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ORIGINAL ARTICLE

Corrective exercises administered online vs at the workplace for pain and function in the office workers with upper crossed syndrome: randomized controlled trial

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Abstract

Objective To evaluate the effects of online-supervised versus workplace corrective exercises on neck–shoulder pain (NSP), sick leave, posture, workability, and muscular activity among office workers with the upper crossed syndrome (UCS).
Methods We performed a parallel-group randomized control trial at Shahid Beheshti University, Tehran, Iran, assigning 36 office workers to online-supervised, workplace, and control groups (mean (SD) age 38.91 ± 3.87, 38.58 ± 7.34, 37.00 ± 8.12). Inclusion criteria were alignment alteration (forward head (≥ 45°), rounding shoulder (≥ 52°), rounding back (≥ 42°), and pain intensity ≥ 3 in neck and shoulder. The two intervention groups performed 8-week exercise program, while the control group continued usual activities. Primary (NSP and sick leave) and secondary outcomes [postural angles, workability, and muscular activity were measured by VAS, outcome evaluation questionnaire (OEQ), photogrammetry, workability index, and EMG, respectively, at the baseline and an 8-week follow-up].
Results ANCOVA results revealed improvements for the online-supervised group versus control for NSP ($P = 0.007$), postural angles ($P = 0.000$, $P = 0.001$, $P = 0.005$), workability ($P = 0.048$, $P = 0.042$), and upper trapezius activation ($P = 0.024$, $P = 0.016$), respectively. Using paired t tests, both intervention groups improved from baseline to follow-up for NSP ($P = 0.000$, $P = 0.002$), forward head posture ($P = 0.000$, $P = 0.000$), round shoulders ($P = 0.001$, $P = 0.031$), and round back ($P = 0.034$, $P = 0.008$), respectively. Related parameters of workability ($P = 0.041$, $P = 0.038$), upper trapezius ($P = 0.005$, $P = 0.005$, $P = 0.022$), and serratus anterior ($P = 0.020$, $P = 0.015$) changed only in the online-supervised group.
Conclusion Online-supervised corrective exercise seems to improve a range of parameters related to work performance. These findings are highly applicable in light of the ongoing COVID pandemic; many workers have to work from home.

Keywords Online-supervised · Workplace corrective exercises · Neck–shoulder pain · Workability · Muscle activation · Postural malalignment

Introduction

Sedentary work is increasingly common in large parts of the world as the nature of work has been changed rapidly because of technology (Buckle and Devereux 2002; Caneiro et al. 2010). Some researchers have proposed that prolonged static postures—e.g., sitting in the same forward-leaned position in front of a computer all the day—may cause postural malalignment and be considered as a risk factor for work-related musculoskeletal disorders (WMSDs), leading to office workers' complaints (Szeto et al. 2005; So et al. 2019). Janda believed that sustained awkward positions could very likely lead to transformation in the head, shoulder, and spinal curves, causing forward head posture, round shoulders, and round back, anteriorly tilt, and winged scapula (Morris et al. 2006; Zad and Patil 2021). Such conditions are postulated to result in constant pressure and degenerative changes in an individual's joints, and are simultaneously associated with musculoskeletal imbalance and pain (Barrett et al. 2016; Isper Garbin et al. 2017). Based on the literature, neck and shoulder impairments, headaches, chronic neck tension, and scapular dyskinesia could negatively influence workability and typical daily performance (Singla and Veqar 2017).

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Furthermore, many studies have reported approximately 50.5% and 44.8% of the prevalence of shoulder and upper back pain among office workers (Madeleine et al. 1999; Kaliniene et al. 2016; Hasan et al. 2020). Computer users reported musculoskeletal discomforts symptoms 68% in the neck, 66% in the back, and 45% in the shoulder (Ardahan and Simsek 2016). In 2014, among Iranian office workers, Nejati et al. published a high prevalence of UCS symptoms containing forward head posture, round shoulders, and round back as 61.3, 48.7, and 78.3%, respectively (Nejati et al. 2014). Meanwhile, Noroozi et al. stated that office workers have a high prevalence of musculoskeletal disorders, since prolonged sitting and working with computers are some of the causes for these individuals to experience musculoskeletal disorders increasing the risks relatively (Noroozi et al. 2015). However, high-quality research based on prospective cohort studies found no association between the computer use and the risk of chronic neck and shoulder pain (Andersen et al. 2008). Thus, it is why only certain individuals are prone to develop UCS. It has been approved previously that increasing pain intensity, regardless of its cause, decreases the workability among sedentary and physical work demands (Bayattork et al. 2019). Due to musculoskeletal symptoms imposing indirect costs including sick leave, productivity loss, treatment costs, disability, early retirement, and work absenteeism in office workers, the issues such as lifestyle interventions, identification of the groups at the risk of disability, increased health promotion, and early prevention in the workplace could be assumed as great potential for increasing workability and reducing work absenteeism (Sundstrup et al. 2020). Other risk factors influencing the productivity and workability in the working environment may be related to personal, organizational, social, and environmental factors, including noise, lighting, temperature, and the like, often leading to economic losses (Lister et al. 1998; Welch et al. 2020).

Additionally, UCS is characterized by tightening upper trapezius and sternocleidomastoid following the deep cervical flexors and middle, lower trapezius, and serratus anterior muscles' weakness (Page 2011a, b; Ohlendorf et al. 2017). It may cause alteration in scapula muscle activation, movement patterns, and some misalignments in the upper limb that simultaneously contribute to cervicothoracic and glenohumeral joint dysfunction (Culham and Peat 1993; Seidi et al. 2020). Acting as a bridge between the shoulder and cervical region, the scapula plays a significant role in providing mobility and stability for the neck and shoulders (Cools et al. 2014).

