Comparing the Effect of Two Exercise Protocols, Dynamic Neuromuscular Stability and Stabilization, on Pain, Disability, and Tolerance of Deep Neck Flexor Muscles in Employees with Non-Specific Chronic Neck Pain

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Abstract

Introduction: Chronic non-specific neck pain is one of the most common musculoskeletal disorders in modern society and is considered a cause of disability in many jobs, especially in office workers. **Materials and Methods:** In this study, 36 female office worker with mean±SD age of 39.20±4.29 years, mean ± SD weight of 70.60±12.37 kg and mean±SD height of 163.15±6.23 cm were randomly divided into three groups: 1. Dynamic neuromuscular stability exercises 2. Stabilization Exercises and 3. Control group. Stabilization exercises with emphasis on the effect on deep neck muscles dynamic neuromuscular stability exercises with emphasis on the effect on cervical thoracic and lumbar pelvic chain coordination were performed for six weeks (3 sessions per week). Visual Analog Scale and disability questionnaire were used to measure the pain and disability of the subjects, respectively, and to measure muscle tolerance, two methods of assessing activation score and deep neck flexor muscle performance index were used by compression biofeedback device. Finally, data analysis was performed using SPSS software (version 22) at the significance level of P=0.05. **Results:** The one-way ANOVA test results showed a significant difference between the three groups in all variables (P<0.05). The Turkey post hoc test results showed no significant difference between the pain score and disability of the dynamic neuromuscular stability exercises and stabilization exercise groups (P>0.05). On the other hand, the results showed that after six weeks of training, there was no significant difference between muscle activation score and muscle performance index in the control and stabilization exercise groups (P>0.05). **Conclusion:** Both training protocols had a significant effect on reducing pain and disability. However, dynamic neuromuscular stability and stabilization exercises substantially increased the tolerance of deep neck flexor muscles compared with the stabilization exercises group. It can also be a better approach to treat non-specific chronic neck pain.

Keywords: Disability; Dynamic neuromuscular stability exercises; Neck pain; Stabilization exercises

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Introduction

Neck pain is one of the most common musculoskeletal disorders in modern society and is considered the second most common musculoskeletal disorder and an important cause of disability (1, 2). This can cause severe disability in 5% of patients. Chronic non-specific neck pain is a condition that lasts more than three months and has not been mentioned for any specific reason (3). This pain is often indicated by discomfort between the lower edge of the occipital bone and the first vertebrae of the chest (4). Among jobs, there is a higher prevalence of neck pain among office workers. 42%-69% of office workers reporting at least one case of neck pain within 12 months (5). The results of some studies suggested that neck pain reduces employees' work productivity, increases absenteeism in the workplace, and ultimately leads to substantial economic losses (6).

In addition, it can be said that bending the trunk and head forward increases the mechanical burden on the muscles of postural maintenance and tension of postural stabilizing muscle. On the other hand, the burden of pressure on the neck joints eventually can lead to an increased risk of neck pain (7). The neck muscles play an important role in the normal mobility and stability of cervical vertebrae and may also be a source of pain. Recently the role of muscles in maintaining and sustaining the spine has become more prominent (1). In fact, the stability of the cervical spine is provided by a series of deep flexor muscles of the neck, and many studies have pointed to reduced strength and tolerance of flexor muscles in patients with non-specific chronic neck pain (8). In this context, Noah *et al.* reported that muscle fatigue caused by holding the head forward or repetitive abnormal movements can cause neck pain (9). According to the Punjabi mode, approximately 80% of the stability of the spine is due to muscle activity, but in patients with neck pain, coordination between the deep and superficial flexor muscles of the neck is impaired, so that the electrical activity of the anterior Scalene and Sternocleidomastoid muscles increases as superficial flexors and the electrical activity of the longus Colli and longus Capitis muscles as deep neck flexors decreases (10).

Considering the pain and problems of non-specific chronic neck pain and the lack of a definite treatment for this pathology, and regarding the side effects of drugs in the long term, many physicians have turned to sports interventions. There are various noninvasive therapeutic interventions for patients with chronic nonspecific neck pain. Some have also introduced a multidisciplinary approach. The most common non-invasive physical therapy treatments are: exercise interventions, hydrotherapy, electrotherapy, and manual therapy (11). The first factor considered in noninvasive and non-pharmacological treatment of chronic neck pain patients is the reduction of pain intensity and disability in these patients, because according to the findings of the studies, pain factors can affect many other factors including joint proprioception, muscle strength, function, quality of life, social communication, and emotional relationships (12). In line with the Punjabi mode, spine stabilization exercises by activating deep muscles and organizing superficial muscle over activity have become popular for treating and preventing musculoskeletal disorders of the vertebrae. On the other hand, some researchers have introduced these exercises as effective exercises for improving strength, endurance, and coordination of spinal stabilizing muscles in people with neck pain (13).

