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The Effect of Tissue Stretching and Release Strategies on Neck Muscles Fatigue and Pain Intensity in Office Workers Affected by Chronic Neck Pain: A Rater-Blind, Semi-Experimental Study

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ABSTRACT

Background and Aims: Nonspecific chronic neck pain (ns-CNP) is a common cause of disability among office workers. However, the effectiveness of tissue release and stretching strategies in managing pain and fatigue of neck muscles in employees affected by ns-CNP has not been assessed.

Methods: Thirty-nine employees who suffered from ns-CNP were randomly assigned to stretching, tissue release interventions or control group ($n = 13$). Neck pain and fatigue in neck extensors, upper trapezius, and sternocleidomastoid muscles were measured during 40 min of typing with a 45-degree head flexion at baseline and immediately after a 6-week intervention using visual analog scale and surface electromyography.

Results: Pain significantly decreased after 6 weeks of both interventions ($p < 0.05$). There were no significant within-group differences for right cervical muscle fatigue in the intervention groups, but a significant difference was noted in the control group at the 25th and 40th minutes ($p < 0.05$). Additionally, a significant difference was observed between the release and control group at the 30th, 35th, and 40th minutes ($p < 0.05$). Left cervical muscle fatigue significantly decreased at the 25th and 40th minutes only for the release group ($p < 0.05$). A significant difference was observed between the release and control groups at the 40th minute for the right upper trapezius ($p < 0.05$).

Conclusion: Only the stretching group showed a significant difference with the control in the left sternocleidomastoid at the 10th and 15th minutes, and the release group with the control in the last 5-min. Stretching and release interventions could control neck pain and muscle fatigue in the 45-degree head flexion position.

Abbreviations: ATPs, adenosine triphosphate; MDF, median frequency; NMF, neuromyofascial; ns-CNP, nonspecific chronic neck pain; VAS, visual analog scale.

1 | Background

Neck pain arises from a variety of factors, which may include ergonomic considerations and individual characteristics such as age, behavioral attitudes, or psychosocial issues like anxiety and job satisfaction. Since most cases of neck pain do not have a specific identifiable cause and are often linked to posture or mechanical issues, they are typically classified as nonspecific chronic neck pain (ns-CNP) [1]. Previous studies have reported that standing at work for more than 4 h a day and the cumulative time spent working in a sitting or standing position are risk factors for the development of chronic venous disease [2]. Psychosocial factors have also been reported as a major risk for workers in Malaysia, a situation exacerbated by the COVID-19 pandemic [3]. Unfortunately, the prevalence of self-reported symptoms of musculoskeletal disorders (MSDs) is highest for the neck (58%), shoulder (57%) and lower back (51%) [4]. Changes in technology, social dynamics, and organizational structures within the workplace, combined with the rapid pace of globalization, introduced new risks and challenges. Addressing the increasing prevalence of musculoskeletal and mental health disorders will require innovative strategies [5].

Nonspecific chronic neck pain is one of the MSDs that is more common in office workers [6–8]. This complication ranks fourth regarding disability worldwide [9–11], with a significant effect on the performance and productivity of organizations, jobs, and the quality of work life of employees. ns-CNP decreases motion control in neck muscles, and muscle strength and endurance limit the range of motion, changes muscle activation patterns, and causes forward head deformity, biomechanical changes in the chest, and lung dysfunction [12, 13]. Impaired breathing pushes the muscle towards anaerobic metabolism to supply the required Adenosine Triphosphate (ATPs), causing an increase in lactate and acidosis and, subsequently, faster muscle fatigue [14, 15]. Muscle fatigue can be defined as a decrease in the muscle's ability to produce energy in the neuromuscular system [16]. Fatigue reduces energy and physical activity and may affect proprioceptive, mental, or cognitive function. Consequently, fatigue decreases productivity and the economic efficiency of organizations. Repetitive movements and prolonged postures can change tissue characteristics and movement patterns, which leading to disorders in motor function [17, 18]. Pain and problems, lack of a specific and definitive treatment for this disorder, side effects of drugs, and high costs of physiotherapy have led many specialists to use noninvasive interventions [19, 20]. Scientific evidence suggests that soft tissue release is one of the interventions that may be effective in reducing the symptoms of stiff tissue in these patients. Musculoskeletal pain and stiffness can be reduced by these exercises by breaking down adhesions that form after micro-tissue injuries [21–23]. Myofascial pain syndrome is identified as one of the causes of muscle stiffness and pain, resulting in shortness, stiffness, and dysfunction of the muscle-tendon system [24–26]. Myofascial release occurs by releasing endorphins and reducing ischemia by increasing local blood circulation and creating relaxation in skeletal muscle (through sympathetic stimulation) [27].

Stretching exercises in soft tissue are another intervention that can be effective as a rest strategy in reducing fatigue and pain levels in employees with ns-CNP. This type of exercise can help reduce muscle fatigue and pain levels, ultimately improving the performance and quality of life of affected employees [28, 29]. Stretching may reduce pain by inhibiting Golgi tendon organs and reducing nerve discharge. Acute changes in the length-tension relationship in muscle tissue led to greater flexibility, affected by individual stretch tolerance and possibly changes in muscle viscoelasticity [30]. Research by Sarker et al. examined the effect of different rest strategies on measuring the fatigue in the neck and shoulder muscles in adults, finding that short-term breaks significantly relieved fatigue compared to long and medium breaks. The amount of time spent using computers at work or home is associated with symptoms of fatigue and neck discomfort [10].

The ns-CNP in office workers are often flexed while working on the computer, causing increased pressure on the neck extensor and stabilizing muscles due to gravity. This flexion can lead to muscle fatigue and chronic neck pain [31–33] Therefore, it is important to develop protocols that can reduce the fatigue threshold of neck control muscles and can be easily done during work breaks without help from others. This study aimed to compare the effect of two exercise protocols, stretching and soft tissue release, on reducing muscle fatigue and neck pain levels in individuals with idiopathic neck pain.

