Online Supervised Versus Workplace Corrective Exercises for Upper Crossed Syndrome: A Protocol for a Randomized Controlled Trial

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Abstract

Background and Objective

Musculoskeletal disorders (MSDs) including upper crossed syndrome (UCS) are considered as the leading cause of work-related issues worldwide among office workers. Therefore, the present study aims to evaluate the effect of workplace-based versus online-supervised home-based corrective exercises among office workers with UCS.

Methods and Design

To this end, 45 subjects within the age range of 30-45 years are randomly assigned to three groups in the present parallel-group, randomized control trial using a pretest-posttest design. These groups include the subjects who receive online-supervised exercise and work-place supervised exercise containing three sessions of intervention for eight weeks and the control group receives no intervention while performing routine activities. The primary outcome variables are neck-shoulder pain and sick-leave due to pain, followed by alignment, workability, and the surface electromyography of upper, middle, and lower trapezius (UT, MT, and LT), sternocleidomastoid (SCM), and serratus anterior (SA) as the secondary variables.

Discussion

The present study seeks to assess the effect of work-place versus online-supervised corrective exercise interventions among 45 office workers suffering from UCS. It is expected to improve and reduce the related symptoms including postural malalignment and imbalance muscles after eight weeks of corrective exercises. If effective, the findings may lead to adherence and work performance among the office workers, and individuals subjected to UCS can use the benefits of an online-supervised intervention. In addition, the findings may be useful in different work-places as the evidence for employers to benefit from the reduction in the related costs and side effects of work-related neck-shoulder disorders including work disability, productivity loss, time expense, social insurance, work absenteeism, and treatment costs. Finally, clinicians and corrective exercise therapists can consider it as a clinical based-evidence intervention for their further actions.

Trial registration

IRCT No. IRCT20200729048249N1 dated 2020.10.05 approved by the Iranian Registry of Clinical Trials ([https://en.irct.ir/user/trial/49992/view](https://en.irct.ir/user/trial/49992/view)).

Background

Nowadays, sedentary work is considered predominant in various parts of the world due to the rapid development of technology and the new nature of work. The workers are exposed to prolonged static posture and repetitive upper limb movements (1, 2) and spend long periods in front of a computer or at a
desk in a dorsiflexed position with rounded shoulders (3). According to (4, 5), these prolonged postures may under-activate some muscles while over-activating other muscles leading to joint dysfunction known as ‘upper crossed syndrome’ (UCS). In addition, specific postural changes due to the UCS may decrease glenohumeral stability causing elevated shoulders and scapulae winging. Accordingly, the levator scapula and upper trapezius require increasing activation in order to maintain glenohumeral centration to compensate for the loss of this stability (6-9). All these alterations may be associated with work-related neck-shoulder disorders (WNSDs) although the casualty of the association between computer use and pain is unknown (10).

As one of the main concerns of public health, WNSDs may be related to pain and impaired physical functions causing musculoskeletal complaints and affecting work performance among the office workers (11). Further, WNSDs with annual prevalence rates of 27-48% influence the musculoskeletal system leading to numerous work-related disorders (12, 13). Regardless of the actual cause of pain, musculoskeletal pain in the neck and shoulders increase the risk of long-term sickness absence in white-collar workers (14). The prevalence of this type of pain was reported relatively high in the neck and shoulders (45.8 and 40.1%, respectively) in Iran (15). Thus, different employees are at the increased risk of sickness absence. Regarding the major role of WNSDs in both employees and employers, as the most common reasons for work disability, sick leaves, and early retirement, it is considered as one of the most significant current discussions due to the cost accompanying treatment, production loss, and work absenteeism (16-18). Thus, it has become one of the most serious challenges in occupational health for reducing the financial impacts of health-related productivity and labour costs among office workers as a worthwhile business consideration (19).

Neck or shoulder pain symptoms appear to intensify since office workers with UCS generally sit with curved postures, take prolonged constant muscle activity, and perform repetitive job tasks (4, 20). Pain is considered as the strongest stimulus to central motor programming, which can alter electromyography (EMG) patterns in functional tasks since it has an inhibitory effect on muscle activation (21). Some clinical studies confirmed that the tenderness of muscles is considered as the most common type of neck or shoulder pain in office workers (20, 22, 23). Furthermore, individuals with insidious-onset cervical pain demonstrate poor postural stability more and significantly increased EMG levels in the SCM activity, respectively (24, 25). Therefore, knowledge is highly required regarding effective interventions for relieving WMSD symptoms and preventing the related consequences such as pain, work disability, and sickness absence (26). In this regard, some studies reported statistically significant positive effects for improving office workers’ workability by increasing physical activities (27). Additionally, the results of some studies demonstrated that exercise has positive effects on health-related productivity loss and sickness absenteeism among office workers with neck pain in the longer term (28). In addition, Seeberg et al. found a relationship between forward head posture (FHP) improvement and musculoskeletal pain after therapeutic exercises (26). Further, the results of some studies indicated that exercises specific to the involved muscles restored malalignment and increased the ability to keep an upright cervical posture during work, as well as improved pain, disability, and the quality of life among office workers (29, 30). On the other hand, considering that different mechanisms may contribute to abnormal scapular movements,
causing pain, abnormal thoracic posture, and imbalance in muscle strength or activation (31), an exercise program can improve neck pain displaying positive and significant alterations in the forward head and protracted shoulder posture, disability, and the timing of superficial neck muscle activation (32, 33). Finally, some positive effects of exercise interventions are presented for improving postural malalignments based on the majority of studies. However, both the neural and muscular components should be considered to accomplish the best performance (34-37).