Previous studies also indicated the relationship between chronic NSP and scapular dyskinesis by altering dynamic scapular stability during the scapular orientation in the resting position and also reported that neck pain may alter postural behavior when performing prolonged sitting tasks, such as during computer use (Szeto et al. 2002; Cagnie et al. 2014). Furthermore, increased cervical and thoracic curves and a slouched posture are known to affect scapular orientation, shoulder muscle strength, and shoulder range of motion (Kebaetse et al. 1999; Finley and Lee 2003; Kibler 2003). Many studies have determined impaired muscle coordination in the neck muscles, cervical pain, and abnormal head position associated with high amounts of EMG activity in the neck flexors' muscles, and have highlighted a direct correlation among upper trapezius muscle activity, neck angle, and perceived discomfort during the prolonged sitting tasks (Falla et al. 2004, Berolo et al. 2011; Pietropaoli et al. 2019; D'Anna et al. 2021). Brandt et al. reported a strong association between perceived NSP intensity and trapezius muscle tenderness among the office workers (Brandt et al. 2014).

Based on the previous findings, serratus anterior and lower trapezius provide stability for the scapula and maintain the appropriate scapular location to act as an essential shoulder stabilizer and balance the scapular rotation coupling forces (Johnson et al. 1994; Phadke et al. 2009; Weon et al. 2010). Consequently, altered stability of the scapula may create or sustain symptomatic mechanical dysfunction in the cervical spine and influence the neck pain's recurrence (Helgadottir et al. 2011). Meanwhile, disturbances in scapular function could be found in both shoulder and neck pain due to the neuromuscular imbalance between the deep phasic and superficial tonic muscles. This phenomenon is worth considering for effective management of UCS among office workers (Page et al. 2010; Page 2011a, b). In this regard, Cools et al. suggested a basic rehabilitation approach focused on the office workers' functional demands, like correcting the function of axioscapular muscles and scapular alignment during the prolonged upper extremities activities (Cools et al. 2014). Hence, implementing posture-correction strategies early in the rehabilitation program, performing all interventions in a sitting or standing position with a correct posture, and maintaining an upright body position to retrain a neutral posture are considered different techniques for reducing chronic neck pain (Falla et al. 2007; Lee, Lee et al. 2017).

Although several studies investigated the efficiency of workplace interventions for rehabilitation or prevention of WMSDs as a global health issue, which influences both employers and employees, an effective intervention is still needed to be warranted (Skamagki et al. 2018; Grimani et al. 2019; Ting et al. 2019; Welch et al. 2020).

UCS symptoms may alter muscle activation patterns, which can be considered one of the most potent stimuli to central motor programming (Madeleine et al. 1999; Brandt et al. 2014; Gu et al. 2016). Furthermore, muscle activation alterations were observed in office workers suffering frequent pain in the shoulder and neck and poor postural stability, respectively (Jull et al. 2004; Andersen et al. 2011;

Sterling 2011). In this population, postural malalignments and altered muscle activation are associated with work disability and sickness absence (Loghmani et al. 2013).

Due to lack of research on computer users suffering from UCS, it seems rational to evaluate associated various musculoskeletal symptoms, including forward head posture, round shoulders, and round back along with related muscles' EMG influenced by UCS, and pain in neck and shoulder areas, as well as assessing the extent of workability and sick-leave variables in such populations. Although most research reported positive effects of supervised and un-supervised interventions in managing WMSDs, some studies underlined that supervised exercise programs are most likely to be beneficial in maintenance and adherence and, as a result, significantly influence diminishing consequential symptoms (Blangsted et al. 2008; Coury et al. 2009). Conversely, implementing exercise under supervision can be cost-effective and not always an available workplace resource; however, some individuals prefer to exercise when it fits into their daily working routine (Gram et al. 2014). Since many countries worldwide have applied social quarantine during the COVID-19 global pandemic, office workers were advised to work from home and follow the rules of social distance (Aegerter et al. 2021). Nevertheless, evidence-based guidelines for performing home exercise are lacking. The current study is the first randomized controlled trial with the purpose of comparing the effect of corrective exercises at the worksite versus home under direct supervision during the pandemic.

In more detail, it is hypothesized that performing corrective exercises diminishes UCS-related symptoms, including work parameters, postural malalignment, and imbalanced muscles in office workers with NSP. The primary objectives were to assess the effects of an 8-week online-supervised home-based versus workplace-based corrective exercises to decrease NSP and sick leave. The secondary objectives were to evaluate postural angles (forward head posture, round shoulders, and round back), workability, and the surface EMG of interest muscles (upper, middle, lower trapezius, sternocleidomastoid, and serratus anterior) among the computer users working at the offices with UCS.

Methods

Study design and participants

A parallel-group randomized controlled trial with testing at baseline and follow-up was approved by Ethics Committee on the Research at Shahid Beheshti University, Tehran, Iran (approval number: IR.SBU.REC.1399.036/2020.06.20). The trial was registered at IRCT (IRCT20200729048249N1/2020.10.05). The assessments were conducted at baseline and after 8 weeks of intervention in the Sport Sciences and Health Laboratory at Shahid Beheshti University, Tehran, Iran. The subjects signed an informed consent followed by the Declaration of Helsinki. They were randomly assigned to three groups; the intervention groups (online-supervised and workplace) and the control group. Figure 1 demonstrates the whole procedure according to CONSORT guidelines to ensure the transparent and standardized reporting of the trial (Grant et al. 2018). The study protocol has been published, and all detailed procedures have already been presented elsewhere (Yaghoubitajani et al. 2021).

The entire study procedure, including assessments, was clarified for 118 volunteers who were invited through invitation letters. Qualified office workers, including 23 females and 13 males, were performed the pre-test, and they were all able to meet the eligibility criteria with postural alterations (forward head posture ≥ 45°, round shoulders ≥ 52°, round back ≥ 42°) and pain intensity (≥ 3) in the neck and shoulder areas, measured by photogrammetry and VAS, respectively. Based on the above inclusion criteria, the individuals were excluded from the list of participants if they were pregnant, had a history of joint diseases in the spine, shoulder, pelvis, and fracture, had surgery during the past year, or had a bodyweight out of the normal range (18 ≥ BMI ≥ 25). The subjects were considered as dropouts if they missed three sequential sessions or the follow-up test. For their convenience, the subjects were permitted to leave the study at any stage of the research process.

