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Tailored physiotherapeutic intervention for musculoskeletal disorders among video display terminal users: a case-control study

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Abstract

Background: *Musculoskeletal disorders represent one of the most common complains among video display terminal (VDT) users and are responsible for an important burden of disease in white collars.* **Methods**: *From May 2017 to March 2018, 69 VDT users working at Trieste hospitals were recruited for a training session aimed to reduce musculoskeletal disorders in white collars workers. Thirty-three were assigned to the intervention group, whereas 36 were included in the control group. The intervention group received three personalized 1-hour-one-to-one sessions with a physiotherapist and a thorough evaluation of their workstation. Data were collected at baseline (T0), at 2 months (T1) and at 6 months (T2) using a standardized questionnaire and analyzed with the software STATA.* **Results**: *Overall pain significantly decreased in cases at T1 and T2 ($p < 0.05$). Headache significantly decreased in cases at T1 ($p < 0.05$). Body awareness significantly increased in cases both at T1 and T2 ($p < 0.05$). Headache was positively correlated with an increased perception of pain (Coef 6.85, CI95% 3.2-10.5; $p < 0.001$), while the intervention determined a significant reduction of overall pain during the follow up (OR 0.97, IC 0.95-0.99, $p = 0.013$). Cases showed a significant increase of the cranial-vertebral angle at the 6 months follow up ($p < 0.05$).* **Conclusion**: *A tailored physiotherapeutic intervention has showed a statistically significant decrease in osteoarticular pain and an increased body awareness in VDT users undergoing a personalized training session.*

1. Introduction

Musculoskeletal disorders represent one of the most common complains among video display terminal (VDT) users, both in western and in developing countries [1, 2], and are responsible for an important burden of disease in white collars workers. The most commonly involved sites are upper extremities and neck [3- 10], but involvement of the lower back and lower extremities must not be ignored [11-13]. Hence, the potential efficacy of a preventive intervention is currently being evaluated worldwide [14-19].

In accordance with legal provisions in force in Italy [20], all workers, including white collars, must attend regular training sessions focused on the specific occupational risks they are exposed to due to their job. VDT users in Trieste hospitals usually attend the event "Posture and Ergonomics in VDT

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work", a 3-hour educational event divided into a theoretical part (anatomy and physiology of rachis, pelvis, shoulder and hand, risks of VDT work, workstation's adequacy) and a practical part (proprioception, stretching and ocular movement exercises). The aim of the training is to increase knowledge of preventive measures for musculoskeletal disorders. The aim of the study was to verify the effects of a tailored training on VDT users' global health.

2. Methods

2.1 Population studied

From May 2017 to March 2018, 69 VDT users who participated in the aforementioned training program were recruited in our study. Inclusion criteria were defined as follows: 1) Trieste hospitals worker status at the time of the study; 2) VDT minimum worktime of 20 h/week; 3) regular use of a personal workstation. Exclusion criteria were defined as follows: 1) absence of written informed consent; 2) pregnancy; 3) severe musculoskeletal disorders (e.g.: active rheumatoid arthritis, active ankylosing spondylitis, etc.); 4) severe disability.

2.2 Study protocol

The 69 participants were randomly assigned to the control group (36 workers) or the intervention group (33 workers). Both groups received a standardized questionnaire at T0 (baseline), T1 (2 months follow-up) and T2 (6 months follow-up), composed of an anamnestic section, musculoskeletal pain and discomfort (MSPD) section, the Short-Form 12 Standard (SF-12) Questionnaire to evaluate health conditions [21, 22] (data not reported), the Multidimensional Assessment of Interoceptive Awareness (MAIA) Questionnaire [23] and the Migraine Disability Assessment Score (MiDAS) Questionnaire [24] (data not reported). MSPD was measured by asking participants to rate their pain/discomfort severity for 6 different body areas on a scale of 1-10 (ranging from minimal to extreme) over the previous month [25].

Additionally, the intervention group underwent a physiotherapeutic follow-up: 1) an ergonomic and postural evaluation of the personal workstation; 2) a personalized physiotherapeutic examination, with a photographic evaluation of the cranial-vertebral angle of 12 randomly selected individuals [26]; 3) three personalized 1-hour-one-on-one sessions with the physiotherapist.