Although previous studies have revealed the hopeful results of exercise interventions among different occupational groups, the question remains is whether such interventions should be implemented under supervision or the workplace (26, 38). The performance of worksite exercises in a group may be more motivating for some employees regarding increasing adherence although various barriers exist in this respect during working hours, which may be costly for employers regarding spending time and facilities (38). Furthermore, although previous literature has demonstrated the positive efficacy of both supervised and unsupervised exercise programs, contradictory results are present about whether supervised or unsupervised exercise is more effective (39-41). Several studies have simultaneously addressed all the involving factors related to UCS by applying exercise therapy. However, scarce research has focused on some separate areas of the upper body including the neck or shoulder among office workers (20, 32, 35, 42-45). According to (46), the world is currently experiencing an extraordinary, life-altering challenge due to social-distancing and home quarantine recommended by the World Health Organization in order to minimize the speed of the coronavirus disease (COVID-19). Outdoor physical activities have been postponed in different cases (47, 48) since it is difficult to precisely predict when the COVID-19 pandemic diminishes and communities can return to normal function (49). Accordingly, online-guided physical activities at home may be a way forward. Thus, studying the effect of work-place versus online-supervised exercises among office workers suffering from WMSDs including UCS is relevant.

Objectives

Given the above-mentioned explanations, the present study seeks to evaluate the effect of workplace-based versus online-supervised home-based corrective exercises on pain, workability, sick-leave, alignment (i.e., head, shoulder, and thoracic spine angles), and the surface EMG of designated muscles including upper, middle, and lower trapezius (UT, MT, and LT), SCM, and SA among office workers with UCS before and after performing eight weeks of the corrective exercise program.

Methods

Study Design

A parallel-group randomized control trial with a pretest-posttest design is used for the present study. Additionally, the selected subjects are randomly assigned to three groups including two interventions (i.e., online-supervised exercise and work-place supervised exercise receiving eight weeks of intervention) and a control group with no intervention performing routine activities. In addition, baseline assessments are organized at the Sports Science and Health Laboratory at Shahid Beheshti University, Tehran, Iran and are
repeated after eight weeks of intervention. The procedure and flow diagram are shown in Table 1 and Fig. 1, respectively. The procedure is followed according to the SPIRIT[1] guidelines to ensure the apparent and standardized reporting of the trial.

### Table 1. Procedure of the study

| Study Period | Enrolment | Allocation | Post-allocation |
|--------------|-----------|------------|-----------------|
| **TIMEPOINT** | -t<sub>1</sub> | 0 | t<sub>1</sub>-<br>Pre-Test | t<sub>2</sub>-<br>Post-Test |
| ENROLMENT: | | | |
| Eligibility screen | X | | |
| Informed consent | X | | |
| Allocation | | X | |
| ASSESSMENTS: | | | X X |
| Outcome variables | | | |
| Neck-shoulder pain | | | |
| Sick-leave | | | |
| Alignment (i.e., neck, shoulder, and thoracic kyphosis angles) | | | |
| Workability | | | |
| Electromyography | | | |
| INTERVENTIONS: | | | |
| Intervention 1: | | | |
| Online-supervised exercises | | | |
| Intervention 2: | | | |
| Workplace exercises | | | |
| Intervention 3: | | | |
| Control | | | |
Ethical Considerations

Before commencing the study, the procedure including assessments is explained to the subjects, and they are requested to complete and sign an informed consent form. Ethical clearance No. IR.SBU.REC.1399.036 dated 2020.06.20 was issued by the Ethics Committee on the Research at Shahid Beheshti University, Tehran, Iran. Further, IRCT No. IRCT20200729048249N1 dated 2020.10.05 was approved by the Iranian Registry of Clinical Trials (https://en.irct.ir/user/trial/49992/view). Furthermore, deviations from the present protocol are clearly described in the main article with the results of the trial.

Subjects and Eligibility Criteria

The subjects (30-45 years) are primarily screened for three main UCS features and then recruited from private and public organizations in Tehran, Iran through invitation letters. Furthermore, photogrammetry is applied for measuring relative postural alterations such as forward head (≥ 45°), round shoulder (≥ 52°), and round back (≥ 42°) according to previous studies (50, 51). Then, the visual analogue scale (VAS) is used to specify pain intensity (≥3) in the head, neck, shoulder, and upper back, respectively (19, 52, 53). Additionally, the presence of scapular dyskinesis may indicate the lack of neuromuscular control such as muscle activation and timing. Thus, the related tests are performed to evaluate the position and rhythm of the scapula, which plays a significant role in facilitating the upper extremity function among the office workers (52, 54, 55). Due to any postural alteration impacting the muscle activity, muscle length and muscle strength tests are implemented for upper trapezius and pectoral muscles, as well as middle, lower trapezius, and deep cervical flexor, respectively (56). Meeting the above-mentioned criteria, office workers are eligible if using a computer or lab-tops most commonly during the working day (about 30 hours per week) with at least five years of experience (19, 57). On the other hand, individuals are ineligible if they are pregnant, have a surgical operation on the upper extremities during the past year, are unable to perform exercise due to any medical conditions, have a bodyweight out of the normal range (18≤BMI≤25), attend no post-tests, lose three sequential sessions, or any other factors which may affect the results of the study. However, the subjects are allowed to discontinue the study at any stage (58). At the first encounter at baseline, the researchers are asked for permission in order to contact them in the case of study discontinuation. Accordingly, performing an accurate intention-to-treat analysis of the primary result is possible.