2 | Methods

2.1 | Participants

This semi-experimental study was conducted using a blind evaluator with parallel groups and a baseline-posttest design on thirty-nine 25-35-year-old women with a history of ns-CNP. Participants were randomly assigned to interventions and control groups: stretching exercises group ($n = 13$), release exercises group ($n = 13$), and control group ($n = 13$) (Figure 1). The inclusion criteria were women aged 25–35 with ns-CNP, defined as neck pain lasting 12 weeks or more with normal MRI findings [19]. Participants had to have a minimum pain intensity of three out of ten on the visual analog scale (VAS) and at least 5 years of work experience (Figure 1). Exclusion criteria included active trigger points, neurodegenerative diseases, a history of neck and shoulder surgery, fibromyalgia based on the American College of Rheumatology criteria (1990), a regular exercise program, apparent neck and shoulder deformities, mental illnesses, previous local steroid injection or acupuncture, cardiovascular and neuromuscular diseases, non-completion of treatment courses, simultaneous use of other treatment methods, and worsening of pain and disability symptoms with exercises.

The sample size was estimated using G. Power software (Ver. 3.1, Heinrich Heine University, Düsseldorf, Germany). For the one-way ANCOVA statistical method, statistical power (0.80), effect size (0.86) [34] significance level of (0.05), the sample size of 34 were determined, however, we chose to include 45 participants to account for potential drop-out. After identifying employees with chronic neck pain and

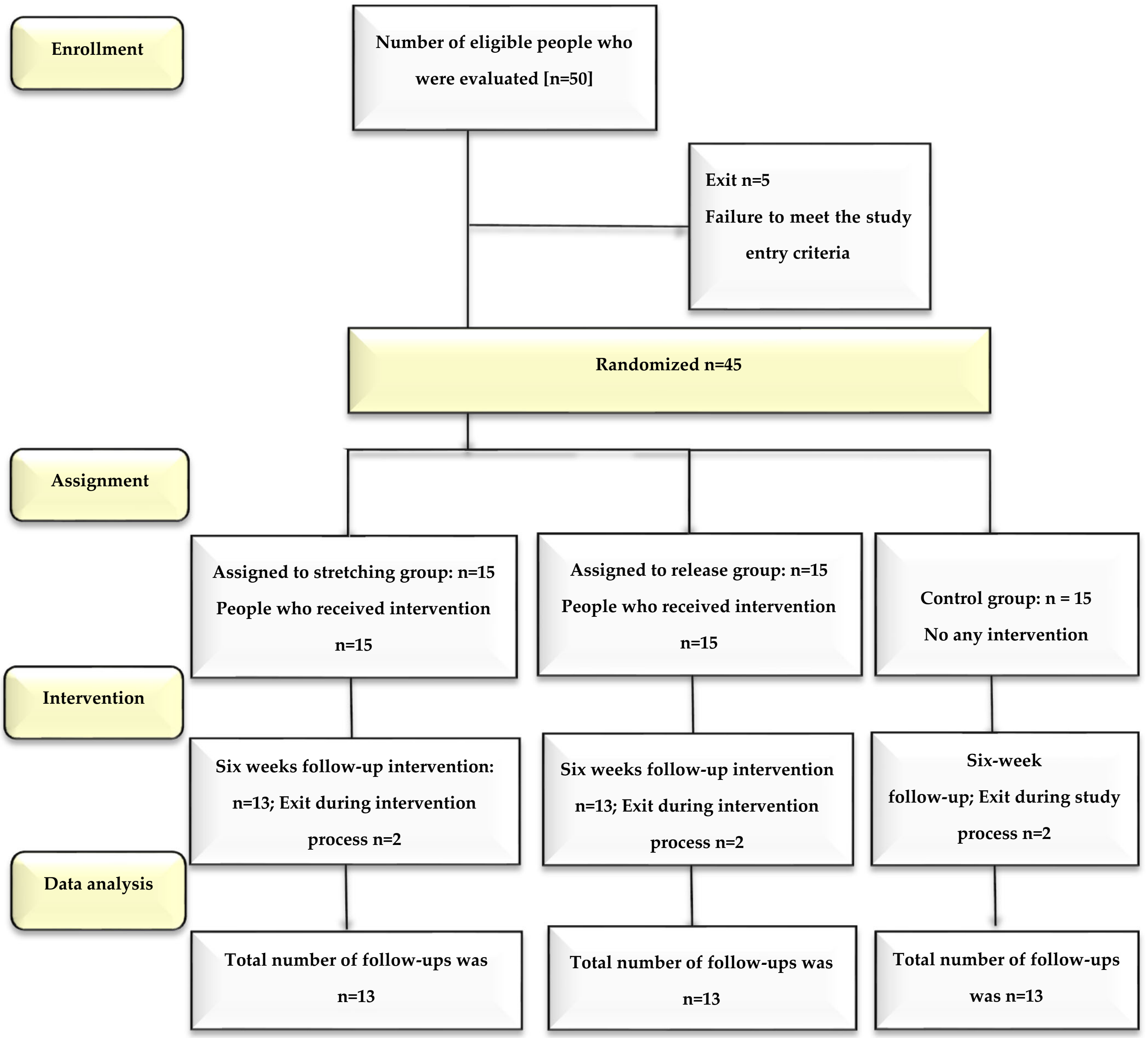

FIGURE 1 | Flowchart of the process of allocation and follow-up of subjects.

confirming the nonspecific nature of neck pain with a rheumatologist, those who met the inclusion criteria were invited to participate in the study. The objectives and research methods were explained to all participants at the sports rehabilitation and corrective exercises laboratory of RAZI University. The general questionnaire was completed after obtaining written consent. At baseline, pain intensity (primary outcome), and neck muscle fatigue (secondary outcome) were measured. Participants were then randomly assigned to intervention and control groups using a Random number generator software and SNOSE method by a person not involved in the research. The group allocation was concealed from the outcome evaluator by blinding the group assignment.

The intervention groups received three training sessions per week for 6 weeks. Meanwhile, the participants in the control group maintained their regular daily routines without undergoing any additional treatment interventions. However, in adherence to ethical standards the research, after the completion of the study, the control group also received stretching and soft tissue release interventions after the study was completed.

2.2 | Outcome Measures

2.2.1 | Perceived Pain Intensity

A Visual Analogue Scale (VAS) was used to determine the intensity of neck pain in the last week, which is a valid sensitive scale (ICC = 0.88) [35]. The VAS consisted of a continuous line between two points (0 = no pain and 10 = maximum pain tolerable). VAS scores ≤ 3.4 were described as mild pain, 3.5–7.4 as moderate pain, and ≥ 7.5 as severe pain for patients with chronic musculoskeletal pain [36].