2.3 Workstation evaluation

The evaluation of the personal workstation in the intervention group was performed by a trained physiotherapist by using the Postural Burden in Sedentary Work scale [PBSW, 27] considering <10 as low risk, 10-24 as medium risk, 25-49 as very high risk, >49 as extremely high risk. The biomechanical and postural load in various districts was evaluated by using the RULA scale [Rapid Upper Limb Assessment scale, 28] considering 1-2 as a negligible risk, 3-4 as low risk, 5-6 as medium risk and >6 as very high risk. The personal workstation was optimized taking into account the PBSW and RULA scales outputs during the intervention. The control group received a class lesson on rules to follow for a more comfortable workstation.

2.4 Physiotherapeutic intervention

The physiotherapeutic intervention consisted of a detailed clinical history and examination, focusing on previous and current pain symptoms reported by the worker, and provided counseling regarding osteoarticular disorders and pain. The worker was instructed to exercise on a daily basis and was assigned a personalized training program; the recommended exercises included e.g. diaphragmatic breathing, stretching, cervical spine extension and retroposition, lumbar spine extension, neurodynamics and muscular activation (multifidus, transversus abdominis, cervical spine deep flexors, rotator cuff, etc.) [29-32]. Follow up sessions were aimed at evaluating workers' compliance and program efficacy (Suppl 1).

2.5 Statistical analysis

Data analyses were performed using the software STATA™ v.9.0 (Stata Corp., LP, College Station, TX, USA). Data were expressed as mean ± SD or as percentage, as needed. Continuous variables were compared using the t-test. Categorical data were compared using the chi-square test or ANOVA test. Differences between T1 and T2 were analyzed with the Mc Nemar test for categorical data and the Wilcoxon signed rank test for continuous data. Factors associated with osteoarticular pain were evaluated with a multivariate regression analysis. The effect of the intervention during the follow up was assessed with the Generalized Estimated Equations. A P-value of 0.05 was established as the limit of statistical significance.

2.6 Ethics

The study was approved by the Local Ethical Committee n. 9624 on 23/03/2018.

3. Results

3.1 Study population

General characteristics of the study population, musculoskeletal conditions and headache prevalence are described in Table 1, comparing cases with controls. All the participants were females. We found no statistically significant difference between the two groups regarding previous diseases, age, BMI, drugs intake and physical activity. Prevalence of disc herniation, disc protrusion, arthrosis, osteoporosis, and scoliosis were similar.

Table 1. General characteristics of the studied population, musculoskeletal diseases and headache prevalence

	Study Subjects	Controls	p. value
n.	33	36	
Previous diseases n. (%)	22 (66.7)	28 (77.8)	0.30
Age (years +/- SD)	50.5 ± 7.1	48 ± 8.5	0.09
BMI (mean ± SD)	25 ± 4.9	23.8 ± 4.4	0.14
Drugs intake (%)	15 (45.5)	15 (41.7)	0.75
Physical Activity (%)	15 (45.5)	19 (52.8)	0.72
Hours/week physical activity (mean ± SD)	2.4 ± 0.8	2.5 ± 0.9	0.56
Musculoskeletal conditions			
Disc herniation n. (%)	6 (18.2)	6 (16.7)	0.90
Disc protrusion n. (%)	4 (12.1)	1 (2.8)	0.30
Arthrosis n. (%)	7 (21.2)	2 (5.6)	0.11
Osteoporosis n. (%)	1 (3.0)	5 (13.9)	0.20
Scoliosis n. (%)	6 (18.2)	7 (19.4)	0.90
Headache n. (%)	27 (81.8)	20 (55.6)	0.028
No pathologies n. (%)	12 (36.4)	12 (33.3)	0.79

3.2 Workstation

Cases' workstations were analyzed to evaluate biomechanical and postural burden, according to the RULA scale and the Postural Burden in Sedentary Work Scale (Table 2). 23 workers (69.7%) had a medium risk of developing a work-related arm and wrist disorder according to the RULA scale, while 3 workers (9.1%) had a very high risk. Only low risk (20 workers, 60.6%) or negligible risk (13 workers, 39.4%) could be found regarding neck, trunk and legs. The final score shows that 19 workers (57.6%) had a low global risk of developing a work-related musculoskeletal disorder, while 14 workers (42.4%) had a medium risk. More than 90% of the workers had a very high or extremely high strain on head, trunk, shoulder, arms, legs and feet, according to the Postural Burden in Sedentary Work Scale. Control group received instructions on how to modify their workstation according to good ergonomic practices.