Randomization

For bias reduction, the website https://www.sealedenvelope.com is applied for randomization, followed by performing randomization through a computer-generated sequence for allocation concealment including concealed, sequentially numbered, sealed, and opaque envelopes, putting a card inside which indicating the allocated group to each subject randomly (e.g., work-place exercise, online-supervised exercise interventions, and control groups).

Intervention
As illustrated in Figs. 2 and 3, an eight-week corrective exercises protocol is taken by two intervention groups considering the UCS features such as alignment, muscle activity, and movement pattern simultaneously. To achieve the best results, the exercise program is performed three days per week, each session lasting nearly 50 minutes initiating by five-seven minutes of warm-ups and finishing by cool-down, respectively (59). In addition, the exercises are initiated by three repetitions holding for 10 seconds using the Borg scale (60) and progress to six repetitions, holding for 25 seconds based on overload principles and individual characteristics (59, 61). An experienced corrective exercise expert supervises the exercise programs of both intervention groups. The online-supervised group includes up to four subjects during each session. Further, the exercise program is remotely performed and supervised three times a week for eight weeks in their home environment using real-time desktop videoconferencing software ([https://meet.jit.si/](https://meet.jit.si/)) via a laptop computer. Accordingly, subjects are able to have contact and talk with both the instructor and the other subjects (62). Furthermore, the workplace group performs all sessions in the worksite without daily face-to-face supervision although supervision is conducted using diary and telephone interviews. Additionally, each participant in this group is provided with a detailed written exercise and pictorial descriptions to enhance exercise performance. However, the corrective exercise expert is present once a week during the exercise sessions in order to provide input and evaluate the progress and to ensure that all subjects are exercising safely and correctly (41). It is noteworthy that the corrective exercises protocol is expected to prevent the undesired lack of scapula stabilization on the thorax and diminish neck and shoulder pain. Individuals with shoulder pain have excessive activation of the upper trapezius and decreased and/or delayed activation of the LT, MT, and SA (63). Thus, exercises specifically targeting the trapezius and SA muscles are commonly incorporated into rehabilitation programs in order to optimize the scapular position and motion (64). Recent studies indicated that the specific training of the neck muscles such as strengthening deep cervical flexor muscles could reduce neck pain and improve SCM endurance, which is effective in correcting head and shoulder postures (65, 66). Therefore, these exercises are recommended to improve the function of muscles in the neck, shoulder, and thoracic for several painful conditions due to their reduced or altered activation. At the follow-up, subjects are asked whether they have experienced any injuries or other adverse events during the training sessions.

**Outcome Measures**

Before randomization and at baseline, all assessments are performed and repeated after the intervention. Neck-shoulder pain (NSP) and sick-leave due to pain are considered as the primary outcome variables, followed by the alignment, workability, and electromyography (EMG) activities of the selected muscles as the secondary variables. In the first part of the questionnaire, the subjects are asked to insert their demographic and social status including gender, age, weight, and height (Body mass index = kg/m²), work hour/week, years of experience, education level, and marital status (67).

**NSP Intensity**
To determine NSP intensity, the subjects are asked through a questionnaire to mark a vertical line on the VAS line at the point which represents their pain intensity in each area (i.e., head, neck, shoulder, and upper back) on a scale ranging from 0 to 10 representing no pain and severe, respectively (67, 68).

**Workability and Sick-leave due to Pain**

Workability is self-assessed using the related questionnaires by a single validated item from the workability index (69, 70). The subjects respond to one question as to how they rate their current workability according to their capabilities in order to meet the mental and physical demands of their job which can still perform in two years. The response scores range from 0 to 10, indicating inability to work and workability with a cut-off point score of ≤7 implying poor workability, respectively (71). In addition, sick-leave due to pain is evaluated using a single item from the validated Outcome Evaluation Questionnaire in order to obtain data on the number of absence days from work due to pain in muscles or joints within the past month, and response categories ranged from 0 to 31 days (72). Based on a recent meta-analysis, self-reported sick leave demonstrates good reliability and validity against the records (73).

**Alignment**

To determine the angles for forward head and round shoulder postures, visible landmarks are placed on the ear tragus, the acromion process of the scapula, and the neck seventh vertebra process, as well as the 12th dorsal vertebra of the spinous for measuring the kyphosis angle, respectively (51). Further, photogrammetry is utilized, asking the subjects to stand laterally and comfortably with bare feet on the flat floor while looking forward. A digital camera is fixed at a distance of 265 centimeters from the subjects, and then three photos are taken from the lateral view (74). Furthermore, the angles are identified using AutoCAD software (version 2020) connecting a vertical line from the tragus to C7 for determining forward head and continuing to the acromion process for displaying the rounded shoulder angles. To identify the thoracic kyphosis angle, C7 and T12 markers are considered as the starting and ending points of the arch (51, 75, 76). Finally, the mean of three measurements is considered as the alignment angle.