2.2.2 | Subjective and Objective Fatigue

To determine subjective fatigue, a visual analog scale (0–10) was utilized where 0 indicated no fatigue and 10 revealed severe fatigue. Before the intervention, at the end of 40 min of typing and after 6 weeks of intervention, after 40 min of typing, the fatigue intensity was measured using the visual analog scale.

Objective fatigue was evaluated at baseline and after 6 weeks of intervention. Participants were asked to perform a distracting task (typing) for 40 min. While typing, the participants were asked to bend their head to a 45-degree angle, as previous studies have shown this angle significantly affects fatigue [10]. A helmet equipped with a laser light and a goniometer was used to ensure the head was at a 45 -degree angle. A strip was then placed on the monitor screen at the laser light's location, with participants tasked to keep the light aligned with a 1 cm strip on the monitor's surface while seated in front of the computer (Figure 2). Participants were seated in a chair with their elbows and forearms comfortably resting on the chair handles, and their feet flat on the floor. They were instructed to pause typing every 5 min, during which the fatigue of the neck extensor, upper trapezius, and sternocleidomastoid muscles was recorded for 1 min. Fatigue levels were recorded eight times for each muscle using a surface electromyography device (Noraxon, Ultium TM wireless EMG system, Noraxon Inc. Scottsdale, AZ, USA). Muscle fatigue recordings were conducted after skin preparation and electrode placement following SENIAM recommendations. Data processing involved band-pass filtering to eliminate unwanted signals, with a focus on median frequency (MDF) analysis [10]. Each muscle had 8 MDF data points, with higher MDF scores indicates less fatigue.

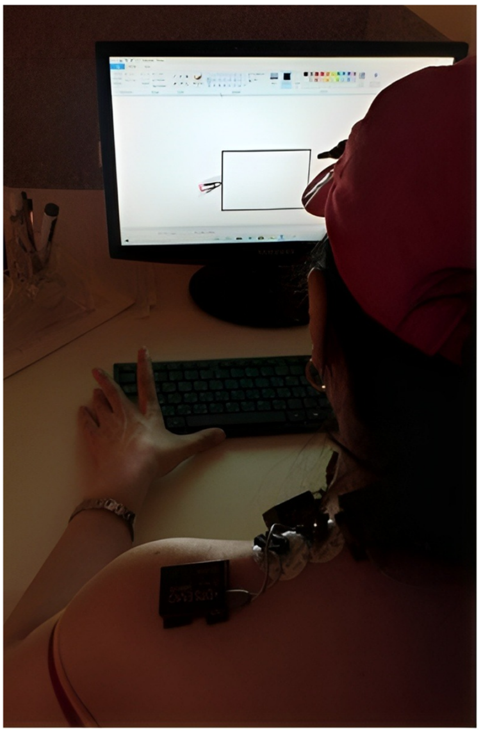

FIGURE 2 | Evaluation of neck muscle fatigue during the 40-min typing protocol.

2.3 | Study Interventions

2.3.1 | Tissue Release Exercises

The tissue release protocol involved the subject targeting the muscles in the neck and back for 6 weeks, with three sessions per week. The purpose of the tissue release technique was to reduce the excessive activity of the neuro-myofascial (NMF) tissue and prepare the muscles for other corrective movement techniques. Vertical pressure was applied to the soft tissues surrounding the neck spines, sternocleidomastoid muscle, splenius capitis, cervicals, levator scapula, and upper trapezius using a foam roller and tennis ball to inhibit adhesions and excessive activity of NMF tissues. Initially, a soft, thicker foam roller was used, followed by a harder one with a smaller diameter for self-myofascial release. The foam roller was placed in the middle of the back, and by applying body weight, it was rolled up and down. The harder foam roller increased pressure on soft tissue structures and accessed deeper layers of fascia. During the protocol, the subject moved the foam roller to the desired area for 30 s. Tennis balls were then introduced to further progress the exercise. A soft, larger diameter foam roller was used in weeks 1–2, a harder, smaller diameter foam roller in weeks 3–4, and tennis balls in weeks 5–6 [22, 23]. All NMF release exercises were performed against a wall or on the floor (Table 1).

2.3.2 | Stretching Exercises

Three sessions per week were implemented for 6 weeks, with each exercise session lasting 30 min. Initially, the subjects began by running on the treadmill for 10 min to warm up. The exercises were demonstrated to participants by the examiner in the correction exercise room at Razi University. The stretching routine included static stretches, focusing on the soft tissues around the neck, spines, sternocleidomastoid muscle, rhomboid, levator scapula, and upper trapezius muscles. The goal of the stretching exercises was to reach the first point of resistance, holding the stretch for 15 to 30 s once that point was reached. The duration of the stretching exercises increased from 15 s in the first week to 30 s in the final week (Table 2) [30].

2.4 | Data Analysis

Descriptive statistics of this study were reported based on mean and standard deviation. First, the Shapiro-Wilks test was used to check the normality of data distribution, and Levene's test was utilized to check the homogeneity of variances. A one-way ANOVA was applied to check the homogeneity of the subjects' demographic characteristics and pain intensity in the baseline after establishing the default assumptions of parametric statistics. Then, a paired *t*-test was used for within-group comparisons and a one-way ANCOVA test with baselines as a covariate was utilized to compare between-group averages. Bonferroni's post hoc test was applied to examine the difference between groups. The mixed model analysis of variance (3×8, group $\times$ time) was used to examine the differences between groups regarding the degree of fatigue of the neck muscles in the posttest.

TABLE 1 | NMF release exercise protocol.

Week	Exercise	Muscles	Period
NMF release with a foam roller (soft and bigger diameter). (Week 1–2)	Release of NMF tissue by the subject	Opener of dorsal vertebral column, sternocleidomastoid muscle, levator, upper trapezius	One set with five repetitions, hold for 30 s, rest for 20 s (gradually hold for 40 s)
NMF release with a foam roller (harder one with a smaller diameter) (Week 3–4)	Release of NMF tissue by the individual	Opener of dorsal vertebral column, sternocleidomastoid muscle, levator, upper trapezius	One set of five repetitions, hold for 30 s, rest for 20 s (gradually hold for 40 s)
NMF release with a tennis ball. (Week 5–6)	Release of NMF tissue by the subject	Opener of dorsal vertebral column, sternocleidomastoid muscle, levator, upper trapezius	One set of five repetitions, hold for 30 s, rest for 20 s (gradually hold for 40 s)

Abbreviation: NMF, neuromyofacial.