Study outcomes and assessments

The main researcher measured the study outcomes at the baseline before randomization and after 8 weeks. The NSP and sick leave as the primary outcomes were measured by VAS and OEQ, respectively. The secondary outcomes, including postural alignment angles (forward head posture, round shoulders, and round back), workability (physical and mental), muscle activation, and timing of the interested muscles (upper, middle, lower trapezius, sternocleidomastoid, and serratus anterior), were assessed by photogrammetry, workability index questionnaire, and EMG, respectively. Demographic data were obtained, including age, weight, height, BMI, smoking behavior, marital status, and education level. The baseline and follow-up tests were conducted using assessment methods and testing equipment in the same setting.

Data were collected on the paper questionnaires using a 10-cm VAS scale; the subjects rated their NSP intensity, ranging from zero ("no pain") to ten ("worst pain"). The sick leave was assessed by a single item extracted from OEQ of the validated outcome. The response categories ranged from 0 to 31 days, inserting the number of absence working days due to NSP within the past month (Keefe et al. 1992;

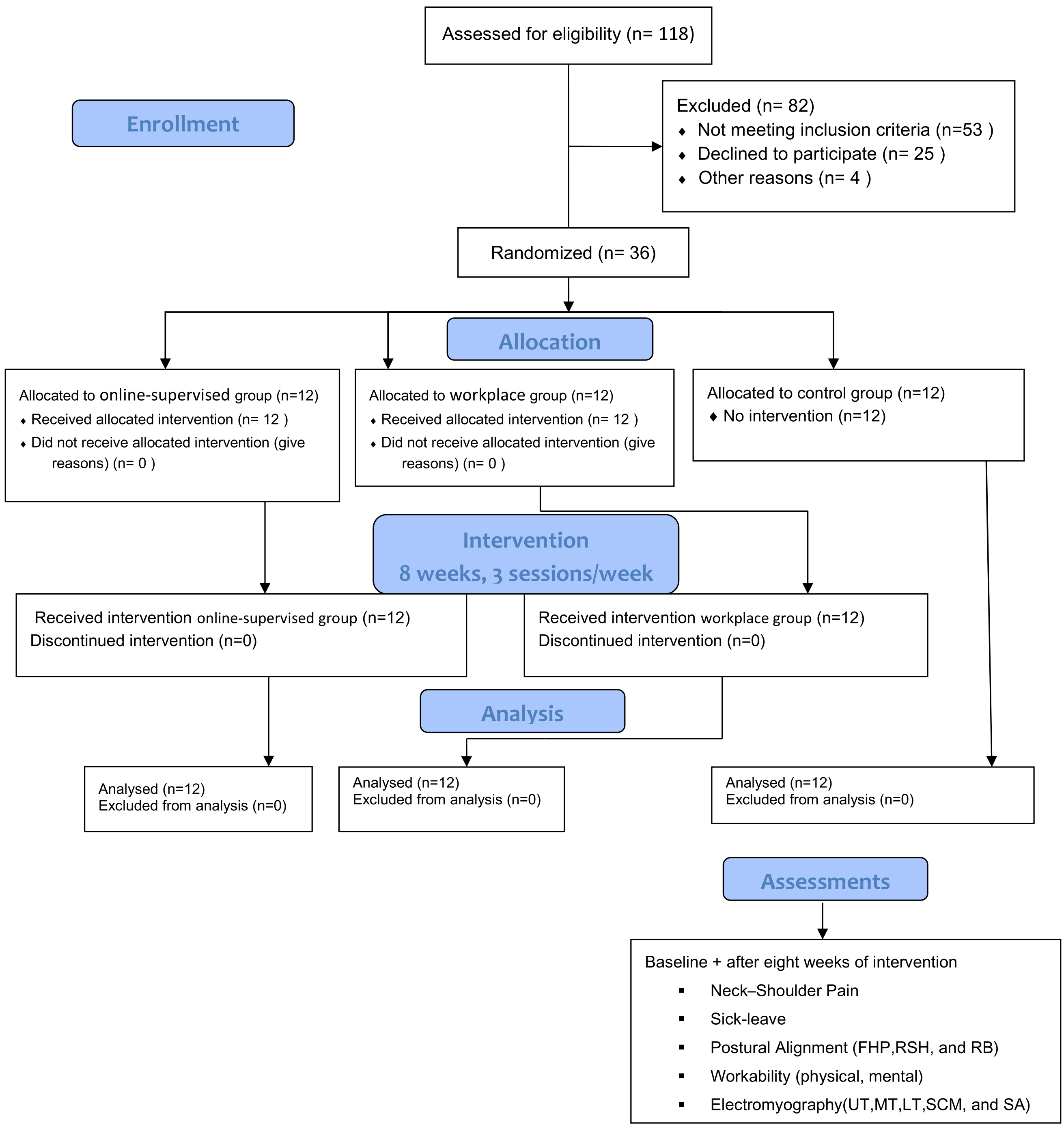

Fig. 1 Study flowchart

Hallman et al. 2019). Self-reported sick leave demonstrates good test–retest reliability and sufficient convergent validity against records (Miraglia and Johns 2016). The photogrammetric method was applied for the postural angles' assessments by identifying anatomical landmarks of the tragus, acromion process of the scapula, spinous process of C-7 and T-12 through removable colored dots to be laterally visible (Karimian et al. 2019). Workability was evaluated by self-report using a single validated item from the Workability Index questionnaire. The scores ranged from 0 to 10 (0 = completely unable to work, 10 = workability at its best), indicating a cut-off point score of ≤ 7, implying the poor workability (Gram et al. 2012; Hallman et al. 2019).