**EMG**

The onset timing and amplitude for the dominant side of the selected muscles (i.e., UT, MT, LT, SCM, and SA) are recorded using EMG, and Matlab software is applied for data analysis (77). After preparing the skin, electrodes are placed according to the European protocol of SENIAM[2], and then the reference electrode for each muscle is attached to the nearest bony site of the muscle. Additionally, a maximum voluntary isolated contraction (MVIC) is used to normalize and standardize the data by the root of the mean square (RMS). In addition, the subjects are requested to elevate their hand 30 degrees in the scapular plate without any resistance in three phases (i.e., isometric, concentric, and centric) five times with a three-second break within each repetition. Then, the mean RMS is calculated based on three of five repetitions, followed by divining the mean RMS by the MVIC value multiplied by 100 in order to obtain the percentage of muscle activity (78).
Sample Size

Based on the results of the previous studies (36, 51, 79) and a pilot study, 11 subjects are calculated for each group using the following formula with an alpha level of 0.05 and power (1-\(\beta\)) of 80%. However, to avoid the probability of losing the subjects during the research process, the number is considered 15 in every three groups (N=45 subjects).

\[
n = \frac{\left(Z_{1-\alpha/2} + Z_{1-\beta}\right)^2 (S_1^2 + S_2^2)}{(M_1 - M_2)^2} = 11
\]

\[
n = (1.96 + 0.84)^2 \frac{2(4.83^2 + 1.92^2)(39.90 - 45.29)}{2} \sim 10
\]

\[
n = (1.96 + 0.84)^2 \frac{2(4.86^2 + 3.34^2)(47.85 - 58.10)}{2} \sim 10
\]

\[
n = (1.96 + 0.84)^2 \frac{2(2.23^2 + 2.71^2)(41.15 - 44.20)}{2} \sim 11
\]

\[Z_{1-\alpha}^2 \text{ for sig. 0.05} = 1.96\]

\[Z_{1-\beta} \text{ for power 80\%} = 0.84\]

M1: Mean of FHP, FSP, and kyphosis for the experimental group in the post-test

M2: Mean of FHP, FSP, and kyphosis for the control group in the post-test

S1: Standard deviation of FHP, FSP, and kyphosis for the experimental group in the post-test

S2: Standard deviation of FHP, FSP, and kyphosis for the control group in the post-test

Statistical Method and Analysis

Data are analyzed using IBM SPSS statistics software, version 24 for Windows, and descriptive statistics are applied to describe the variables considering sig. \(\leq 0.05\). Further, data normality is reported based on the Shapiro-Wilk test.

A 3 (group) × 2 (time) mixed-model repeated-measures ANOVA is used to compare all values from the pre-test to each point of the time within each group. Furthermore, the mixed-model repeated-measures ANOVA is applied to analyze within-group changes. Additionally, Bonferroni’s post-hoc test for indicating the significance is utilized for any significant difference, and one-way ANCOVA is employed to compare the groups in the post-test with each pre-test value as a covariate. In addition, the effect size is calculated for the magnitude of the difference using the partial \(\eta^2\) method as small (0.01 \(\leq \eta^2 < 0.06\)), medium (0.06 \(\leq \eta^2 < 0.14\)), or large (\(\eta^2 \geq 0.14\)). It should be noted that interim analyses were not planned in the present study.

Discussion
The present randomized control trial is conducted to assess the effect of work-place versus online-supervised corrective exercise interventions among 45 office workers suffering from UCS. The work-place exercise group receives an intervention without the direct supervision of an expert while another group performs the exercise under direct online supervision. These interventions are expected to improve and reduce UCS symptoms containing postural malalignment and imbalance muscles after eight weeks of corrective exercises. Further, it is estimated that the corrective exercises protocol lead to pain relief and an increase in workability in the worksites. Furthermore, the findings may be applied in various work-places as evidence for those large populations of office workers involving WMSDs where employers can benefit from the actions by decreasing the related costs and side effects (e.g., work disability, productivity loss, time expense, social insurance, work absenteeism, and treatment costs, respectively). In this regard, most studies have only evaluated MSDs in different worksites including pain and work disability concentrating on a separate area (the neck or shoulder) or some specific muscles exclusively. On the other hand, a limited number of studies have considered the associations between malalignment, muscle imbalances, pain, and work disability among office works as a set of disorders named ‘UCS’. Thus, the results of the present study may lead to the adherence and work performance of office workers who are subject to WMSDs and other individuals with UCS symptoms. Finally, the findings are predicted to elaborate on the effect of work-place exercises with indirect supervision versus direct online-supervision exercises after eight weeks of intervention.

**Trial Status**

The present trial was registered under No. IRCT20200729048249N1 dated 2020.10.05 and the protocol version No. 49992. At present, the study is in the stage of subject enrollment, and recruitment is expected to begin on 2020.12.20 and complete by 2021.06.20.

**Abbreviations**

**MSDs:** Musculoskeletal Disorders  
**UCS:** Upper Crossed Syndrome  
**NSP:** Neck-Shoulder Pain  
**UT, MT, and LT:** Upper, Middle, and Lower Trapezius  
**SCM:** Sternocleidomastoid  
**SA:** Serratus Anterior  
**WNSDs:** Work-related Neck-shoulder Disorders  
**EMG:** Electromyography  
**FHP:** Forward Head Posture
VAS: Visual Analogue Scale
MVIC: Maximum Voluntary Isolated Contraction
RMS: Root Mean Square

Declarations

Ethics Approval and Consent for Participation
The ethical clearance No. IR.SBU.REC.1399.036 dated 2020.06.20 was issued by the Ethics Committee on Research at Shahid Beheshti University, Tehran, Iran. Before study initiation, all subjects are requested to complete and sign a written consent form.

Consent for Publication
The required permission for publishing subjects’ photos in the manuscript was approved by written informed consent.