TABLE 2 | Stretching exercise protocol.

Week	Exercise	Involved muscles	Period
1–3	Seated and standing stretch	Levator scapulae upper trapezius and SCM muscles	One set with five reps, hold for 30 s, rest for 20 s (gradually increase the hold to 40 s)
	Seated segmental Cat/Caw	Rhomboid and trapezius muscles	One set with five reps, hold for 30 s, rest for 20 s (gradually increase the hold to 40 s)
4–6	Swan stretch	Pectoralis major	One set with five reps, hold for 30 s, rest for 20 s (gradually increase the hold to 40 s)
	Corner stretch	Pectoralis minor and major muscles	One set with five reps, hold for 30 s, rest for 20 s (gradually increase the hold to 40 s)
	Pectoral muscles stretch	biceps brachii	One set with five reps, hold for 30 s, rest for 20 s (gradually increase the hold to 40 s)

All the statistical analyses were performed in SPSS software version 22 at a significance level 0.05 and all the tests were considered two-sided.

2.5 | Ethical Approval Details

The Ethics Committee in Biological Research of Razi University approved the research process [IR.RAZI.REC.1400.045]. This investigation was conducted in agreement with the Declaration of Helsinki. All subjects signed a written consent forms and were free to withdraw from the study at any time they chose to.

3 | Results

This study was conducted to compare the effect of stretching and release strategies on pain intensity and fatigue in patients with ns-CNP. A total of 50 participants were invited to the study, of whom 45 met the inclusion criteria. Two participants in the traction group dropped out after 3 weeks due to excessive workload and busy schedules. Two participants in the control group also refused to participate in the posttest without giving any specific reason. In addition, two participants in the release group dropped out of the study due to family problems (having a small child) and missed the posttest. Consequently, 39 participants' data were analyzed. The results of the Shapiro-Wilk test confirmed the normality of the data distribution, and the effects of Levene's test verified the homogeneity of the data variance ($p > 0.05$). Table 3 presents the demographic characteristics of the subjects.

Within-group comparisons revealed that release exercises significantly improved the pain intensity ($p < 0.001$; $t12 = 8.83$). Stretching intervention significantly improved the pain ($p < 0.001$; $t12 = 6.50$) based on pairwise comparisons within the group, but no significant difference was observed in the control group ($p > 0.05$).

Between-group comparisons indicated a significant difference between the stretch-control ($p < 0.001$; mean difference = 3.07) and release-control ($p < 0.001$; mean difference = −3.48) groups by adjusting the baseline scores. Both experimental groups had a significant difference in the posttest compared to the control group in the pain factor after adjusting the baseline, but this difference and recovery were more effective in the release group (Figure 3).

The fatigue of the right and left cervical extensor muscles of all patients was assessed by 40 min of typing with a 45-degree flexion head. There was no significant difference between the participants of the three groups at eight time points in the baseline. Therefore, the muscular fatigue of 39 participants in the three groups was measured at eight time points during the baseline to determine when the 40 min of typing occurred in the baseline and before the intervention. In the baseline and

TABLE 3 | Demographic characteristics of the participants.

Groups	Number	Domin hand Right/left (frequency)	Age (years) Mean ± standard deviation	Weight (kg) Mean ± standard deviation	Height (cm) Mean ± standard deviation	Body mass index (Kg/m^2) Mean ± Standard deviation
Release	13	1.12	28.6 ± 4.32	69.62 ± 15.72	165.59 ± 6.55	21.56 ± 2.39
Stretching	13	0.13	28.61 ± 5.10	62.12 ± 10.84	158.65 ± 3.12	20.44 ± 3.03
Control	13	2.11	26.83 ± 4.78	52.18 ± 15.65	164.58 ± 5.29	23.56 ± 3.49
Sig.*		0.54	0.67	0.84	0.83	0.45

*Significance level ($p < 0.05$). The output of the one-way ANOVA test indicates that the groups had no significant difference in demographic characteristics in the baseline.

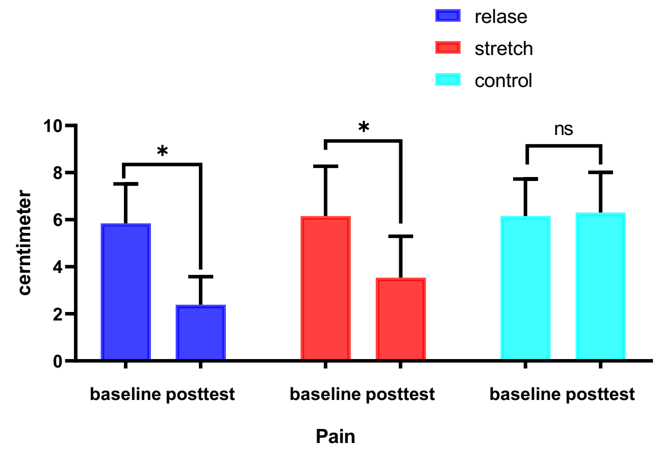

FIGURE 3 | Within-group comparison of perceived pain intensity in the posttest compared to the baseline.

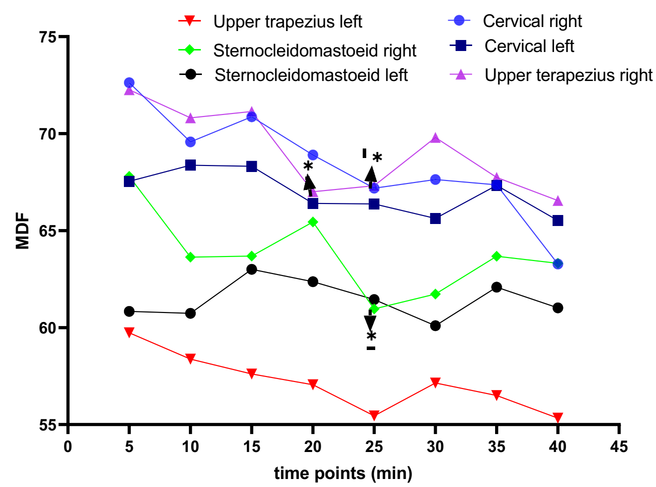

FIGURE 4 | Examining the fatigue course of the studied muscles among all the subjects, before applying all interventions.

before applying the interventions, repeated measures ANOVA showed that the average MDF (as a fatigue index) was significantly decreased in the right cervical muscle from the 25th minute ($p < 0.001$), in the right upper trapezius muscle from the 20th minute ($p = 0.04$), in the right sternocleidomastoid muscle from the 25th minute ($p = 0.02$). The patients experienced fatigue in the studied muscles (Figure 4).