The EMG recordings were made through the standard procedure to normalize the recommended range in work-related disorder studies for activation and timing of upper, middle, and lower trapezius, sternocleidomastoid, and serratus anterior muscles. Careful skin preparation followed based on SENIAM and previously published guidelines concerning the skin impedance (≤ 10 kΩ) and bipolar Ag/AgCl (SKINTACT, Austria) surface electrodes' application (Johnston et al. 2008). The ME-6000 Megawin (MegaWin, Finland) was used for data collection, and all EMG signals were amplified (gain, 1000), passed through a 10–500 Hz band-width filter, and sampled at 1000 Hz processed through the Matlab software (Seidi et al. 2020). The maximal voluntary isometric test (MVIC) was performed and normalized the EMG data. After training and a short warm-up, the subjects implemented three MVICs holdings for 5 s against the manual static resistance. The duration was controlled by a stopwatch considering 30 s rest time between each repetition and 2 min for subsequent muscle testing. Those subjects who reported pain during the test were excluded to minimize the impact of pain on the assessment. After five minutes of resting, the subjects performed bilateral arm elevation five times in the scapular plane over concentric, isometric, and eccentric phases, which lasted 3 s as well as 3 s of rest between each phase. After rectifying and smoothing, the root mean square (RMS) was calculated at the time constant of 50 ms for 3 s from the middle of three trials out of five. The RMS mean was divided using MVIC value, and was multiplied by 100 to calculate the muscle activity percentage (Arshadi et al. 2019). The muscle activation onset/offset was calculated based on concentric/eccentric phases from the point that the level of muscle activity reached three standard deviations above/below the rest of the muscle activity and then was analyzed based on the middle deltoid onset/offset timing (De Mey et al. 2012).

Randomization

The computer-generated block randomization was performed in a 1:1:1 allocation ratio through the website https://www.sealedenvelope.com. The main investigator performed the enrollment, generated the random allocation sequence, and assigned the subjects to the groups. The random allocation sequence was implemented by concealed, sequentially numbered, sealed, and opaque envelopes by putting a card inside, indicating that the allocated group to each subject was randomly executed. A university assistant professor supervised all procedures, including the sequence generation process and allocation concealment mechanism, to ensure that the assignment schedule was unpredictable.

Intervention

Intervention groups performed 8-week corrective exercises three times/week, lasting about 50–60 min pertaining to typical 5-min warm-up and cool-down. Each exercise was individualized based on demographic characteristics, pain intensity, and overload principles. The pain intensity up to five (VAS) was allowed to have ten max. repetition, only if the pain decreased immediately after completing the exercise. The subjects who experienced the higher pain levels could modify the exercise accordingly.

The online-supervised group performed the program under direct remote supervision in their home environment using desktop videoconferencing software (https://meet.jit.si/). To do so, a laptop monitored by a qualified corrective exercises expert was utilized to ensure the progress movement pattern and the control load progression. The workplace group who performed the program in their worksite was provided a diary with detailed written and pictorial descriptions. In addition to telephone interviews, the expert's weekly presence was accentuated to evaluate the progress, safety, and performance constantly.

The exercise program was prescribed concerning spontaneous postural alterations, muscle activation, movement pattern, and lack of scapula stabilization for the individuals with UCS suffering from NSP. A detailed pictorial description of the interventions, along with the list of the given corrective exercises to both interventional groups, is available elsewhere (Yaghoubitajani et al. 2021).

Sample size and statistical analysis

The G × Power software (Version 3.0.10, Germany) was used to calculate the sample size regarding the effect size reported for the corrective exercises compared with the control group without any intervention in a similar study, totally ($n = 33$). To avoid potential dropout during the study, a total of 45 subjects were considered adequate to compensate for the potential loss to follow-up; however, we achieved only 36 subjects due to recruitment difficulties related to the COVID pandemic, i.e., we assigned 12 subjects to each group (Yaghoubitajani et al. 2021). The analyses were conducted using IBM SPSS version 20 for Windows (SPSS Inc., Chicago, IL, USA). Variables' distribution was examined by the Shapiro–Wilk ($P \geq 0.05$). Paired t test and one-way ANCOVA were used for within-group and between-group comparisons. The follow-up values were used as the outcome while controlling the baseline values. The M ± SD and the significance levels at $P \leq 0.05$ were applied for data demonstration. The partial η^2 method was utilized to determine the effect size of the differences' magnitude as small ($0.01 \leq \eta^2 < 0.06$), medium ($0.06 \leq \eta^2 < 0.14$), or large ($\eta^2 \geq 0.14$) (Richardson 2011). For the minimum clinically important differences, the formula of (MCID = SD × 0.5) was used (Norman et al. 2003).

Results

The assessments were implemented among 36 subjects, and the study outcomes were analyzed for the original assigned three groups. Table 1 demonstrates baseline demographic and lifestyle characteristics. All variables had normal distribution based on Shapiro–Wilk test ($P \geq 0.05$).

Within-group comparison using paired *t* tests demonstrated significant differences in both online-supervised and workplace groups for NSP ($P = 0.000$, $P = 0.002$), forward head posture ($P = 0.000$, $P = 0.000$), round shoulders ($P = 0.001$, $P = 0.031$), and round back ($P = 0.034$, $P = 0.008$), respectively. The online-supervised group differed in physical and mental workability variables ($P = 0.041$, $P = 0.038$). Also, in this group, the upper trapezius improved in Max., Ave. activation ($P = 0.005$, $P = 0.005$), and offset timing ($P = 0.022$). Serratus anterior indicated Max. and Ave. activation changes ($P = 0.020$, $P = 0.015$), respectively.

Using ANCOVA for comparing between-groups, the results revealed significant differences in the online-supervised group NSP ($P = 0.007$) in pairwise comparisons with the control group. Significant differences were observed in postural angles, including forward head posture ($P = 0.000$) comparing control with online-supervised and workplace groups, round shoulders ($P = 0.001$) between control and online-supervised groups, and round back ($P = 0.005$) between control and workplace groups. In addition, comparing between control and online-supervised groups, physical and mental workability ($P = 0.048$, $P = 0.042$), and upper trapezius muscle Max., Ave. activation ($P = 0.024$, $P = 0.016$) differed significantly. The sick leave and other variables were not the cases in all three groups ($P \geq 0.05$). Tables 2 and 3 display within-group and between-group significant differences along with the magnitude effect sizes in study outcomes' improvement at the follow-up, and the MCIDs changes in the intervention groups, respectively.