While stabilization exercises indeed play a crucial role in strengthening the core and improving overall posture, they may not have a significant impact on the vertical alignment and coordination of the cervical thoracic lumbar pelvic chain movements. This is because the central chain in the neck area is closely connected with the thoracic lumbar pelvic chain, providing a stable foundation for the cervical vertebrae and their corresponding movements (14). Jul *et al.* (15) reported that lumbo-pelvic chain instability inactivates deep stabilizers such as the longus Colli and longus Capitis muscles and overa ctivates superficial muscles such as the anterior scalene. Finally, this instability in the lumbo-pelvic chain often leads to a forward head posture with increased chest bulge and craniocervical arch, which are also involved in musculoskeletal injuries of other cervical thoracic spine, ribs, and shoulders (16).

Dynamic neuromuscular stability (DNS) training is a novel exercise approach that addresses the limitations of traditional stabilization exercises. It focuses on neck thoracic and lumbo pelvic chain coordination for better body balance and stability. DNS is non-invasive, rehabilitative, and based on developmental kinesiology principles. This science states that human motor function development in early childhood is genetically determined and follows a predictable pattern connected to the growth of the central nervous system. The DNS system activates multiple muscle groups for whole-spine stability and coordination, thereby benefiting various aspects of daily life and physical activities (17). Therefore, this study aimed to evaluate the effectiveness of DNS and stabilization exercises in alleviating pain, improving function, and enhancing the endurance of deep neck flexor muscles in office workers experiencing non-specific chronic neck pain. This is an important area of research because of the high prevalence of neck and shoulder issues among individuals working in office settings and the lack of a definitive treatment protocol for this population. By implementing DNS and stabilization exercises, researchers hope to provide a potential solution to these common issues.

Materials and Methods

This research involves a clinical trial, specifically a pretest–posttest experiment with parallel groups, conducted in the rehabilitation lab of a university between November 22, 2020, and June 10, 2021. This study was undertaken with ethical approval code of IR. RAZI. REC.1399.032 from University,

Participants

The participants of this study were female office workers who were suffering from chronic neck pain. After recall in various departments, eligible people were enrolled in the study. To be match, all office workers were non-athletes and used computers during office hours (between 4 and 8 hours in a day). Inclusion criteria included as: age range of 59–30 years, persistent neck pain for more than 3 months, using a computer for at least 4 hours per day, obtaining a minimum score of

Table 1. Neck stability training protocol in 6 weeks

Resistance Training	Repeated in the week	Number of repetitions	Repeat Time	Rest between repetitions	Rest between moves	Total Time
Resistance of head in forward and sideways bending and turning left and right using elastic rope						
China Tuck in position sitting on Swiss Ball Wing and simultaneously flexing 90 to 120 degree shoulders and continuing to lift the opposite leg	3 days a week	3 times	15	30 second	60 second	30-40 minute
High Catch Ball Swiss Ball and China Vine						

three on the visual Analog Scale (VAS), and disability index of at least 5 weeks before pre-tests and based on research references. Exclusion criteria were as: factors affecting age (menopause), history of neurological or mental illness, fibromyalgia, spinal surgery, heart disease or hypertension, neck arthritis, cervical vertebral disk herniation, and spinal stenosis in this area, pregnancy, and the use of physiotherapy or drug interventions during the past 3 months.

To estimate the number of samples required for the study, 3.1G*power software (made in Germany) was used. Pain score is the primary outcome of this study, according to which the effect size of pain has been extracted in previous studies and estimated to be 25%. In addition, the statistical potency of 90% and alpha level was considered 0.05 (17), so software suggested 12 patients for each group, which with a 5% probability of loss, 15% in each group was considered. To randomly assign the subjects to the intervention and control groups, allocation software was used randomly. Numbers 1 to 45 are given by someone outside the research team in 3 groups, group 1. Neck stabilization exercise group (n=15) 2. DNS training group (n=15) and 3. The control group (n=15) was randomly assigned, and each number was assigned to one person. After the evaluation, the assessor delivered a sealed envelope with the group name and conducted the evaluations without any conflict. The groups did not receive information about the existence of a parallel group.