Availability of Data and Materials
The researchers interested in using the final dataset for scientific purposes may contact the corresponding author.

Competing Interests
The present study received no specific grant from funding agencies in the public, commercial, or not-for-profit sectors. In addition, there are no sponsors and competing interests for the present protocol.

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The authors report no conflicts of interest and no sources of funding.

Authors’ Contributions
Zohreh Yaghoubi Tajani (ZYT) and Mehdi Gheitasi (MG) conceived the idea and designed the project. In addition, ZYT performed clinical examination and data collection. Further, MG and Mohammad Bayattork participated in the methodologically development and design of the statistical analysis. Furthermore, Lars Louis Andersen contributed to the comments that greatly improved the manuscript. Finally, all authors contributed to the refinement of the study protocol and approved the final manuscript.

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References

1. Buckle PW, Devereux JJ. The nature of work-related neck and upper limb musculoskeletal disorders. Applied ergonomics. 2002;33(3):207-17.

2. So BC, Szeto GP, Lau RW, Dai J, Tsang SM. Effects of Ergomotor Intervention on Improving Occupational Health in Workers with Work-Related Neck-Shoulder Pain. International Journal of Environmental Research and Public Health. 2019;16(24):5005.

3. Caneiro JP, O’Sullivan P, Burnett A, Barach A, O’Neil D, Tveit O, et al. The influence of different sitting postures on head/neck posture and muscle activity. Manual therapy. 2010;15(1):54-60.

4. Gu S-Y, Hwangbo G, Lee J-H. Relationship between position sense and reposition errors according to the degree of upper crossed syndrome. Journal of physical therapy science. 2016;28(2):438-41.

5. Moore MK. Upper crossed syndrome and its relationship to cervicogenic headache. Journal of manipulative and physiological therapeutics. 2004;27(6):414-20.

6. Page P. Shoulder muscle imbalance and subacromial impingement syndrome in overhead athletes. International journal of sports physical therapy. 2011;6(1):51.

7. Page P. Cervicogenic headaches: an evidence-led approach to clinical management. International journal of sports physical therapy. 2011;6(3):254.

8. Luttmann A, Jäger M, Griefahn B, Caer G, Liebers F, Organization WH. Preventing musculoskeletal disorders in the workplace. 2003.

9. Robertson MM, Ciriello VM, Garabet AM. Office ergonomics training and a sit-stand workstation: Effects on musculoskeletal and visual symptoms and performance of office workers. Applied ergonomics. 2013;44(1):73-85.

10. Andersen JH, Fallentin N, Thomsen JF, Mikkelsen S. Risk factors for neck and upper extremity disorders among computers users and the effect of interventions: an overview of systematic reviews. PloS one. 2011;6(5):e19691.

11. Ketkar GN, Malaiappan S. Knowledge Attitude and Practice of Ergonomics and Musculoskeletal Disorders as an Occupational Hazard among Periodontists in India–A Questionnaire Based Survey. Journal of Pharmaceutical Research International. 2020:162-83.

12. Côté P, Boyle E, Shearer HM, Stupar M, Jacobs C, Cassidy JD, et al. Is a government-regulated rehabilitation guideline more effective than general practitioner education or preferred-provider
rehabilitation in promoting recovery from acute whiplash-associated disorders? A pragmatic randomised controlled trial. BMJ open. 2019;9(1).

13. Hallman DM, Holtermann A, Dencker-Larsen S, Jørgensen MB, Rasmussen CDN. Are trajectories of neck–shoulder pain associated with sick leave and work ability in workers? A 1-year prospective study. BMJ open. 2019;9(3):e022006.

14. Andersen LL, Mortensen OS, Hansen JV, Burr H. A prospective cohort study on severe pain as a risk factor for long-term sickness absence in blue-and white-collar workers. Occupational and environmental medicine. 2011;68(8):590-2.

15. Dianat I, Bazazan A, Azad MAS, Salimi SS. Work-related physical, psychosocial and individual factors associated with musculoskeletal symptoms among surgeons: Implications for ergonomic interventions. Applied ergonomics. 2018;67:115-24.

16. Thacker D, Jameson J, Baker J, Divine J, Unfried A. Management of upper cross syndrome through the use of active release technique and prescribed exercises. Logan College of Chiropractic. 2011.

17. Daneshmandi H, Choobineh A, Ghaem H, Alhamd M, Fakherpour A. The effect of musculoskeletal problems on fatigue and productivity of office personnel: a cross-sectional study. Journal of preventive medicine and hygiene. 2017;58(3):E252.

18. Sundstrup E, Seeberg KGV, Bengtsen E, Andersen LL. A Systematic Review of Workplace Interventions to Rehabilitate Musculoskeletal Disorders Among Employees with Physical Demanding Work. Journal of Occupational Rehabilitation. 2020:1-25.

19. Ting JZR, Chen X, Johnston V. Workplace-Based Exercise Intervention Improves Work Ability in Office Workers: A Cluster Randomised Controlled Trial. International journal of environmental research and public health. 2019;16(15):2633.

20. Brandt M, Sundstrup E, Jakobsen MD, Jay K, Colado JC, Wang Y, et al. Association between neck/shoulder pain and trapezius muscle tenderness in office workers. Pain research and treatment. 2014;2014.

21. Madeleine P, Lundager B, Voigt M, Arendt-Nielsen L. Shoulder muscle co-ordination during chronic and acute experimental neck-shoulder pain. An occupational pain study. European journal of applied physiology and occupational physiology. 1999;79(2):127-40.