3.3 Intervention

Table 3 describes the scoring of MSPD in various anatomic districts, overall pain, headache and body

Table 2. Results of workplace risk assessment in study subjects to evaluate the biomechanical and postural load in various anatomic districts according to the Rapid Upper Limb Assessment (RULA) scale and the Postural Burden in Sedentary Work in various anatomic districts (SUVA)

	Risk			
RULA	**Negligible**	**Low**	**Medium**	**Very high**
	Score 1-2	Score 3-4	Score 5-6	Score >6
Arm-Wrist n. (%)	0 (0)	7 (21.2)	23 (69.7)	3 (9.1)
Neck-Trunk-Leg n. (%)	13 (39.4)	20 (60.6)	0 (0)	0 (0)
Final score n. (%)	0 (0)	19 (57.6)	14 (42.4)	0 (0)
	Strain			
SUVA	**Minimal**	**High**	**Very high**	**Extremely high**
Head	0 (0)	0 (0)	31 (94)	2 (6)
Trunk	0 (0)	0 (0)	31 (94)	2 (6)
Shoulder	0 (0)	1 (3)	30 (91)	2 (6)
Arm	0 (0)	2 (6)	30 (91)	1 (3)
Leg	0 (0)	0 (0)	27 (81.8)	6 (18.2)
Foot	0 (0)	1 (3)	32 (97)	0 (0)

awareness in cases and controls at baseline, T1 and T2. No statistically significant difference was found between cases and controls at baseline, except for headache prevalence (81.8% vs 57.1%; p = 0.028). VAS score at the dorsal spine was significantly decreased in cases at T1, but not in controls (1.9 ± 2.9 vs 3.2 ± 3; p < 0.05). There was no statistically significant difference between cases and controls at T2. VAS score at the lumbar spine was significantly decreased at T1 in cases (2.9 ± 2.9 vs 4.9 ± 3.2; p < 0.05), but not in controls; we found a statistically significant difference in VAS score at T2 between cases and controls (2.5 ± 2.9 vs 4.3 ± 2.7; p < 0.05). Overall pain was significantly decreased at T1 in cases (12.9 ± 11 vs 19.5 ± 11.2; p < 0.05), but not in controls. Overall pain in cases at T2 remained lower than baseline level (13.4 ± 11.5 vs 19.5 ± 11.2; p < 0.05). Headache prevalence was significantly reduced in cases at T1 (58.3% vs 81.8%, p < 0.05), but not in controls. Body awareness was significantly increased in cases at both T1 and T2 (p < 0.05).

Factors involved in overall pain were assessed by multivariate regression analysis (Table 4). The physiotherapeutic intervention was inversely correlated with overall pain (Coef. -6.3, CI95% -9.7; -2.8; p < 0.001), while BMI and headache were correlated with an increased perception of pain (Coef. 0.6, CI95% 0.23;1.01, p < 0.002 and Coef. 6.85, CI95% 3.2-10.5; p < 0.001). The effect of the intervention

Table 3. Scoring of symptoms (1-10) in various anatomic districts, headache and body awareness in cases and controls. Data expressed as mean ± SD

	Baseline (T0)		Two months follow-up (T1)		Six months follow-up (T2)	
(n.)	**Study subjects (33)**	**Control group (36)**	**Study subjects (33)**	**Control group (36)**	**Study subjects (19)**	**Control group (18)**
Cervical spine	3.5±2.8	4.3±3.1	2.4±2.4	3.5±2.7	2.8±2.1	3.8±2.9
Shoulders	3.5±2.6	4.3±3.1	2.6±2.6	3.5±2.9	2.7±2.2	3.6±2.9
Upper limbs	2.1±2.7	2.3±3.1	1.1±2.3	1.8±2.5	1.5±2.2	2.7±3.3
Dorsal spine	3.2±3	3.6±3.1	1.9±2.9*	3.1±2.9**	2.2±2.4	2.7±2.8
Lumbar spine	4.9±3.2	4.8±3.2	2.9±2.9*	3.7±3.1	2.5±2.9	4.3±2.7***
Lower limbs	2.5±3.4	3.1±3.3	2±3.1	2.1±3.1	1.8±3	2.4±3.4
Overall pain	19.5±11.2	22.6±13.3	12.9±11*	17.7±11.6**	13.4±11.5^	19.4±11.8
Headache (%)	27(81.8%)	20(57.1%)	21(58.3%) *	17(54.8%)	13(72.2%)	14(73.8%)
Body awareness	6.6±2	6±2.3	7.5±1.6*	6.4±2.2	7.6±1.2^	6.7±1.9