Outcome measures

Pain

The VAS scale was used to measure pain in the neck. The scale was a 10-cm ruler, with zero points indicating the absence of pain and 10 indicating maximum pain. We asked the subject to report the extent of their pain while using the computer for a long time at a point on the ruler. The reliability of this test has been acceptable in previous studies (ICC=0.74) (18).

Disability

The Neck Disability Index (NDI) questionnaire is a valuable tool for assessing neck-related issues, including pain, Activity of Daily Livings (ADLs), and concentration. Consisting of ten sections rated from 0 to 5, it helps healthcare professionals monitor patients' status and treatment progress. Scores indicate disability levels, with lower scores indicating non-disability and higher scores suggesting complete disability. NDI has acceptable reliability, aiding in treatment adjustments for improved patient quality of life (ICC=0.81) (19).

Measurement of the activation score and function index of deep neck flexor muscles

The Biofeedback Presher Model (2009 DJLLC) is a method to assess the activation score and functional index of the deep neck muscles. It involves a comfortable posture with bent knees and a normal cervical spine, with a device cuff placed under the neck and at the occipital bone area (initial 20 mm Hg). The subject performs a craniocervical flexion test, increasing pressure by 2 mm Hg each time, holding it for 10 s, resting for 30 s, and continuing until 30 mm Hg. The examiner monitors the superficial neck muscles while minimizing their activity. The function is determined by the highest pressure maintained for 10 s, and the functional index is the maximum repetition of the test, representing isometric endurance. The method has high reliability (ICC=0.91)(20, 21).

Interventions

Neck Stabilization Exercises Protocol

At the beginning of the training sessions, after the general warm-up for 10 min, stabilization exercises were performed for 30-40 min without causing fatigue, and finally, the subjects cooled down for 5 min (22) (Table 1).

Stabilization exercises

The depiction of stabilizing activities is shown in Figure 1.

Dynamic Neuromuscular Stabilization Exercise Protocol

These exercises were performed at different levels along with dumbbells armbands and balls in all motor plates and with the progress of training sessions for 6 weeks (3 sessions per week

Figure 1. A) Resistance of head in forward and sideways bending and turning left and right using elastic rope; B) China Tuck in position sitting on Swiss Ball Wing and simultaneously flexing 90 to 120 degree shoulders and continuing to lift the opposite leg; C) Control the Swiss ball with the back of the head and forehead and continue shoulder abduction up to 90 degrees with elastic elastic.

for 50 minutes). The exercise protocol includes a warm-up (5 minutes), DNS (40 minutes) and cooling (5 minutes). DNS training according to the reference of each session was different from the previous session (23).

DNS exercises

The depiction of DNS exercises is shown in Figure 2.

Statistical Analysis

This study employed both descriptive and inferential statistics for data analysis. The mean and standard deviation were calculated using descriptive statistics. The Shapiro– Wilk test was used to check the normality of the data distribution. If the data were normal, one-way ANOVA was performed on the pre-test and post-test data analyzing. If significant, Tukey's post hoc test was used to identify the location of the differences. Additionally, paired t-tests were conducted using SPSS software version 22 at a significance level of $P<0.05$ to investigate the differences between the pre-test and post-test within each group.

Results

In the descriptive findings of the study, the mean and standard deviation of the demographic characteristics of the participants are presented in Table 2.

The results of The Shapiro– Wilk test showed that data had normal distribution ($P> 0.05$).

The results of the mean changes in each group after the intervention are presented in Table 2. The results indicated that the amount of pain, disability, and performance index improved in both exercise groups, and this difference was significant compared with that before the start of the exercise. However, the activation score only changed in the DNS group, and in the control and stabilization groups, this difference was not significant.

In this study, Tukey's post hoc test revealed some significant differences between the control, stability training, and DNS training groups in terms of pain and disability, deep neck muscle activation, and deep neck muscle function index after 6 weeks of intervention.