Within-group comparisons revealed that release intervention significantly decreased the subjective fatigue intensity in both the release (t12 = 16.41, $p < 0.001$) and the stretching intervention (t12 = 12.28; $p < 0.001$). However, the differences were not significant in the control group ($p > 0.05$). There also was a significant difference between groups ($p < 0.001$; mean difference = 118.56, $\acute{\eta}^2 = 0.93$). Moreover, pairwise comparisons showed a significant difference between the stretch-control ($p < 0.001$, Mean difference = 4.67) and release-control ($p < 0.001$; mean difference = 5.77) groups by adjusting the baseline scores.

The objective fatigue mean between the groups was compared in the posttest, given the lack of significant difference between the fatigue levels in the studied muscles at eight time points in the baseline. The mixed analysis of variance (3 × 8, group × time) was used to examine the differences between groups regarding the degree of fatigue of the right cervical muscle in the posttest. The findings showed that the effect of time (F (7, 252) = 8.58; $p < 0.001$; $\eta^2 = 0.19$) and the interaction effect was significant (F (14, 252) = 2.50; $p = 0.01$; $\eta^2 = 0.12$). Based on the significance of the interaction effect, each group's effect of time and fatigue level was examined separately. No significant difference was observed in the release and stretching group between the 5-min intervals in the posttest ($p > 0.05$). However, in the control group, there was a significant difference between the fatigue level of the right cervical muscle after the test between the 5-min intervals ($p < 0.05$). There was a significant increase in fatigue after the 25th minute compared to the first 5 min, but no significant changes in the 30th or 35th minute. However, in the 40th minute, there was a significant increase in the intensity of fatigue ($p < 0.05$) (Table 4).

Differences between groups in left cervical muscle fatigue after the test revealed that the effect of time was not significant (F (7, 252) = 2.07; $p = 0.09$), but the interaction effect was significant (F (14, 252) = 2.83; $p = 0.007$; $\eta^2 = 0.13$). Therefore, time effects in each group and fatigue levels between groups were examined separately, taking into account the interaction effect.

Repeated measures ANOVA was used in repeated measures for different groups to check within-group differences in the posttest. There was a significant difference between the time intervals in the release group ($p < 0.001$), and the amount of fatigue significantly decreased between times 1 and 3 ($p = 0.005$), 1 and 5 ($p = 0.04$), and 1 and 8 ($p = 0.001$). No significant difference was observed between the 5-min intervals in the stretching group ($p > 0.05$). In addition, no significant difference was observed between the stretching and control groups in the amount of fatigue of the left cervical muscle after the test between the time intervals ($p > 0.05$) (Table 5).

The difference analysis between the eight time periods in the posttest was conducted separately in the groups, and the reduction of muscle fatigue was significant only in the release group between the time points between 5 and 15, 5 and 25, and 5 and 40 min.

Within-group differences to compare fatigue of the right upper trapezius muscle at eight time points showed no difference in all three groups regarding the right upper trapezius muscle ($p > 0.05$). Moreover, within-group differences in comparing left upper trapezius muscle fatigue at eight time points did not show any difference in all three groups ($p > 0.05$).

Moreover, within-group differences in comparing left upper trapezius muscle fatigue at eight time points did not show any difference in all three groups ($p > 0.05$).

Within-group differences comparing right and left sternocleidomastoid muscle fatigue at eight time points showed no difference in all three groups ($p > 0.05$).

One-way ANOVA was used, given the significance of the interaction effect, to examine the differences between groups in the posttest. The groups had a significant difference in the right cervical muscle at 30, 35, and 40 min, and the level of fatigue at 30 and 35 min was better in the release and stretching groups than in the control group, respectively. While the release group had the lowest level of fatigue, both stretching and release groups were significantly different from the control group in the 40th minute. The release group had a significant difference with the control at the 30th minute ($p = 0.05$), but the stretching and control groups did not differ ($p = 0.28$). There was a significant difference between the release group and the control group at the 35th minute ($p = 0.005$) but not between the stretching and control groups ($p = 0.06$). In the 40th minute, the release group had a significant difference with the control ($p < 0.001$), and the stretching and control groups had a significant difference ($p < 0.001$). However, there was no significant difference between the stretching and releasing groups, and no significant difference was found between the groups in the left cervical muscle ($p > 0.05$) (Table 6).

Comparing the averages regarding the upper trapezius muscle showed that the groups were significantly different only at the 40th time point (last 5 min) ($p < 0.05$). Based on Bonferroni's

TABLE 4 | Sidak's post hoc test to check within-group differences in fatigue the right cervical muscle.

		Release group ($n = 13$)		Stretching group ($n = 13$)		Control group ($n = 13$)	
Reference time[&]	**Time**	**Mean**	**SD**	**Mean**	**SD**	**Mean**	**SD**
Time 1	Time 2	71.76	11.98	67.58	8.44	69.37	11.79
	Time 3	69.15	11.70	75.54	14.94	67.89	9.59
	Time 4	69.32	12.68	67.70	5.24	69.66	11.11
	Time 5	68.61	12.72	65.07	12.32	67.86	9.23
	Time 6	67.26	13.30	68.47	9.61	67.16	10.23
	Time 7	69.14	15.75	65.47	10.05	67.49	11.75
	Time 8	66.05	11.17	64.97	14.52	58.80	11.61
Sig.[€]	—	0.13		0.43		> 0.001	
η^2	—	0.13		0.19		0.52	

[€]Significance level. The differences between time in different groups were insignificant in the posttest.
[&]MDF is a fatigue index, the increase of which indicates fatigue decrease; η^2: effect size.

TABLE 5 | Sidak's follow-up test for examining within-group differences in the fatigue of the left cervical extensor muscle.