Discussion

The present study found that online-supervised corrective exercises seem to be effective in improving a range of parameters related to work performance, since significant differences occurred in the two intervention groups.

These findings are highly relevant in light of the ongoing COVID pandemic, where many workers have to work from home.

The findings confirmed that performing 8-week corrective exercises significantly affected the NSP among the subjects in the two intervention groups. This is in line with the previous findings, showing that corrective exercises improve neck pain (Sheikhhoseini et al. 2018; Mehri et al. 2020).

Table 1 Demographic characteristics and lifestyle characteristics: mean ± standard deviation (M ± SD), and normality distribution

Variable	Group	M ± SD	*t*	*P*	Percent (%)
Age (year)	Control	38.91 ± 3.87	0.902	0.196	
	Online-supervised	38.58 ± 7.34	0.941	0.517	
	Workplace	37.00 ± 8.12	0.923	0.451	
Weight (kg)	Control	67.18 ± 13.02	0.878	0.099	
	Online-supervised	66.33 ± 8.97	0.841	0.059	
	Workplace	67.63 ± 9.68	0.953	0.746	
Height (m)	Control	1.72 ± 0.09	0.959	0.756	
	Online-supervised	1.67 ± 0.08	0.913	0.235	
	Workplace	1.74 ± 0.07	0.894	0.253	
BMI (kg/m^2)	Control	24.27 ± 2.91	0.919	0.310	
	Online-supervised	25.86 ± 1.77	0.919	0.281	
	Workplace	25.90 ± 1.82	0.936	0.570	
Smoking	Control(yes/no)				27.3/72.7
	Online-supervised (yes/no)				0.0/100.0
	Workplace (yes/no)				25.0/75.0
Marital status	Control (single/married)				18.2/81.8
	Online-supervised (single/married)				66.7/33.3
	Workplace (single/married)				50.0/50.0
Educational level	Control (BS, MSc, Ph.D)				45.5/27.3/27.3
	Online-supervised (Diploma, BS, MSc)				16.7/33.3/50.0
	Workplace (Diploma, BS, MSc)				12.5/62.5/25.0

Table 2 Within-group differences (Paired *T* Test) in NSP; Sick-leave(SL); Workability (WA)physical/mental; Forward head posture(FHP), Round shoulders(RSH), Round back(RB) angles; ave./ max. activity, onset/offset of Upper, Middle, Lower trapezius, Serratus anterior, and Sternocleidomastoid(UT,MT,LT,SA, and SCM)

Group	Variable (baseline/follow-up)	Mean difference	95% Confidence interval of the difference		*t*	Sig.
			Lower	Upper		
Control	NSP	0.45455	− 0.00736	0.91645	2.193	0.053
	SL	0.09091	− 0.11165	0.29347	1.000	0.341
	WA.physical	0.27273	− 0.25548	0.80093	1.150	0.277
	WA.mental	− 0.09091	− 0.45326	0.27144	− 0.559	0.588
	FHP	0.04545	− 0.30539	0.39630	0.289	0.779
	RSH	0.00909	− 1.53766	1.55584	0.013	0.990
	RB	− 0.23636	− 1.48682	1.01409	− 0.421	0.683
	UT—ave	− 0.03182	− 0.09037	0.02673	− 1.211	0.254
	UT—max	− 0.07091	− 0.15618	0.01436	− 1.853	0.094
	UT—onset	− 209.754	− 641.00996	221.50087	− 1.084	0.304
	UT—offset	− 36.5727	− 1372.7919	1299.6465	− 0.061	0.953
	MT—ave	− 0.08818	− 0.17138	− 0.00498	− 2.362	0.060
	MT—max	− 0.20636	− 0.40210	− 0.01063	− 2.349	0.061
	MT—onset	− 238.454	− 595.92326	119.01417	− 1.486	0.168
	MT—offset	1022.663	− 456.49804	2501.8253	1.540	0.154
	LT—ave	− 0.07091	− 0.15878	0.01696	− 1.798	0.102
	LT—max	− 0.18909	− 0.39920	0.02101	− 2.005	0.073
	LT—onset	− 73.3090	− 433.51906	286.90088	− 0.453	0.660
	LT—offset	231.5727	− 1017.1562	1480.3017	0.413	0.688
	SA—ave	− 0.05818	-0.14805	0.03169	− 1.442	0.180
	SA—max	− 0.11364	− 0.29595	0.06868	− 1.389	0.195
	SA—onset	39.80909	− 417.37975	496.99793	0.194	0.850
	SA—offset	312.0454	− 558.06528	1182.1561	0.799	0.443
	SCM—ave	− 0.05455	-0.11038	0.00129	− 2.177	0.055
	SCM -max	− 0.13545	− 0.27971	0.00880	− 2.092	0.063
	SCM—onset	317.2636	− 621.44766	1255.9749	0.753	0.469
	SCM—offset	139.2818	− 1120.7945	1399.3581	0.246	0.810

Table 2 (continued)

Group	Variable (baseline/follow-up)	Mean difference	95% Confidence interval of the difference		*t*	Sig.
			Lower	Upper		
Online-supervised	NSP	3.91667	2.52310	5.31023	6.186	0.000*
	SL	0.16667	− .08065	.41398	1.483	0.166
	WA. physical	0.16667	− 1.00907	1.34240	.312	0.041*
	WA. mental	− 0.33333	− 2.05392	1.38726	− .426	0.038*
	FHP	5.62917	4.00022	7.25811	7.606	0.000*
	RSH`	6.40417	3.28478	9.52356	4.519	0.001*
	RB	1.89583	0.16869	3.62298	2.416	0.034*
	UT—ave	0.09583	0.03523	0.15644	3.480	0.005*
	UT—max	0.14750	0.05518	0.23982	3.517	0.005*
	UT—onset	− 119.333	− 468.56510	229.89843	− .752	0.468
	UT—offset	1408.000	242.71548	2573.2845	2.659	0.022*
	MT -ave	− 0.03417	− 0.14252	0.07418	− 0.694	0.502
	MT—max	− 0.02333	− 0.16929	0.12262	− 0.352	0.732
	MT—onset	− 815.033	− 2099.1133	469.04668	− 1.397	0.190
	MT –offset	1007.941	− 382.80656	2398.6899	1.595	0.139
	LT—ave	− 0.07750	− 0.19466	0.03966	− 1.456	0.173
	LT—max	− 0.12750	− 0.31262	0.05762	− 1.516	0.158
	LT—onset	− 45.7166	− 396.91904	305.48571	− 0.287	0.780
	LT—offset	910.8250	16.90960	1804.7404	2.243	0.056
	SA—ave	− 0.13667	− 0.24699	− 0.02634	− 2.726	0.020*
	SA—max	− 0.24250	− 0.42903	− 0.05597	− 2.861	0.015*
	SA—onset	48.42500	− 348.15777	445.00777	0.269	0.793
	SA—offset	921.3416	− 280.81276	2123.4961	1.687	0.120
	SCM—ave	0.02167	− 0.07419	0.11752	0.497	0.629
	SCM -max	0.07250	− 0.10371	0.24871	0.906	0.385
	SCM—onset	− 745.600	− 1872.3410	381.14100	− 1.456	0.173
	SCM—offset	1053.433	− 148.57581	2255.4424	1.929	0.080