Figure 2. Dynamic neuromuscular stability exercises: DiaphragmBreathing Exercises, Baby Rock, Prone, Rolling, Oblique sit, kneeling, squat, Tripod

Table 2. Mean (SD) of demographic characteristics of research subjects

Variable	SE exercise	DNS exercise	control
Age (year)	40.3 (58.7)	37.8 (83.6)	33.12 (1.62)
Height (cm)	163.4 (91.4)	160.4 (33.5)	162.6 (83.3)
Weight (kg)	69.16 (9.9)	71.08 (7.25)	71.33 (16.6)
Pain duration (year)	4.08 (3.3)	4.42 (4.31)	3.42 (3.4)
Disability index	15.92 (5.21)	15.01 (5.36)	16.02 (10.6)
Work with computer(hour)	5.83 (2.62)	7.42 (3.11)	6.5 (3.14)

For pain and disability, there was a significant difference between the control group and both the stability training and DNS training groups (P=0.00). However, there was no significant difference between the two training groups.

Regarding deep neck muscle activation, there was a significant difference between the DNS group and the stabilization training group (P=0.026) and the control group (P=0.002). However, there was no significant difference between the activation scores of the stabilization training and control groups (P=0.586). In terms of the deep neck muscle function index, there was a significant difference between the DNS group and the control group and stability training group (P=0.000). However, there was no significant difference between the deep muscle function index of the two training groups (P=0.168). In summary, this study highlights the importance of DNS training in improving pain, disability, and deep neck muscle activation, whereas stabilization training appears to have less impact. However, more research is needed to understand the differences in the deep neck muscle function index between the two training groups (Tables 3, 4, 5).

Discussion

This study aimed to evaluate the effectiveness of two dynamic neuromuscular stabilization and stabilization protocols in alleviating pain and disability and enhancing the endurance of deep neck flexor muscles in office workers with non-specific chronic neck pain. After 6 weeks of training, both treatment groups experienced a significant reduction in pain and disability levels. There was no noticeable difference between the two intervention groups, and the control group showed no significant improvement. Based on the results of present study it's suggested that both methods were effective in reducing pain and disability in patients with chronic nonspecific neck pain, and exercises played a significant role in this process.

The findings of present study is align with the study results of Mazidi *et al.* (24), Falla *et al.* (25), Javedaneh *et al.* (8) as they all demonstrate that stabilization exercises effectively alleviate pain and disability in individuals with neck issues. Falla *et al.* (25) also highlighted that people experiencing neck pain often struggle with

Table 3. Mean (SD) of correlated t-test results to compare

variable		Pre test	Post test	t	*P*-value
pain	Stabilization exercise	6.1 (16.74)	2.1 (25.3)	12.52	0.00*
	Dynamic neuromuscular stability training	5.1 (50.8)	1.1 (91.6)	7.40	0.00*
	Control	5.1 (25.8)	4.2 (83.3)	0.624	0.45
Deep neck muscle activation score	Stabilization exercise	7.1 (50.93)	7.1 (83.8)	-0.616	0.55
	Dynamic neuromuscular stability training	5.3 (33.8)	1 (8.9)	-0.473	0.001*
	Control	5.2 (33.3)	3 (5.13)	0.804	0.43
Function index of deep neck muscles	Stabilization exercise	18.12 (50.47)	26.18 (16.01)	-3.72	0.003*
	Dynamic neuromuscular stability training	6 (9.95)	29.1 (33.35)	-10.02	0.000*
	Control	6.4 (66.11)	9.7 (33.7)	-1.66	0.124
Disability	Stabilization exercise	15.92 (5.21)	10.5 (6.23)	4.50	0.001*
	Dynamic neuromuscular stability training	15 (5.36)	7.58 (4.68)	6.51	0.000*
	Control	16 (10.65)	17.5 (10.4)	-1.64	0.129

(*) significant difference after six weeks of training intervention compared to before training; significant level (P≥0.05)

Table 4. One-way analysis of variance test results

variable		F	*P*-value
pain	Stabilization exercise Dynamic neuromuscular stability training Control	14.38	0.000*
Deep neck muscle activation score	Stabilization exercise Dynamic neuromuscular stability training Control	7.45	0.002*
Function index of deep neck muscles	Stabilization exercise Dynamic neuromuscular stability training Control	22.8	0.000*
Disability	Stabilization exercise Dynamic neuromuscular stability training Control	18.24	0.000*

(*) significant difference after six weeks of training intervention compared to before training; significant level (P≥0.05)

