2012, Portuguese society of occupational safety and hygiene, Guimarães, 2012: pp. 266-267.
[31] Waling, K., Sundelin, G., Ahlgren, C. and Järvholm, B., Perceived pain before and after three exercise programs – A controlled clinical trial of women with work-related trapezius myalgia. Pain, 85, pp. 201-207, 2000. DOI: 10.1016/S0304-3959(99)00265-1
[32] Larsson, B., Søgaard, K. and Rosendal, L., Work related neck-shoulder pain: a review on magnitude, risk factors, biochemical characteristics, clinical picture and preventive interventions. Best Practice & Research. Clinical Rheumatology, 21, pp. 447-463, 2007. DOI: 10.1016/j.berh.2007.02.015
[33] Côté, J.N., A critical review on physical factors and functional characteristics that may explain a sex/gender difference in work-related neck/shoulder disorders. Ergonomics, 55, pp. 173-182, 2012. DOI: 10.1080/00140139.2011.586061
[34] Matos, M. and Arezes, P.M., Impact of an occupational gym program on flexibility in office workers, In: Occup. Saf. Hyg. SHO2015, Portuguese society of occupational safety and hygiene, Guimarães, 2015.
[35] Silveira, M., Effects of the workplace exercises in the morphologic, functional, lifestyle and absenteeism variables in workers of the pharmaceutical industry of Montes Claros - MG. Fitness & Performance Journal, 6, pp. 295-301, 2007. DOI: 10.3900/fpj.6.5.295.e
[36] Rasotto, C., Bergamin, M., Simonetti, A., Maso, S., Bartolucci, G.B., Ermolao, A., et al., Tailored exercise program reduces symptoms of upper limb work-related musculoskeletal disorders in a group of metalworkers: A randomized controlled trial. Manual Therapy, 20, pp. 56-62, 2015. DOI: 10.1016/j.math.2014.06.007
[37] Tsauo, J.-Y., Lee, H.-Y., Hsu, J.-H., Chen, C.-Y. and Chen, C.-J., Physical exercise and health education for neck and shoulder complaints among sedentary workers. Journal of Rehabilitation Medicine, 36, pp. 253-257, 2004. DOI: 10.1080/16501970410029807

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