** p<0.05 between T0 and T1 in cases; ** p<0.05 between case and controls at T1; *** p<0.05 between cases at T2 and controls at T2; ^p<0.05 between cases T0 and T2*

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Table 4. Factors involved in overall pain assessed by multivariate regression analysis

	β	CI 95%	P
Intervention	-6.3	-9.7-2.8	<0.001
Age	0.2	-0.01-0.45	0.057
BMI	0.6	0.23-1.01	0.002
Headache	6.85	3.2-10.5	<0.001

on osteoarticular pain was assessed during the follow-up by Generalized Estimating Equations, as shown in Table 5. The intervention determined a significant decrease of overall pain (OR 0.97, IC 95% 0.95-0.99, p = 0.013), while we ascertained no effect for BMI and age. Data obtained from SF-12, and Migraine Questionnaires showed no statistically significant difference between cases and controls at baseline, T1 and T2. A statistically significant increase of the cranial-vertebral angle was found in cases after the intervention (p = 0.013) (Table 6).

4. Discussion

Our study evaluated the effect of a physiotherapeutic intervention on the global health of a sample of middle-aged female VDT users. Our population differs from most studies found in literature [1, 14, 33), because it only consists of females. The intervention group and the control group were similar in almost all general variables considered (previous diseases, age, BMI, drugs intake, physical activity, musculoskeletal conditions), except for headache. Almost two thirds of our sample complained of at least one musculoskeletal disorder. This result is considerably higher than what was reported by Gerassis and colleagues in a recent comparative analysis on health surveillance strategies on 2453 medical examinations on VDT users [34] but is comparable with other results found in literature [1- 3, 11]. This may be explained by the higher mean age of our sample population and the fact that it comprised only females. In fact, females tend to develop more musculoskeletal symptoms than males, both in the upper limbs and neck and in the lower limbs [1 3, 12]). The majority of our sample population was overweight or at the upper limit of normal weight, with a mean BMI of 25 ± 4.9 in cases and 23.8 ± 4.4 in controls. This result is comparable with what described by Garzaro and colleagues in a recent cross-sectional study on Work Ability among VDT operators in Italy [35].

Table 5. Effect of the intervention on osteoarticular pain assessed during the follow-up by Generalized Estimating Equations

Intervention	OR	CI 95%	P
BMI	1.05	0.96-1.13	0.19
Age	1.03	0.99-1.08	0.13
Overall pain	0.97	0.95-0.99	0.013

Table 6. Values of the cranio-vertebral angle in cases, before and after treatment

	Pre-treatment (°)	Post-treatment (°)	Difference (°)	P. value
n.	Mean±SD	Mean±SD		
1	43.2±0	52.1±0.8	9	
2	49.3±1.8	50.8±0.5	1.4	
3	49.7±0.9	51.6±1.1	2.6	
4	41.9±0.9	48±0.9	6.3	
5	50.1±0	5.8±2.8	4.7	
6	50.3±0.5	52.7±0.3	2.4	
7	52.7±0.5	61.7±0.6	9.1	
8	39.2±0.6	49.3±0.4	10.1	
9	48.9±1.5	46.9±1.6	-2.1	
10	59.1±0.5	60.9±1.5	1.8	
11	40.4±0.8	46.6±0.7	6.2	
12	29.2±1	32.7±2.2	3.5	
TOT	46.1±0.7	50.7±1.1	4.6	0.013*