Table 5. Tukey's post hoc test to track the difference between groups

Group F			*P*-value
pain	Stabilization exercise	control	0.000*
	Dynamic neuromuscular stability training	control	0.000*
	Stabilization exercise	Dynamic neuromuscular stability training	0.889
Deep neck muscle activation score	Stabilization exercise	control	0.586
	Dynamic neuromuscular stability training	control	0.002*
	Stabilization exercise	Dynamic neuromuscular stability training	0.026*
Function index of deep neck muscles	Stabilization exercise	control	0.000*
	Dynamic neuromuscular stability training	control	0.000*
	Stabilization exercise	Dynamic neuromuscular stability training	0.168
Disability	Stabilization exercise	control	0.417
	Dynamic neuromuscular stability training	control	0.000*
	Stabilization exercise	Dynamic neuromuscular stability training	0.000*

(*) significant difference after six weeks of training intervention compared to before training; significant level (P≥0.05)

maintaining and stabilizing their head position. Post exercise therapy, they observed improvements in muscle strength, endurance, and the ability to maintain a proper head and neck posture, which in turn reduces pressure on the neck (8, 24, 26, 27).

Exercise therapy is crucial in preventing musculoskeletal issues because it fortifies muscles, improves resistance against movement, and boosts blood flow to muscle cells, providing them with vital oxygen and nutrients. By incorporating stabilization exercises and maintaining proper head and neck alignment, we can alleviate discomfort and lower risk of exacerbating neck pain. The pain relief experienced by the participants in our study could be attributed to increased blood supply, leading to more oxygen and nutrients for muscle cells.

In addition, other factors contributing to reduced pain and disability include decreased efferent gamma nerve activity, reduced muscle excitability, stimulation of alpha fibers, and regulation of muscle tone (28). Stabilizing exercises play a crucial role in activating the deep neck muscles, which contain numerous spindles. These exercises can enhance spindle performance and improve proprioception. Proprioceptive receptors in the neck muscles are vital for maintaining proper head and neck positioning by shaping motor signals in the brain. Stabilizing exercises have been linked to reduce neck pain, possibly due to improved proprioception and better coordination between the surface and deep muscles (29). However, research on DNS training is limited, so direct comparisons with other studies are scarce. Indirect comparisons can be made with studies examining the effects of this training method on other variables.

The study by Davidek *et al*. (16) demonstrated that DNS exercises significantly enhance the performance and well-being of kayak athletes. These exercises improve muscle coordination and core trunk stability, resulting in a reduction in pain and an increase in arm strength. Chronic pain often results from reduced muscle endurance, which causes premature fatigue and increased pressure on the spine. By incorporating DNS training, including optimal muscle involvement and diaphragm breathing exercises, athletes can improve their muscular endurance, maintain trunk stability, and prevent premature fatigue. Consequently, this approach helps to reduce pain and promote overall athletic performance.

These studies highlight the significant role of core stability exercises in improving muscle endurance, reducing pain, and enhancing overall performance for individuals, particularly athletes. By focusing on DNS training and diaphragm breathing exercises, one can effectively strengthen trunk muscles, maintain proper spinal alignment, and prevent premature fatigue (26). This, in turn, reduces stress on the muscles and alleviate pain. The consistency between Davidek *et al*.'s (16) study on kayak athletes and Emami *et al*.'s study on individuals with back pain suggests that core stability exercises can be beneficial for a wide range of people, contributing to a healthier and more pain-free lifestyle (30).

In summary, both studies highlight the benefits of DNS exercises in improving overall performance and reducing pain in athletes. The first study by Davidek *et al*. (16) demonstrated how these exercises can enhance core trunk stability and arm strength in kayak athletes, reducing pain caused by reduced muscle endurance. The second study focused on the activation of deep neck flexor muscles, showing that DNS training leads to a significant increase in activation scores compared with other training methods. These findings emphasize the importance of incorporating DNS exercises into training programs to promote better athletic performance and minimize pain-related issues.

The other variable of the performance index increased after 6 weeks in both exercise groups, but in the control group, there was no difference after 6 weeks. In addition, despite the difference in the stability group after 6 weeks of training, there was a significant difference between the DNS group and the stability and control group, which indicates the effectiveness of the DNS group.