Table 2 (continued)

Group	Variable (baseline/follow-up)	Mean difference	95% Confidence interval of the difference		*t*	Sig.
			Lower	Upper		
Workplace	NSP	2.50000	1.23606	3.76394	4.677	0.002*
	SL	3.62500	− 2.40260	9.65260	1.422	0.198
	WA. physical	0.50000	− 1.39592	2.39592	0.624	0.553
	WA. mental	− 0.12500	− 1.70098	1.45098	− 0.188	0.857
	FHP	3.82500	2.36547	5.28453	6.197	0.000*
	RSH	3.30625	.39228	6.22022	2.683	0.031*
	RB	2.77500	.98933	4.56067	3.675	0.008*
	UT—ave	− 0.01250	− 0.11766	0.09266	− 0.281	0.787
	UT—max	0.00375	− 0.15817	0.16567	0.055	0.958
	UT—onset	− 206.287	− 592.17509	179.60009	− 1.264	0.247
	UT—offset	660.7875	− 699.68739	2021.2623	1.149	.288
	MT—ave	− 0.00375	− 0.01464	0.00714	− 0.814	0.442
	MT—max	− 0.02375	− 0.04159	− 0.00591	− 3.148	0.056
	MT—onset	256.3250	− 401.93566	914.58566	0.921	0.388
	MT—offset	25.63750	− 817.89258	869.16758	.072	0.945
	LT -ave	− 0.03500	− 0.09611	0.02611	− 1.354	0.218
	LT -max	− 0.10000	− 0.24473	0.04473	− 1.634	0.146
	LT-onset	545.0375	− 222.28843	1312.3634	1.680	0.137
	LT -offset	− 117.875	− 1006.7134	770.96349	− 0.314	0.763
	SA—ave	− 0.11125	− 0.24945	0.02695	− 1.903	0.099
	SA—max	− 0.20500	− 0.46101	0.05101	− 1.893	0.100
	SA—onset	− 155.600	− 546.49397	235.29397	− .941	0.378
	SA—offset	− 252.037	− 785.41698	281.34198	− 1.117	0.301
	SCM—ave	− 0.01000	− 0.18422	0.16422	− 0.136	0.896
	SCM—max	0.03125	− 0.27779	0.34029	0.239	0.818
	SCM—onset	− 126.712	− 1304.8925	1051.4675	− 0.254	0.807
	SCM—offset	− 180.812	− 2010.2942	1648.6692	− 0.234	0.822

*Statistical significance: $P \leq 0.05$

Some studies reported that prolonged sitting or improper neck and shoulder posture during work might be associated with NSP among office workers (Falla al. 2007; Lee et al. 2017). Neck pain is associated with the ability to maintain an upright posture, as reported previously, and there could be a relationship between the correction of forward head posture, round shoulders, and pain (Lynch et al. 2010). In this regard, Lee et al. suggested that maintaining an upright body position and implementing posture-correction strategies in different sitting positions can prevent musculoskeletal pain (Cools et al. 2014; Lee et al. 2017). Hence, all the subjects were initially informed about the UCS consequences; hence, their postural awareness was repeatedly developed throughout the study days, and frequent corrections to an upright neutral postural position were recommended focusing on the control system in postural re-education programs such as memory joggers, to ensure that those behaviors become kinds of habit (Abdollahzade et al. 2017).

Furthermore, muscle strengthening or endurance exercises are recommended for an incorrect posture leading to pain through increased load on the cervical spine and changing the muscle's length (Gram et al. 2012). Meanwhile, training and rehabilitation of power and endurance of the deep neck flexors have been previously proved to be

Table 3 Between-group differences (one-way ANCOVA) in NSP; SL; WA (physical/mental); FHP, RSH, RB angles; ave./ max. activity, onset/offset of UT,MT,LT,SA, and SCM