The personalized workstation evaluation showed a significant risk of developing work-related musculoskeletal disorders among the vast majority our study population: 26 workers (78.8%) had a medium-high risk of developing a work-related arm and wrist disorder according to the RULA scale, while more than 90% of the workers had a very high-extremely high strain on head, trunk, shoulder, arms, legs and feet, according to the Postural Burden in Sedentary Work Scale. 14 workers (42.4%) had a global medium risk of developing a work-related musculoskeletal disorder (RULA action level 3), while 19 workers (57.6%) were at low risk (RULA action level 2). This pre-interventional result is significantly better than what described by Rasoulzadeh and colleagues in a cross-sectional interventional study on 84 VDT workers in Iran [36], with 18.8 % of VDT users at action level 2, 63.5% at action level 3 and 17.6% at action level 4 before any intervention.

We ascertained a statistically significant reduction of dorsal pain, lumbar pain, overall pain and headache prevalence and a statistically significant increase in body awareness in cases at T1. The effect on dorsal pain and headache prevalence reduced over time and no statistically significant difference could be found at T2, probably because the adherence to prescribed exercises reduced during the follow-up.

On the contrary, the effect on overall pain and body awareness in cases at T2 remained constant. This result suggests a medium-term persistent effect of the intervention on overall pain and body awareness and it is confirmed by the multivariate regression analysis and the Generalized Estimating Equations.

Our results are consistent with a one-year follow-up survey on 626 VDT users in South Korea, which demonstrated a significant reduction in work-related musculoskeletal pain after a tailored rehabilitation education, especially in the shoulder, wrist, and low back [14]. The same results were obtained by Rasotto et al. in 2015 in a study on a population of health care workers, which indicated a positive effect of a tailored workplace exercise protocol in female workers exposed to moderate risk for work-related musculoskeletal disorders, showing clinically meaningful reductions of pain symptoms and disability of the upper limb and neck regions [37]. BMI and headache were positively correlated with an increased perception of pain, as already suggested by previous literature [3]. We observed a statistically significant increase of the cranial vertebral angle in 12 randomly selected cases; an increase of the cranial-vertebral angle has been previously associated with a reduction of upper limbs, neck and shoulder pain [38].

However, since this optimization of the workstation was not done for the control group, it is not possible to establish which of the two actions, namely the optimization of the workstation and / or the personalized training program, resulted in the improvements recorded at 2 and 6 months. Probably both actions are needed for the improvement while the persistence of the effect is mainly due to adherence to prescribed exercise upon time.

Our study has several limitations. First, our study lacks a control group without both the training event and the personalized intervention. Although we acknowledge that this limitation seriously hinders the validity and the potency of our study, we remind the reader of the legislative reasons that prevented us from creating a true control group, since an adequate information and formation of the worker is required by law [20]. Our study showed a statistically significant difference between the intervention group and the group that underwent a 3-hour lecture on occupational risks. Thus, it is reasonable to assume that a statistically significant difference, of a similar or greater magnitude, could be found by comparing our intervention group with a true control group. A second important limitation of our study is the limited time frame of the follow-up. The decision to follow the two groups for a 6-month period was mainly made for organizational reasons and to reduce drop-out. Nonetheless, a long-term follow up would be helpful in assessing any permanent effects of the physiotherapeutic intervention on VDT users' global health. A third limitation is the elevated number of subjects lost to follow-up (19 subjects out of 33, 58%, for the group subject to the intervention; 18 subjects out of 36, 50%, for the control group. This is an important limitation of our study, however, we can hypothesize that subjects with less symptoms did not participate to the follow-up.

A fourth limitation lies in the absence of a control group regarding the cranial-vertebral angle assessment. We found a statistically significant increase of the cranial-vertebral angle in cases after the intervention, but this result can be only considered explorative and demands further research.

Despite its limitations, this study provides evidence that a proper "intervention", i.e. training in preventive measures for musculoskeletal disorders, may have beneficial health effects among female VDT users, simply introducing postural changes. It also fulfills the objective of promoting the evidence-based approach in Occupational Health [38].

5. Conclusion

Our study evaluated the short- and medium-term effect of a personalized physiotherapeutic intervention on musculoskeletal disorders in white collars, compared with a one-time lecture. Our cases reported a significant decrease in lumbar pain and an increased body awareness, and these results remained prominent at the six months follow up. Therefore, our data suggests that workplace evaluation and improvement combined with physiotherapy may have a possible role in the prevention and control of work-related disorders in VDT users. Further research is needed to ascertain the long-term effect of a preventive approach.