Few studies have investigated the effect of therapy on the activation score and function index of the deep neck flexor muscles in patients with non-specific chronic neck pain, and studies in this area have mostly been performed by electromyography or measuring strength and endurance, which is aimed to investigate the performance and fatigue of the deep neck flexor muscles and considering the relationship between fatigue and endurance. We'll pay. Many studies have reported a decrease in the strength and endurance of the neck flexor and opener muscles in people with neck pain. In two separate studies, fatigue of the sterno-claido-mastoid and anterior screen muscles during fixed contraction with 25% and 50% MVC was evaluated in two groups of neck pain and healthy subjects in which subjects were placed in a supine position and performed neck flexion with 25% and 50% MVC for 15 and 20 s, respectively. The electromyography signals, as the slope of the mean frequency curve, indicate fatigue. In fact, comparing fatigue due to contraction in both neck pain and healthy groups showed a greater increase in fatigue in patients with chronic neck pain, which can be attributed to reduced tolerance of flexor muscles in these patients.

DNS training has been introduced as an exercise that emphasizes the overall coordination of the neck–thoracic and lumbo–pelvic chains. It is also considered a non-invasive and rehabilitation method for optimizing the human movement system based on the scientific principles of developmental kinesiology. In fact, these scientific principles suggest that the development of human motor function at an early age is genetically predetermined and follows a predictable pattern, which is considered to be the development of the central nervous system and occurs automatically in a particular growth sequence during the development of the central nervous system. On the other hand, DNS training on the flexor and neck extensor muscles has been more effective and has increased the endurance time of the extensor muscles compared with the flexor muscles. Our study also showed that by increasing the performance and activity of the stabilizing muscles, the level of endurance of these muscles increased with stabilizing exercises, and due to the increase in muscle endurance in the stabilizing exercise group, pain reduction and increased ability level in patients occurred. Finally, it helps to regulate the coordination of spinal muscle groups, especially the neck, so that these muscles can be fully synchronized, at the right time, with the right combination of forces.

In this study, Asgari-Ashtiani (27) investigated the effect of stabilization exercises and maximum isometric exercises on the tolerance of deep flexor muscles. He found a significant increase in the endurance of deep flexion muscles after training in both training groups, which was consistent with our results. In another study, Patroncini (31) evaluated the activation score and function index of the deep neck flexor muscles in subjects with chronic low back pain, in which subjects with low back pain had a significantly lower activation score and the function index of the deep neck flexor muscles was significantly lower than that of healthy subjects, indicating lower tolerance of the deep neck muscles in subjects with low back pain. Several studies have reported that strength training and endurance training for 12 months were effective methods to reduce pain and disability in women with chronic neck pain only in nonspecific lateral extension and flexion, which was not consistent with our results of stabilizing exercises (32, 33). The reason for not changing the activation score of neck flexion muscles is the short-term 6-week perio, as in Hockkinen and Hakkinen. Colleagues report that if the exercise is performed at low intensity, it takes at least 12 months for the exercise to affect the factors affecting neck pain (34).

Note that in this study, we only evaluated the flexor muscles and did not examine the neck extensor muscles. Considering that strength has been reported in people with low neck pain, it may be that the reason for the failure to improve the function of deep flexor muscles is pain-induced reflex inhibition (10), and it is likely that patients after neck pain recovery following exercises continue to be involved with some pain and have not fully recovered and when power is produced in this test with some pain. Muscle strength is strongly influenced by neuromuscular coordination, and deep flexor muscles are no exception. The DNS training program is based on the involvement of the central nervous system and growth and development, which thus improves sensory-motor pathways and increases neuromuscular coordination, thereby having a positive effect on muscle strength. In addition, these exercises improve muscle endurance by using basic movement patterns and optimal muscle involvement, and respiratory exercises improve trunk stability (29). These results agreed with the results of Dehghani *et al.*, (26) who examined the strength and endurance of trunk muscles after 6 weeks of DNS training. Due to the limited amount of information on the activation score and function index of deep flexor muscles as well as the exercises performed in this study, there was no further discussion of this issue. In order to improve muscle strength and endurance and postural individual, strengthening the muscles individually cannot be a basic step in treatment and prevention. Therefore, DNS training improves trunk strength and endurance by facilitating the activity of nerve cells, neuromuscular coordination, and spinal integration.

Conclusion

This study examined the impact of two DNS protocols on neck pain, disability, and deep neck flexor muscle endurance among office workers with non-specific chronic neck pain. Both training methods proved effective in reducing pain and disability. However, DNS training showed a more significant improvement in deep neck flexor muscle endurance compared with the stability training group. This suggests that DNS training is a better approach for treating non-specific chronic neck pain. The study's limitations include a small sample size and lack of gender diversification.

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Authors' contributions
All authors contributed equally to the preparation of this manuscript.

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