22. Buckle P. Ergonomics and musculoskeletal disorders: overview. Occupational medicine. 2005;55(3):164-7.

23. Juul-Kristensen B, Kadefors R, Hansen K, Byström P, Sandsjö L, Sjøgaard G. Clinical signs and physical function in neck and upper extremities among elderly female computer users: the NEW study. European journal of applied physiology. 2006;96(2):136-45.

24. Jull G, Kristjansson E, Dall’Alba P. Impairment in the cervical flexors: a comparison of whiplash and insidious onset neck pain patients. Manual therapy. 2004;9(2):89-94.

25. Sterling M. Whiplash-associated disorder: musculoskeletal pain and related clinical findings. Journal of Manual & Manipulative Therapy. 2011;19(4):194-200.
26. Seeberg KGV, Andersen LL, Bengtsen E, Sundstrup E. Effectiveness of workplace interventions in rehabilitating musculoskeletal disorders and preventing its consequences among workers with physical and sedentary employment: systematic review protocol. Systematic reviews. 2019;8(1):1-7.

27. Lusa S, Punakallio A, Mänttäri S, Korkia Kangas E, Oksa J, Oksanen T, et al. Interventions to promote work ability by increasing sedentary workers’ physical activity at workplaces—A scoping review. Applied Ergonomics. 2020;82:102962.

28. Pereira M, Comans T, Sjøgaard G, Straker L, Melloh M, O’Leary S, et al. The impact of workplace ergonomics and neck-specific exercise versus ergonomics and health promotion interventions on office worker productivity: A cluster-randomized trial. Scandinavian Journal of Work, Environment and Health. 2019;45(1):42-52.

29. Sheikhhoseini R, Shahrbanian S, Sayyadi P, O’Sullivan K. Effectiveness of therapeutic exercise on forward head posture: a systematic review and meta-analysis. Journal of manipulative and physiological therapeutics. 2018;41(6):530-9.

30. Borisut S, Vongsirinavarat M, Vacha latithi R, Sakulsriprasert P. Effects of strength and endurance training of superficial and deep neck muscles on muscle activities and pain levels of females with chronic neck pain. Journal of physical therapy science. 2013;25(9):1157-62.

31. Camargo PR, Neumann DA. Kinesiologic considerations for targeting activation of scapulothoracic muscles—part 2: trapezius. Brazilian journal of physical therapy. 2019;23(6):467-75.

32. Welch A, Healy G, Straker L, Comans T, O’Leary S, Melloh M, et al. Process evaluation of a workplace-based health promotion and exercise cluster-randomised trial to increase productivity and reduce neck pain in office workers: A RE-AIM approach. BMC public health. 2020;20(1):180.

33. Mehri A, Letafatkar A, Khosrokiani Z. Effects of Corrective Exercises on Posture, Pain, and Muscle Activation of Patients With Chronic Neck Pain Exposed to Anterior-Posterior Perturbation. Journal of Manipulative and Physiological Therapeutics. 2020.

34. Hotta GH, Santos AL, McQuade KJ, de Oliveira AS. Scapular-focused exercise treatment protocol for shoulder impingement symptoms: three-dimensional scapular kinematics analysis. Clinical Biomechanics. 2018;51:76-81.

35. Saeterbakken AH, Makrygiannis P, Stien N, Solstad TEJ, Shaw M, Andersen V, et al. Dose-response of resistance training for neck-and shoulder pain relief: a workplace intervention study. BMC Sports Science, Medicine and Rehabilitation. 2020;12:1-8.

36. Mehri A, Letafatkar A. Efficacy of corrective exercise intervention on forward head angle, pain and timing of superficial neck muscles activation during posterior-anterior perturbation in women with chronic neck pain. Majallah-i pizishki-i Danishgh-i Ulum-i Pizishki va Khadamat-i Bihdashti-i Darmani-i Tabriz. 2018;40(1):66-76.

37. Bayattork M, Sköld MB, Sundstrup E, Andersen LL. Exercise interventions to improve postural malalignments in head, neck, and trunk among adolescents, adults, and older people: systematic review of randomized controlled trials. Journal of exercise rehabilitation. 2020;16(1):36.
38. Jakobsen MD, Sundstrup E, Brandt M, Jay K, Aagaard P, Andersen LL. Effect of workplace-versus home-based physical exercise on musculoskeletal pain among healthcare workers: a cluster randomized controlled trial. Scandinavian journal of work, environment & health. 2015:153-63.

39. Fennell C, Peroutky K, Glickman E. Effects of supervised training compared to unsupervised training on physical activity, muscular endurance, and cardiovascular parameters. MOJ Orthop Rheumatol. 2016;5(5).

40. Cox KL, Burke V, Gorely TJ, Beilin L, Puddey IB. Controlled comparison of retention and adherence in home-vs center-initiated exercise interventions in women ages 40–65 years: the SWEAT study (Sedentary Women Exercise Adherence Trial). Preventive medicine. 2003;36(1):17-29.

41. Stefanov T, Vekova A, Bonova I, Tzvetkov S, Kurktschiev D, Blüher M, et al. Effects of supervised vs non-supervised combined aerobic and resistance exercise programme on cardiometabolic risk factors. Central European journal of public health. 2013;21(1):8-16.

42. Bau J-G, Chia T, Wei S-H, Li Y-H, Kuo F-C. Correlations of neck/shoulder perfusion characteristics and pain symptoms of the female office workers with sedentary lifestyle. PloS one. 2017;12(1):e0169318.