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Institutional Review Board Statement: The study was approved by the Local Ethical Committee (CEUR) n . 9624 on 23/03/2018.

Informed Consent Statement: Informed consent was obtained from all subjects involved in the study.

Conflicts of Interest: The authors declare no conflict of interest.

References

1. Wu S, He L, Li J, Wang J, Wang S. Visual display terminal use increases the prevalence and risk of work-related musculoskeletal disorders among Chinese office workers: a cross-sectional study. *J Occup Health*. 2012;54(1):34–43.
2. Ranasinghe P, Perera YS, Lamabadusuriya DA, et al. Work-related complaints of neck, shoulder and arm among computer office workers: a cross-sectional evaluation of prevalence and risk factors in a developing country. *Environ Health*. 2011; 10:70.
3. Klussmann A, Gebhardt H, Liebers F, Rieger MA. Musculoskeletal symptoms of the upper extremities and the neck: a cross-sectional study on prevalence and symptom-predicting factors at visual display terminal (VDT) workstations. *BMC Musculoskelet Disord.* 2008; 9:96.
4. Korhonen T., Ketola R, Toivonen R, et al. Work related and individual predictors for incident neck pain among office employees working with video display units. *Occup Environ Med.* 2003; 60(7): 475-482.
5. Bergqvist U, Wolgast E, Nilsson B, Voss M. Musculoskeletal disorders among visual display terminal workers: individual, ergonomic, and work organizational factors. *Ergonomics*.1995; 38(4): 763-776.
6. Bernard B, Sauter S, Fine L, et al., Job task and psychosocial risk factors for work-related musculoskeletal disorders among newspaper employees. *Scand J Work Environ Health*. 1994; 20(6): 417-426.
7. Laursen B, Jensen BR, Garde AH, Jørgensen AH. Effect of mental and physical demands on muscular activity during the use of a computer mouse and a keyboard. *Scand J Work Environ Health*. 2002; 28(4): 215-21.
8. Karlqvist LK, Hagberg M, Köster M, et al. Musculoskeletal Symptoms among Computer-assisted Design (CAD) Operators and Evaluation of a Self-assessment Questionnaire. *Int J Occup Environ Health*. 1996; 2(3): 185-194
9. Eltayeb S, Staal JB, Kennes J, et al. Prevalence of complaints of arm, neck and shoulder among computer office workers and psychometric evaluation of a risk factor questionnaire. *BMC Musculoskelet Disord.* 2007; 8: 68.
10. Shin S-J, Yoo W-G. Changes in cervical range of motion, flexion-relaxation ratio and pain with visual display terminal work. *Work*. 2014;47(2):261–265.
11. Abaraogu UO, Okorie PN, Duru DO, Ezenwankwo EF. Individual and work-related risk factors for musculoskeletal pain among computer workers in Nigeria. *Arch Environ Occup Health*. 2018;73(3):162–168.
12. Choi S, Jang SH, Lee KH, et al. Risk Factor, Job Stress and Quality of Life in Workers with Lower Extremity Pain Who Use Video Display Terminals. *Ann Rehabil Med*. 2018;42(1):101–112.
13. Janwantanakul P, Sitthipornvorakul E, Paksaichol A. Risk factors for the onset of nonspecific low back pain in office workers: a systematic review of prospective cohort studies. *J Manipulative Physiol Ther*. 2012; 35(7): 568-577.
14. Lee DH, Kang B, Choi S, et al. Change in Musculoskeletal Pain in Patients with Work-Related Musculoskeletal Disorder After Tailored Rehabilitation Education: A One-Year Follow-Up Survey. *Ann Rehabil Med*. 2015;39(5):726–734.
15. Yoo W-G, Kim M-H. Effect of different seat support characteristics on the neck and trunk muscles and forward head posture of visual display terminal workers. *Work*. 2010;36(1):3–8.
16. Swinton PA, Cooper K, Hancock E. Workplace interventions to improve sitting posture: A systematic review. *Prev Med*. 2017; 101:204–212.
17. Pillastrini P, Mugnai R, Farneti C, et al. Evaluation of two preventive interventions for reducing musculoskeletal complaints in operators of video display terminals. *Phys Ther*. 2007;87(5):536-44. doi: 10.2522/ptj.20060092