Reference time[&]	Time	Release group ($n = 13$)		Stretching group ($n = 13$)		Control group ($n = 13$)	
		Mean	SD	Mean	SD	Mean	SD
Time 1	Time 2	69.90	86.19	66.26	5.70	72.00	19.88
	Time 3	73.17	41.19	70.66	9.42	69.68	15.60
	Time 4	70.53	97.16	70.40	9.74	68.04	15.88
	Time 5	74.22	44.18	67.97	7.84	67.90	15.41
	Time 6	73.46	82.17	66.52	3.38	66.68	14.28
	Time 7	73.75	45.17	70.61	4.56	69.00	18.46
	Time 8	79.83	46.19	71.15	8.57	66.73	17.67
Sig.[€]	—	< 0.001		0.37		0.28	
$\acute{\eta}^2$	—	0.37		0.08		0.10	

[€]Sig, significance level ($p < 0.05$).
[&]MDF is a fatigue index, the increase of which indicates fatigue decrease. $\acute{\eta}^2$: effect size.

TABLE 6 | One-way ANOVA to compare the fatigue averages of the groups in the posttest ($n = 39$).

Variables	Mean square	F	Sig.	$\acute{\eta}^2$
Pain (0–10)	48.35	45.72	< 0.001	0.73
Subjective fatigue (0–10)	118.56	243.53	< 0.001	0.93
Right cervical	483.89	3.27	Period 6: 0.04	0.33
	804.95	6.06	Period 7: 0.005	0.43
	1935.09	16.95	Period 8: < 0.001	0.62
Left cervical	—	—	> 0.05	—
Right SCM	632.52	3.81	Period 2: 0.03	0.35
	1136.19	4.04	Period 3: 0.02	0.36
Left SCM	1359.61	3.28	Period 8: 0.04	0.33
Right trapezius	1404.66	4.01	Period 8: 0.02	0.36
Left trapezius	—	—	> 0.05	—

Abbreviations: $\acute{\eta}^2$, effect size; Sig., significance level ($p < 0.05$); SCM, sternocleidomastoid.

post hoc test, this difference was significant only between the release and control groups ($p = 0.02$), but no significant difference was found in the left upper trapezius muscle between the groups ($p > 0.05$) (Figure 5).

Regarding the right sternocleidomastoid muscle, the groups differed significantly in the 10th and 15th minutes, superior to the stretching group. There was a significant difference between the stretching and control groups at minutes 10 ($p = 0.02$) and 15 ($p = 0.02$), but the release group did not show a significant difference with the control ($p > 0.05$) (Table 6). Regarding the left sternocleidomastoid muscle, the groups had a significant difference only in the last 5 min (35 to 40 min) ($p < 0.05$), and the difference was only between the release group and the control group ($p = 0.05$) (Fig. 5).

4 | Discussion

The rising incidence of noncommunicable diseases and the aging population present significant public health challenges that will necessitate modifications to national healthcare systems. This situation also creates an opportunity for organizational health to be incorporated into these evolving systems. A novel paradigm of organizational health, which prioritizes health and well-being both in the workplace and the community to enhance individuals' employability, raises important inquiries regarding the future structure and capabilities of the organizational health workforce. Addressing these inquiries will require strategic workforce planning and the advancement of human resources [5]. Case studies in some countries have shown that office workers are at risk of eye problems. For example, Ranasinghe et al. found that Sri Lankan computer workers had a high prevalence of computer vision syndrome. Female gender, longer job duration, more daily computer use, pre-existing eye diseases, not using visual display terminal filters, wearing contact lenses and higher ergonomic knowledge were all significantly associated with the presence of computer vision syndrome [37]. Job stress is also one of the concerns of office workers that over the past few decades, more and more research has documented that job stress is associated with a moderately elevated risk of adverse health outcomes, especially cardiovascular-related adverse effects [38]. Musculoskeletal disorders is the most problems in office workers that caused by