Variable	Group	Mean ± SD	*F*	Sig.	Partial eta squared	MCID	Pairwise comparisons
NSP	Control	4.27 ± 1.34	5.944	0.007*	0.306	0.975 1.145	Control > online-supervised
	Online-supervised	3.25 ± 1.95					
	Workplace	4.12 ± 2.29					
SL	Control	1.45 ± 2.73	2.271	0.123	0.144	0.19 0.37	Control < online-supervised
	Online-supervised	0.16 ± 0.38					
	Workplace	0.37 ± 0.74					
WA.physical	Control	8.27 ± .90	0.780	0.048*	0.055	0.67 1.22	Control < online-supervised
	Online-supervised	8.00 ± 1.34					
	Workplace	7.00 ± 2.44					
WA.mental	Control	7.63 ± 1.56	1.758	0.042*	0.115	0.72 1.12	–
	Online-supervised	8.50 ± 1.44					
	Workplace	6.25 ± 2.25					
FHP	Control	45.40 ± .80	26.763	0.000*	0.665	1.25 0.76	Control > online-supervised Control > work-placed
	Online-supervised	39.97 ± 2.50					
	Workplace	41.51 ± 1.52					
RSH	Control	53.31 ± 2.62	10.046	0.001*	0.427	2.255 0.865	Control > online-supervised
	Online-supervised	46.93 ± 4.51					
	Workplace	49.91 ± 1.73					
RB	Control	50.78 ± 3.65	6.400	0.005*	0.322	1.68 1.63	Control > work-placed
	Online-supervised	49.16 ± 3.36					
	Workplace	46.77 ± 3.26					
UT—ave	Control	0.28 ± 0.13	4.289	0.024*	0.241	0.055 0.075	Control > online-supervised
	Online-supervised	0.20 ± 0.11					
	Workplace	0.23 ± 0.15					
UT—max	Control	0.44 ± 0.19	4.808	0.016*	0.263	0.098635 0.10724	Control > online-supervised
	Online-supervised	0.3333 ± 0.19727					
	Workplace	0.3600 ± 0.21448					
UT—onset	Control	− 134.85 ± 497.30	0.789	0.464	0.055	99.205 175.73	–
	Online-supervised	− 134.29 ± 198.41					
	Workplace	85.41 ± 351.46					
UT—offset	Control	329.90 ± 1093.61	2.356	0.114	0.149	851.93 910.015	–
	Online-supervised	− 762.35 ± 1703.86					
	Workplace	− 1244.95 ± 1820.03					
MT—ave	Control	0.17 ± 0.14	0.960	0.396	0.066	0.085 0.035	–
	Online-supervised	0.16 ± 0.17					
	Workplace	0.09 ± 0.07					
MT—max	Control	0.35 ± 0.31	1.933	0.164	0.125	0.105 0.075	–
	Online-supervised	0.25 ± 0.21					
	Workplace	0.17 ± 0.15					
MT—onset	Control	− 77.27 ± 307.90	0.797	0.461	0.056	1039.285 197.455	–-
	Online-supervised	501.47 ± 2078.57					
	Workplace	66.58 ± 394.91					
MT—offset	Control	− 346.70 ± 2816.89	1.152	0.331	0.079	1246.94 337.94	–
	Online-supervised	− 516.26 ± 2493.89					
	Workplace	− 416.51 ± 675.88					
LT—ave	Control	0.22 ± 0.09	0.314	0.733	0.023	0.09 0.07	–
	Online-supervised	0.25 ± 0.18					
	Workplace	0.18 ± 0.15					

Table 3 (continued)

Variable	Group	Mean ± SD	*F*	Sig.	Partial eta squared	MCID	Pairwise comparisons
LT—max	Control	0.45 ± 0.25	0.200	0.820	0.015	0.155 0.165	–
	Online-supervised	0.44 ± 0.31					
	Workplace	0.40 ± 033					
LT—onset	Control	− 74.22 ± 333.85	0.383	0.685	0.028	277.71 320.685	–
	Online-supervised	− 105.75 ± 555.42					
	Workplace	− 118.58 ± 641.37					
LT—offset	Control	− 101.27 ± 1679.62	0.762	0.477	0.053	790.62 343.74	–
	Online-supervised	− 692.82 ± 1581.24					
	Workplace	− 235.21 ± 687.48					
SA—ave	Control	0.34 ± 0.08	0.096	0.908	0.007	0.07 0.07	–
	Online-supervised	0.34 ± 0.14					
	Workplace	0.32 ± 0.14					
SA—max	Control	0.65 ± 0.18	0.014	0.986	0.001	0.11 0.13	–
	Online-supervised	0.63 ± 0.22					
	Workplace	0.64 ± 0.26					
SA—onset	Control	− 152.12 ± 497.08	1.701	0.201	0.112	154.65 180.39	–
	Online-supervised	− 218.33 ± 309.30					
	Workplace	101.58 ± 360.78					
SA—offset	Control	492.03 ± 873.62	0.885	0.424	0.062	928.275 315.895	–
	Online-supervised	− 243.01 ± 1856.55					
	Workplace	210.45 ± 631.79					
SCM -ave	Control	0.27 ± 0.18	0.490	0.618	0.035	0.11 0.12	–
	Online-supervised	0.29 ± 0.22					
	Workplace	0.34 ± 0.24					
SCM—max	Control	0.49 ± 0.32	0.820	0.451	0.057	0.155 0.165	–
	Online-supervised	0.46 ± 0.31					
	Workplace	0.48 ± 0.33					
SCM—onset	Control	284.38 ± 716.78	0.383	0.685	0.028	914.44 386.195	–
	Online-supervised	783.87 ± 1828.88					
	Workplace	627.11 ± 772.39					
SCM—offset	Control	− 395.87 ± 1322.97	0.708	0.501	0.050	1075.325 801.995	–
	Online-supervised	− 1152.22 ± 2150.65					
	Workplace	− 712.12 ± 1603.99					

beneficial for restoring neuromuscular imbalance and cervical stabilization, where the present study highlighted relevant exercises (Falla et al. 2007; Lee et al. 2018). Considering that the scapula plays an important role in NSP and is the keystone of the UCS, the current study primarily focused on the function of the scapula muscles to restore and balance the scapula stabilizers. This phenomenon could be due to activating the neck muscles and reducing the compensatory movements of the muscles involved in the area (Cagnie et al. 2014; Cools al. 2014; Kang et al. 2021).

Our findings significantly affected the postural angles. Since the alteration in the resting scapular position may occur with the abnormal cervical and thoracic spine alignment, the forward head posture can result in round shoulders, which may cause enhancing thoracic kyphotic posture, respectively (Kwon et al. 2015; Lee et al. 2015). Based on the literature, there might be a relationship among the forward head posture, round shoulders, and round back; however, the studies revealed an improvement in response to training programs' exercises (Singla and Veqar 2017; Sheikhhoseini et al. 2018). It is supposed that the involved muscles in the UCS may be shortened or lengthened when they are remained in the improper posture for a long time, occurring adaptive lengthening or shortening over time leading to poor posture. The traditional approach has focused on improving malalignments by stretching the shortened and strengthening the weakened muscles. However, using stretching exercises, some studies reported no changes in the muscle length, but indicated improved tolerance to stretching (Magnusson 1998; Sahrmann et al. 2017).