18. Gerr F, Marcus M, Monteilh C, et al. A randomised controlled trial of postural interventions for prevention of musculoskeletal symptoms among computer users. *Occup Environ Med.* 2005; 62(7):478-487. doi: 10.1136/oem.2004.015792.
19. Andersen LL, Christensen KB, Holtermann A, et al. Effect of physical exercise interventions on musculoskeletal pain in all body regions among office workers: a one-year randomized controlled trial. *Man Ther.* 2010;15(1):100-104. doi: 10.1016/j.math.2009.08.004.
20. "D.lgs. 9 aprile 2008, n. 81 Testo coordinato con il D. Lgs. 3 agosto 2009, n. 106", Jan 2020 Update, found on: https://www.ispettorato.gov.it/it-it/strumenti-e-servizi/Pagine/Testo-unico-salute-e-sicurezza.aspx; last accessed on 19 Mar, 2020
21. Ware J Jr, Kosinski M, Keller SD. A 12-Item Short-Form Health Survey: construction of scales and preliminary tests of reliability and validity. *Med Care.* 1996; 34(3): 220-233.
22. Gandek B, Ware JE, Aaronson NK, et al. Cross-validation of item selection and scoring for the SF-12 Health Survey in nine countries: results from the IQOLA Project. International Quality of Life Assessment. *J Clin Epidemiol.* 1998; 51(11): 1171-1178.
23. Mehling WE, Price C, Daubenmier JJ, et al. The Multidimensional Assessment of Interoceptive Awareness (MAIA). *PLoS One*. 2012; 7(11): e48230.
24. Lipton RB, Stewart WF, Sawyer J, Edmeads JG. Clinical utility of an instrument assessing migraine disability: The Migraine Disability Assessment (MIDAS) questionnaire. *Headache*. 2001; 41(9): 854-861.
25. Stewart SK, Rothmore PR, Doda DV, et al. Musculoskeletal pain and discomfort and associated worker and organization factors: a cross sectional study. *Work*. 2014; 42, 261-271.
26. Singla D, Veqar Z, Hussain ME. Photogrammetric Assessment of Upper Body Posture Using Postural Angles: A Literature Review. *J Chiropr Med.* 2017; 16(2): 131-138.
27. Schmitter D. Test di ergonomia. Valutazione del carico posturale nel lavoro sedentario, 1st edition, Suva code 88212.i, found on: https://docplayer.it/402977-Test-di-ergonomia-valutazione-del-carico-posturale-nel-lavoro-sedentario.html; last accessed on 8 July 2021
28. McAtamney L, Corlett N. RULA: a survey method for the investigation of work-related upper limb disorders. *Appl Ergon*. 1993; 24(2), 91–99.
29. Bonetti F, Curti S, Mattioli S, et al. Effectiveness of a 'Global Postural Reeducation' program for persistent low back pain: a non-randomized controlled trial. *BMC Musculoskelet Disord*. 2010;11:285. doi: 10.1186/1471-2474-11-285. PMID: 21162726.
30. Vanti C, Conti C, Faresin F, et al. The Relationship Between Clinical Instability and Endurance Tests, Pain, and Disability in Nonspecific Low Back Pain. *J Manipulative Physiol Ther.* 2016;39(5):359-368. doi: 10.1016/j.jmpt.2016.04.003. Epub 2016 May 7. PMID: 27167368
31. Pillastrini P, de Lima E, Sá Resende F, et al. Effectiveness of Global Postural Re-education in Patients With Chronic Nonspecific Neck Pain: Randomized Controlled Trial. *Phys Ther*. 2016;96(9):1408-16. doi: 10.2522/ptj.20150501. Epub 2016 Mar 24. PMID: 27013576 Clinical Trial.
32. Heebner ML, Roddey TS. The effects of neural mobilization in addition to standard care in persons with carpal tunnel syndrome from a community hospital. *J Hand Ther*. 2008;21(3):229-240; quiz 241. doi: 10.1197/j.jht.2007.12.001. PMID: 18652967
33. Cheng X, Song M, Kong J, et al. Influence of Prolonged Visual Display Terminal Use and Exercise on Physical and Mental Conditions of Internet Staff in Hangzhou, China. *Int J Environ Res Public Health*. 2019; 23;16(10).
34. 34) Gerassis S, Abad A, Taboada J, et al. A comparative analysis of health surveillance strategies for administrative video display terminal employees. *Biomed Eng Online*. 2019;18(1):118.
35. Garzaro G, Sottimano I, Di Maso M, et al. Work Ability among Italian Bank Video Display Terminal Operators: Socio-Demographic, Lifestyle, and Occupational Correlates. *Int J Environ Res Public Health.* 2019 12;16(9).
36. Rasoulzadeh Y, Gholamnia R. Effectiveness of an Ergonomics Training Program on Decreasing Work-Related Musculoskeletal Disorders Risk among Video Display Terminals Users. *Health Promot Perspect.* 2012; 2(1): 89–95.
37. Rasotto C, Bergamin M, Sieverdes JC, et al. A tailored workplace exercise program for women at risk for neck and upper limb musculoskeletal disorders: a randomized controlled trial. *J Occup Environ Med.* 2015;57(2):178-183.
38. Nejati P, Lotfian SS, Moezy AA, Nejati M. The study of correlation between forward head posture and neck pain in Iranian office workers. *Int J Occup Med Environ Health*. 2015. 28(2):295-303.