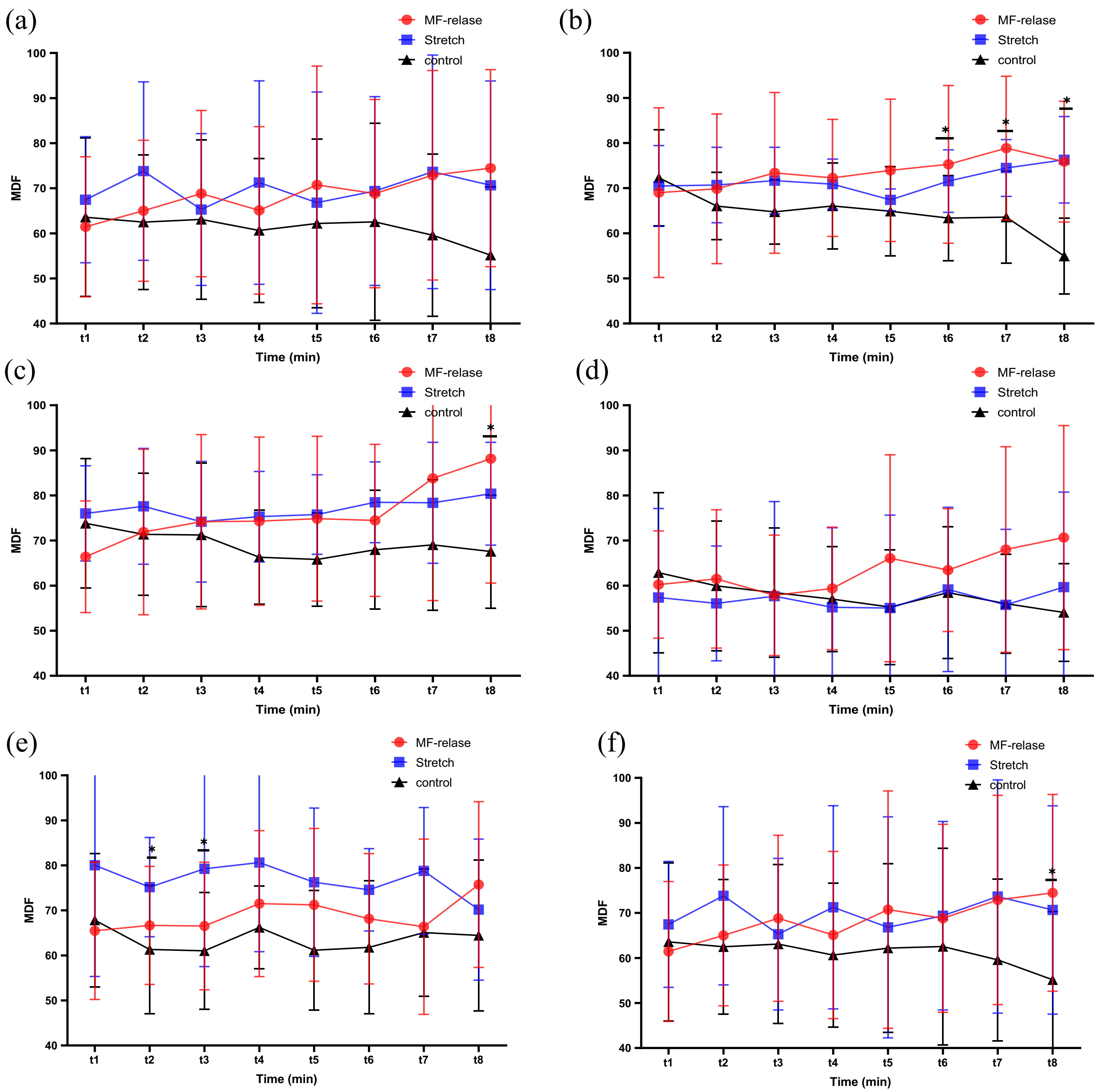

FIGURE 5 | (a) The level of fatigue of the left cervical extensor muscle during 40 min in the posttest and its study between the three groups of release, stretching, and control. (b) The level of fatigue of the right cervical extensor muscle during 40 min in the posttest and its study between the three groups of release, stretching, and control. (c) Comparison of MDF of right upper trapezius muscle between three groups at eight time points. (d) Comparison of MDF of the left upper trapezius muscle between the three groups at eight time points. (e) Comparison of MDF of right sternocleidomastoid muscle between three groups at eight time points. (f) Comparison of MDF of left sternocleidomastoid muscle between three groups at eight time points.

prolonged sitting, and also is a risk factor for cardiovascular diseases [39]. Among them, ns-CNP is very common, even preventing employees from continuing their work.

The perceived pain intensity of employees with ns-CNP decreased significantly after 6 weeks of stretching and releasing interventions. There was no significant difference between the two groups in reducing pain intensity in the posttest, but both intervention and control groups significantly differed in pain improvement. Patho mechanical problems are often identified in the etiology of ns-CNP and contribute to compensatory conditions. The most common compensatory condition in the sagittal plane is a forward head posture. Non-adjustment of the head to the vertical axis can aggravate the cervical spine, and narrowed intervertebral holes may allow nerve roots to get stuck. In addition, anatomical and arthrokinematics changes change the neck joints and offer conditions for uncontrolled movements and small blows causing pain [10]. Based on evidence, the fatigue of the neck and shoulder muscles may negatively affect the sense of proprioception in the neck area. Some researchers believe the lack of joint proprioception can cause pain and injury through poor movement control. The sense of proprioception in a closed loop between mechanical and environmental receptors and the central nervous system significantly maintains the stability of joints in different situations [35, 40]. Kashyap et al. showed that manual pressure release, the muscle energy technique are equally effective for reducing pain and muscle tenderness and for improving neck disability and range of rotation in patients with nonspecific neck pain [30]. Kim et al. studied the effect of the active release technique on pain and range of motion in patients with ns-CNP. According to this study, the active release technique was effective for treating soft tissues, such as nerve and myofascial tendons, for repetitive and functional injuries caused by adopting abnormal body positions. The active release technique also had a significant effect on pain, spasms, tissue adhesion, and increased range of motion. Antagonist muscles should be relaxed to allow the movement of the joint to reach the desired degree of motion in a joint [41]. The tension of the muscles around the joint is more than the optimal tension required in case of pain. Therefore, the muscle is sensitive to stretching and does not allow reaching the maximum range of motion [25]. Release exercises reduce pain, release muscles from tension, and allow more movement in the joint [42, 43]. Cabrera-Martos et al. explored the effects of an active intervention based on myofascial release and neurodynamic in patients with ns-CNP. In this study, a 4-week self-management program for patients with ns-CNP effectively reduced trigger points, and the pain intensity and other functional aspects improved significantly after the intervention [44].

Muscle release exercises probably can reduce muscle stiffness by breaking tissue adhesions in response to micro soft tissue injuries. Fascia attaches to muscle and other surrounding structures to restrict movement when injured, reducing flexibility, muscle spasms, neuromuscular changes, and pain. Physically, increasing muscle stiffness is associated with increasing discomfort and pain, and people exposed to long periods of sitting suffer from musculoskeletal pain [45]. Therefore, this group of release exercises can significantly affect this group of people, which probably includes tissue stimulation strategies using concentrated pressure and rolling massage using dense foam. Rolling massage using a foam roller reduces muscle stiffness, and its self-use makes work more accessible for the working population who do not have the opportunity to participate in physical therapy courses [21]. Myofascial pain syndrome is one of the causes of muscle stiffness and pain, leading to shortness, stiffness, and dysfunction of the muscle-tendon system. Recent studies have evaluated the relationship between ns-CNP and myofascial syndrome. According to Duncan, myofascial release techniques for 90 to 120 s released the restricted fascial tissue and increased the flexibility of the fascia. The effects of myofascial release techniques for massage and soft tissue mobilization techniques changed blood circulation, expansion of capillaries, stimulation of the nervous system, changes in skin temperature, and changes in metabolism. Therefore, the extensibility and flexibility of soft tissue, muscle relaxation, spasm reduction, and analgesic effects were increased [46].