In contrast, the functional approach states that the interactions among all central and peripheral nervous systems, muscular and skeletal structures are the cause of WMSDs (Hamill et al. 1999). Thus, the initial strategy containing posture, muscle activation, and movement pattern intervention is recommended to be more effective (Hodges, Van Dieën et al. 2019). It seems that focusing simultaneously on the neural and muscular components for improving postural malalignments brings about the best results if the intervention is applied at least six weeks with an average of three times a week and a duration of 15–60 min (Bayattork et al. 2020).

The upper trapezius significantly improved in the current study, while no alterations were found in other muscles. The results are to some extent in line with the previous findings of Arshadi et al., conducted among healthy men with the UCS. They reported in their experiment that an 8-week corrective exercise exhibits significant differences in EMG activity of sternocleidomastoid, upper trapezius, serratus anterior; though middle and lower trapezius activity revealed no changes (Arshadi et al. 2019).

Meanwhile, Seidi et al. detected significant differences in the middle, lower trapezius, and serratus anterior activation levels. The young males with no pain performed a comprehensive corrective exercise program; nevertheless, the muscle activation timing indicated no specific differences. In the current study, upper trapezius offset timing varied in the online-supervised group (Seidi et al. 2020). Concerning the muscle activation timing, Cools et al. supported the theory that the individuals with pain may have delayed onset of middle and lower trapezius muscle activity, and injured individuals show abnormal muscle recruitment patterns in the same muscles. The timing of muscle activation is an essential factor in coordination with the scapula and arm movement (Cools et al. 2003).

Due to the presence of a neuromuscular imbalance in the UCS needing sensory–motor function, muscle adaptation to resistance training could happen before the development of hypertrophy, influencing more motor units, learning to use active motor units more effectively, and reducing the inhibitory inputs of alpha motor neurons (Hakkinen 1994).

In our study, the upper trapezius was the only muscle that displayed activation levels decrease. This outcome was in line with the findings of the studies that evaluated the upper trapezius activity among the office workers. It is worth noting that the muscle activation can be occurred by the neural adaptations associated with short-term exercise or may be connected with reduced pain levels rather than a direct result of the exercise program (Lidegaard et al. 2013; Villanueva et al. 2020). In this regard, Andersen et al. described these phenomena in their “wheel of pain reduction” and concluded that specific strength after exercise relieves pain and maximizes the activity, particularly in painful trapezius muscles. Increasing shoulder abduction strength in women with trapezius myalgia and reducing relative workload may indirectly decrease pain (Andersen et al. 2009). Consequently, the diminished upper trapezius activation levels prove this issue as the only trapezius muscle part, which is often overactive in the subjects with UCS. Then, its lesser activation might lead to pain relief (Kwon et al. 2015).

During this research, the applied intervention improved mental and physical workability in the online-supervised group, which was consistent with the study of Gram et al. However, no statistical differences were found for the sick leave as a fundamental problem when the individuals are going to work with pain (Gram et al. 2012). Musculoskeletal pain may negatively affect workability and physical activity, making significant differences in sedentary behavior, productivity, and work absenteeism associated with NSP (Foley et al. 2016, Hallman et al. 2019).

Limitations

The current study’s intervention duration can be considered a limitation, since UCS influencing scapular muscles’ activation may need more time to achieve the appropriate recruitment, timing, and firing rates. Although postural alignment and pain improvements occur sooner, the upper trapezius has started to change. Thus, more comprehensive studies are required to manage the UCS as a sensory–motor disorder due to neuromuscular adaptation. Another limitation of the current study was a relatively small sample size, which was selected to recruit the subjects in COVID-19 conditions. Although the study had sufficient statistical capability to show apparent differences between corrective exercises and the control conditions, it was not powerful enough to compare the two active interventions. However, the main finding of the present study—i.e., that online-supervised corrective exercises are effective—remains relevant to similar types of subjects with UCS. Eventually, a lack of blinding in the study design could be assumed as another unachievable limitation with the exercise interventions.

Conclusion

Implementing an 8-week corrective exercises program resulted in clinically desired significant improvements in most study outcomes. The findings in the online-supervised group revealed significant changes, which confirm that the supervised intervention could be more effective than the un-supervised intervention. However, it seems very difficult to compare the consequences of the current study with those of others. The reason is that previous research with similar titles evaluated the effects of various exercises on different study populations with different outcome measures, which makes it challenging to interpret the results. In the present study, the magnitude of the effect sizes in intervention groups indicated that prescribed corrective exercises positively affect NSP, forward head posture, round shoulders, round back, workability, and restored upper trapezius muscle activity. Based on the findings, it is suggested to perform the training under direct supervision rather than alone and without any supervision. Furthermore, WMSDs impose indirect costs, including productivity loss, treatment costs, and disability. Hence, managing the UCS is highly recommended among office workers, particularly the computer users with NSP, to increase health conditions and early prevention in the workplace, which in turn could significantly increase workability. However, it is worth noting this issue when the individuals go to work when experiencing pain.

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Data availability The datasets generated during and/or analyzed during the current study are available from the corresponding author on reasonable request. The researchers interested in using the final dataset for scientific purposes may contact the corresponding author.

Declarations

Conflict of interest Authors Zohreh Yaghoubitajani (ZY), Mehdi Gheitasi (MG), Mohammad Bayattork (MB), and Lars Louis Andersen (LLA) declare that they have no relevant financial or non-financial interests to disclose.

Ethics approval This study was performed in line with the principles of the Declaration of Helsinki. Approval was granted by Ethics Committee on the Research at Shahid Beheshti University, Tehran, Iran (approval number: IR.SBU.REC.1399.036 / 2020.06.20).

Consent to publish Not applicable.

Informed consent All procedures followed were in accordance with the ethical standards of the responsible committee on human experimentation (institutional and national) and with the Helsinki Declaration of 1975, as revised in 2000 (5). Informed consent was obtained from all the individual subjects for being included in the study.

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