SUPPLEMENTARY TABLE 1

1. **Ergonomic and postural intervention on workstation**

BEFORE	AFTER
1. Too much light from the windows 2. Chair height 3. Back rest too much inclined 4. Video display too high 5. Elbows suspended	1. Tent to avoid reflexes on the screen 2. Chair height fixed to permit 90° angles between legs and body 3. Back rest fixed to avoid a lower discal pressures (Andersson GB, 1979); 4. Video display set to maintain the physiological cervical lordosis 5. Elbows must be supported by the table to maintain shoulders relaxed

2. **Workers' evaluation**

	First examination	2nd examination	3rd examination
Personal history	Evaluation of acute or chronic osteoarticular symptoms, surgeries, and diagnostic exams performed traumas, physical training and physical activity outside work.	-	-
Subjective exam	Pain map (where, intensity, time, increasing factors, impact on quality of life, coping strategies)	Pain map evolution	Pain map evolution
Physical examination	Subject in erect position, sitting-down and walking. Spine active movements in all directions with recording of pain. Cervical spine observed also in sitting position Evaluation of sensitivity, strength, reflexes and Lasegue, Slump, Spurling, Upper Limp Tension and repeated movements tests. Multifidous and Transverse muscular test, activational test for deep cervical spine, stabilizers test. Evaluation of other districts, if symptomatic, or as differential evaluation (shoulder tendinous test, pyriform evaluation, sacrum-iliac test).	- Re-evaluation and progression of the exercises.	Re-evaluation of the cranium-vertebral angle (Forward Head Posture). Changes in comparison to the first session.

	Photographic exam of the cranium-vertebral angle (Forward Head Posture).		
Principal aspects emerged from the evaluation	Head anteposition attitude Rectification of rachis curvatures Difficult activation of lumbar rachis stabilizers muscles Difficult diaphragmatic respiration Neck, shoulders and periscapular muscles tension Pain reported at neck, shoulders and lumbar rachis Frequent tension or cervicogenic headaches Scarce corporeal awareness Scarce physical activity level	-	Video display terminal posture feedback and possible questions. Changes in comparison to the first section.
Proposed exercises and self-treatment based on the personal needs	-	Exercise setting Diaphragmatic respiration exercises, stretching and various districts involved mobility exercises (lumbar rachis extension, cervical rachis extension and retroposition, neurodynamic exercises), muscular activation exercises (multifidous, transversus abdominis, cervical rachis deep flexors, rotator cuff).	Correct exercises execution check and possible progression, aimed at increasing articular range, muscular activation or the complexity of proposed exercises.
Education	Postural variability during working hours, by vertebral column active movements, rising up from the work station at least once an hour. Information about physical activity benefits in cardiovascular, metabolic, tumoral, musculoskeletal pathologies prevention and in pain modulation.	-	Questions, doubts regarding the education received and final feedback.