Stretching exercises were another effective intervention as a rest strategy for reducing the perceived pain level of employees suffering from ns-CNP. Stretching exercises reduce stress on the neck area and increase the available range of motion. Strengthening the deep muscles of the head and neck, increasing the length, and reducing the tone of the upper trapezius muscle after exercises are among the reasons for expanding the range of motion in the present study. Based on the previous study, stretching exercise improves vascular endothelial function and preferable circulation in patients with myofascial infarction [47]. The reduction in pain following static stretch could be due to the inhibitory effects of the Golgi tendon organs, reducing motoneuron discharges and causing relaxation of the muscle-tendon unit by readjustment. Tunwattanapong et al. evaluated the effect of neck and shoulder muscle stretching exercises on the severity of neck pain in employees with ns-CNP. According to this study, a regular stretching program for 4 weeks could reduce neck and shoulder pain and muscle stiffness, increase flexibility, and improve neck function and the quality of life of participants [48]. The effect of corrective exercises on the pain and quality of life of nurses with hyper kyphosis and slouching significantly improved the variables mentioned above [49]. Based on previous research, regular stretching exercises can improve neck and shoulder pain and neck function and reduce fatigue in administrative employees [48]. Kostopoulos et al., Ziaeifar et al., and Weerapong et al. examined the effect of passive stretching exercises on the trigger points of the upper trapezius muscle and reported that stretching exercises reduced pain and improved the electrical activity of the muscle [28, 50, 51]. Kumari compared the effectiveness of isometric neck strengthening exercises versus static stretching alone in managing ns-CNP. Isometric strengthening exercises with static stretching seemed to be more valuable compared to static stretching exercises alone, which reduced pain and disability and increased range of motion in ns-CNP patients [27]. Hakkinen et al. studied the effect of stretching exercises alone with a combination of stretching and strength exercises in the long term on pain, isometric muscle strength, and range of motion in 101 patients with ns-CNP. In this study, even low-intensity strengthening and stretching exercises with stretching in the long term could positively affect ns-CNP [43].

The stretching and release intervention significantly reduced fatigue in the neck muscles of study sample. It is likely that compensatory kyphosis and decreased thoracic space during neck flexion and poor posture are associated with impaired lung function and consequently ischemia and hypoxia and in the absence of adequate oxygen supply, anaerobic muscle metabolism occurs with the inevitable accumulation of lactate in the muscle. These factors ultimately led to fatigue in the neck muscles. This accumulation leads to temporary discomfort in the muscle tissue. In addition, the accumulation of lactate reduces ATP production, which accelerates fatigue. These physiological changes were reflected in changes in the electrical activity of the muscles [52]. Upper extensor muscles of the neck get fatigued sooner and are under more pressure due to continuous and excessive activity to serve align the eyes [53]. More extensor torque is required to counter the bending torque of the neck in the sitting position, which can lead to muscle fatigue, transfer of imposed loads to the cervical spine, and nonspecific chronic neck pain by imposing double loads on the extensor muscles. Stekelenburg et al. also showed that 2 h deformation, inevitably combined with partial ischemia, caused highly localized regions of irreversible muscle damage [54]. The intervention of tissue release by mechanical stimulation of trigger points, followed by increased blood circulation around the trigger points, causes mechanical destruction of the endplate. A dysfunctional endplate causes the contraction of associated muscle fibers by continuously releasing acetylcholine and creating trigger points. The pain caused by destroying these items is reduced due to fiber contraction [55]. Stretching exercises also increase muscle length, decrease muscle tone, increase joint range of motion, and improve neuromuscular function by affecting the deep muscles of the head and neck [28, 51].

The release program was more effective than the two programs based on stretching and release to reduce pain and fatigue. The effects claimed for myofascial release techniques are similar to those for massage. Release may work by releasing endorphins and controlling nerve valves, reducing ischemia by increasing local blood circulation, and creating relaxation in skeletal muscle by stimulating the sympathetic system, which relaxes the muscles, eliminate trigger points, and reduces pain [56]. Improving blood flow and oxygen supply and delivering more food to muscle cells are other reasons for reducing fatigue in subjects. Larsson et al. reported that the blood flow in the trapezius muscle on the painful side is less during contraction in patients with ns-CNP [57]. Other studies have indicated that resistance and endurance exercises increase blood vessels inside the trapezius muscle, reduce pain, and increase muscle strength, which in turn causes fatigue to be reduced and delayed [58].

It seems that using simple tools, such as a foam roller or massage balls, along with rest reminder programs or stretching exercises for the upper limbs prone to fatigue from computer use in the workplace as a break-schedule program, can be beneficial. These methods can help break myofascial adhesions and release trigger points that cause chronic neck pain. This approach may provide long-term relief for office workers experiencing chronic neck pain.

The present study provides evidence of the effects of NMF release and soft tissue stretching programs on the neck pain intensity and neck muscles fatigue of office workers affected by ns-CNP. However, this study has several limitations. First, the lack of a kinematic analysis device for neck and spine posture during the participants' typing time. Second, the small number of samples, which should be increased in future studies, will increase the statistical power of the tests and improve the generalizability. Third, the absence of the male in the participants of current study due to legal restrictions in Islamic countries and the inability to generalize the results to the male gender. One of the other limitations in this study was the control group that did not receive any placebo or alternative activity, so we cannot confidently say the observed changes are not due to participants motivation or increased attention from researchers. Therefore, control of this limitation in the future study is recommended. Moreover, the current study's authors didn't examine the benefits of combining soft tissue stretching and release strategies in the study participants, so we recommend that students study the combination of soft tissue stretching and release in future studies.

5 | Conclusion

The findings of the current study showed that stretching and release interventions after 6 weeks caused a significant reduction in perceived pain intensity in employees with ns-CNP. Therefore, stretching and release interventions can be effective and low-cost in controlling pain in employees with chronic neck pain. Regarding neck muscle fatigue, it was also found that before the interventions, fatigue occurred in some neck muscles from the 20th minute. However, after 6 weeks of interventions, the release and stretching groups did not experience fatigue during 40 min of activity, while the control group still experienced muscle fatigue from the 25th minute. There was no significant difference between the intervention group in reducing pain intensity at the posttest. Still, the intervention and control groups significantly differed in reducing pain intensity. Therefore, it can be concluded that applying stretching and release interventions for 6 weeks can inhibit the occurrence of fatigue in the neck control muscles for at least 40 min, and the person will not experience fatigue and subsequent neck pain.

Author Contributions

Sinaz Niazi: conceptualization, investigation, methodology, writing – original draft. **Farzaneh Gandomi:** conceptualization, methodology, software, supervision, writing – review and editing. **Parviz Soufivand:** methodology, formal analysis, supervision, writing – review and editing. **Leila Ghazaleh:** writing – review and editing, methodology, formal analysis, data curation.

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Conflicts of Interest

The authors declare no conflicts of interest.

Data Availability Statement

The data presented in this study are available on request from the corresponding author.

Transparency Statement

The lead author Farzaneh Gandomi affirms that this manuscript is an honest, accurate, and transparent account of the study being reported; that no important aspects of the study have been omitted; and that any discrepancies from the study as planned (and, if relevant, registered) have been explained.

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