43. Chen X, Coombes BK, Sjøgaard G, Jun D, O’Leary S, Johnston V. Workplace-based interventions for neck pain in office workers: systematic review and meta-analysis. Physical therapy. 2018;98(1):40-62.

44.Louw S, Makwela S, Manas L, Meyer L, Terblanche D, Brink Y. Effectiveness of exercise in office workers with neck pain: A systematic review and meta-analysis. The South African journal of physiotherapy. 2017;73(1).

45. Heredia-Rizo AM, Petersen KK, Madeleine P, Arendt-Nielsen L. Clinical outcomes and central pain mechanisms are improved after upper trapezius eccentric training in female computer users with chronic neck/shoulder pain. The Clinical journal of pain. 2019;35(1):65-76.

46. Hall G, Laddu DR, Phillips SA, Lavie CJ, Arena R. A tale of two pandemics: How will COVID-19 and global trends in physical inactivity and sedentary behavior affect one another? Progress in Cardiovascular Diseases. 2020.

47. Sañudo B, Fennell C, Sánchez-Oliver AJ. Objectively-Assessed Physical Activity, Sedentary Behavior, Smartphone Use, and Sleep Patterns Pre-and during-COVID-19 Quarantine in Young Adults from Spain. Sustainability. 2020;12(15):5890.

48. Hammami A, Harrabi B, Mohr M, Krustrup P. Physical activity and coronavirus disease 2019 (COVID-19): specific recommendations for home-based physical training. Managing Sport and Leisure. 2020:1-6.

49. Constandt B, Thibaut E, De Bosscher V, Scheerder J, Ricour M, Willem A. Exercising in Times of Lockdown: An Analysis of the Impact of COVID-19 on Levels and Patterns of Exercise among Adults in Belgium. International Journal of Environmental Research and Public Health. 2020;17(11):4144.

50. Thigpen CA, Padua DA, Michener LA, Guskiewicz K, Giuliani C, Keener JD, et al. Head and shoulder posture affect scapular mechanics and muscle activity in overhead tasks. Journal of
Electromyography and kinesiology. 2010;20(4):701-9.

51. Karimian R, Rahnama N, Ghasemi G, Lenjannejad S. Photogrammetric Analysis of Upper Cross Syndrome among Teachers and the Effects of National Academy of Sports Medicine Exercises with Ergonomic Intervention on the Syndrome. Journal of research in health sciences. 2019;19(3):e00450.

52. Depreli O, Angin E, Yatar I, Kirmizigil B, Malkoc M. Scapular dyskinesis and work-related pain in office workers-a pilot study. International Journal of Physical Therapy & Rehabilitation. 2016;2016.

53. Jensen MP, Karoly P, Braver S. The measurement of clinical pain intensity: a comparison of six methods. Pain. 1986;27(1):117-26.

54. McClure P, Tate AR, Kareha S, Irwin D, Zlupko E. A clinical method for identifying scapular dyskinesis, part 1: reliability. Journal of athletic training. 2009;44(2):160-4.

55. Tate AR, McClure P, Kareha S, Irwin D, Barbe MF. A clinical method for identifying scapular dyskinesis, part 2: validity. Journal of athletic training. 2009;44(2):165-73.

56. Bayattork M, Seidi F, Minoonejad H, Andersen LL, Page P. The effectiveness of a comprehensive corrective exercises program and subsequent detraining on alignment, muscle activation, and movement pattern in men with upper crossed syndrome: protocol for a parallel-group randomized controlled trial. Trials. 2020;21(1):1-10.

57. Marklund S, Mienna CS, Wahlström J, Englund E, Wiesinger B. Work ability and productivity among dentists: associations with musculoskeletal pain, stress, and sleep. International Archives of Occupational and Environmental Health. 2020;93(2):271-8.

58. Castro RRTd, Silveira Neto JGd, Castro RRTd. Exercise Training: A Hero that Can Fight two Pandemics at Once. International Journal of Cardiovascular Sciences. 2020;33(3):284-7.

59. Sahrmann S. Movement system impairment syndromes of the extremities, cervical and thoracic spines-e-book: Elsevier Health Sciences; 2010.

60. Katzman WB, Vittinghoff E, Kado DM, Schafer AL, Wong SS, Gladin A, et al. Study of hyperkyphosis, exercise and function (SHEAF) protocol of a randomized controlled trial of multimodal spine-strengthening exercise in older adults with hyperkyphosis. Physical therapy. 2016;96(3):371-81.

61. Falla D, Jull G, Hodges P, Vicenzino B. An endurance-strength training regime is effective in reducing myoelectric manifestations of cervical flexor muscle fatigue in females with chronic neck pain. Clinical Neurophysiology. 2006;117(4):828-37.

62. Tsai LLY, McNamara RJ, Dennis SM, Moddel C, Alison JA, McKenzie DK, et al. Satisfaction and experience with a supervised home-based real-time videoconferencing telerehabilitation exercise program in people with chronic obstructive pulmonary disease (COPD). International journal of telerehabilitation. 2016;8(2):27.

63. Cools AM, Struyf F, De Mey K, Maenhout A, Castelein B, Cagnie B. Rehabilitation of scapular dyskinesis: from the office worker to the elite overhead athlete. British journal of sports medicine. 2014;48(8):692-7.

64. Neumann DA, Camargo PR. Kinesiologic considerations for targeting activation of scapulothoracic muscles-part 1: serratus anterior. Brazilian journal of physical therapy. 2019;23(6):459-66.
65. Moon J-H, Jung J-H, Hahm S-C, Jung K-S, Suh HR, Cho H-y. Effects of chin tuck exercise using neckline slimmer device on suprahoid and sternocleidomastoid muscle activation in healthy adults. Journal of physical therapy science. 2018;30(3):454-6.

66. Suvarnnato T, Puntumetakul R, Uthaikhup S, Boucaut R. Effect of specific deep cervical muscle exercises on functional disability, pain intensity, craniovertebral angle, and neck-muscle strength in chronic mechanical neck pain: a randomized controlled trial. Journal of Pain Research. 2019;12:915.

67. Gram B, Holtermann A, Bültmann U, Sjøgaard G, Søgaard K. Does an exercise intervention improving aerobic capacity among construction workers also improve musculoskeletal pain, work ability, productivity, perceived physical exertion, and sick leave?: a randomized controlled trial. Journal of occupational and environmental medicine. 2012;54(12):1520-6.

68. Von Korff M, Ormel J, Keefe FJ, Dworkin SF. Grading the severity of chronic pain. Pain. 1992;50(2):133-49.

69. Ahlström L, Grimby-Ekman A, Hagberg M, Dellve L. The work ability index and single-item question: associations with sick leave, symptoms, and health—a prospective study of women on long-term sick leave. Scandinavian journal of work, environment & health. 2010:404-12.

70. Tuomi K, Ilmarinen J, Jahkola A, Katajarinne L, Tulkki A. Work ability index: Finnish Institute of Occupational Health Helsinki; 1998.

71. Neupane S, Miranda H, Virtanen P, Siukola A, Nygård C-H. Multi-site pain and work ability among an industrial population. Occupational medicine. 2011;61(8):563-9.

72. Holtermann A, Hansen JV, Burr H, Søgaard K. Prognostic factors for long-term sickness absence among employees with neck-shoulder and low-back pain. Scandinavian journal of work, environment & health. 2010:34-41.

73. Johns G, Miraglia M. The reliability, validity, and accuracy of self-reported absenteeism from work: A meta-analysis. Journal of Occupational Health Psychology. 2015;20(1):1.

74. Harman K, Hubley-Kozej CL, Butler H. Effectiveness of an exercise program to improve forward head posture in normal adults: a randomized, controlled 10-week trial. Journal of Manual & Manipulative Therapy. 2005;13(3):163-76.

75. Gadotti IC, Armijo-Olivo S, Silveira A, Magee D. Reliability of the craniocervical posture assessment: visual and angular measurements using photographs and radiographs. Journal of manipulative and physiological therapeutics. 2013;36(9):619-25.

76. Ruivo RM, Pezarat-Correia P, Carita AI. Intrarater and interrater reliability of photographic measurement of upper-body standing posture of adolescents. Journal of manipulative and physiological therapeutics. 2015;38(1):74-80.

77. Johnston V, Jull G, Souvlis T, Jimmieson NL. Neck movement and muscle activity characteristics in female office workers with neck pain. Spine. 2008;33(5):555-63.

78. Castelein B, Cools A, Parlevliet T, Cagnie B. Are chronic neck pain, scapular dyskinesis and altered scapulothoracic muscle activity interrelated?: A case-control study with surface and fine-wire EMG. Journal of Electromyography and Kinesiology. 2016;31:136-43.
79. Kim E-K, Kang JH, Lee HT. The effect of the shoulder stability exercise using resistant vibration stimulus on forward head posture and muscle activity. Journal of physical therapy science. 2016;28(11):3070-3.

Figures

Figure 1
Figure 2

Workplace corrective exercises 1. Sitting Position: Arms in a W shape, horizontal abduction with external rotation; 2A and 2B. Sitting Position: Chin tuck; 3. Sitting Position: Scapula retraction and depression with arms in a T shape; 4A and 4B. Sitting Position: Scapula retraction overhead and arms overhead; 5A and 5B. Sitting Position: Forward flexion starting with the arms parallel with the body; 6A and 6B. Sitting Position: Elevation 90° flexed elbows in the scapular plane with 30° external rotation by an elastic band; 7A and 7B. Sitting Position: Dynamic hug exercise by the elastic material as resistance performing bilateral, maximum scapular protraction; 8. Sitting Position: Horizontal arm 90 abduction with external rotation; 9A and 9B. Sitting Position: Extension starting with the arm at 90° of forward flexion; 10A and 10B. Sitting Position: Thoracic extension exercises.
Online-supervised corrective exercises

1. Supine Position: Arms in a W shape and horizontal abduction with external rotation; 2A and 2B. Sitting Position: Chin tuck; 3. Prone Position: Scapula retraction and depression with arms in a T shape; 4A and 4B. Standing Position: Scapula retraction overhead and arms overhead; 5A and 5B. Side-lying Position: Forward flexion starting with the arms parallel with the body; 6A and 6B- Prone Position: Extension starting with the arm at 90° of forward flexion; 7. Prone Position: Horizontal arm 90 abduction with external rotation; 8A and 8B. Sitting Position: Thoracic extension exercise; 9A and 9B: Standing Position: Elevation 90° flexed elbows in the scapular plane with 30° external rotation by the elastic band; 10A and 10B. Standing Position: Dynamic hug exercise by the elastic material as resistance performing bilateral, maximum scapular protraction.