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The effect of scapular muscles training using a suspension system in patients with non-specific chronic neck pain and scapular dyskinesia: a randomized clinical trial

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Authors’ Contribution: A – Study design; B – Data collection; C – Statistical analysis; D – Manuscript Preparation; E – Funds Collection

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How to Cite

Abstract

Purpose: Non-specific chronic neck pain (NSCNP) is a major health problem. Scapular dyskinesia is one of the contributing factors to NSCNP. The suspension-type of exercise is a relatively new method used in rehabilitation of scapular dysfunction. The purpose of this pretest post-test randomized clinical trial was to study the effects of scapular muscles training using a prefabricated suspension system on improving pain, function, scapular muscle strength, and scapular position in subjects with non-specific chronic neck pain and scapular dyskinesia.

Materials and methods: This was a quasi-experimental two groups pre-post test clinical trial performed at an outpatient clinic. Fifty-two patients diagnosed with NSCNP, and scapular dyskinesia participated in this study. Their mean age was 24.46± 5.32 years. They were randomized to receive either stretching exercises and manual scapular resistance (group A) or stretching exercises and scapular training using a prefabricated suspension system (group B). Researchers measured pain intensity using the numeric pain rating scale (NPRS), function using the neck disability index (NDI), scapular muscle strength using a handheld dynamometer, and scapular stability using the lateral scapular slide test (LSST). Twelve sessions were given to the individuals over a period of six weeks, and pre- and post-intervention outcome measures were evaluated.

Results: Mann-Whitney test demonstrated no statistically significant difference between the two groups after the intervention in terms of pain relief, functional improvement, or scapular stability (p>0.05). On the other hand, there was a statistically significant difference between groups in favor of group B who received suspension-type exercise regarding improvement in scapular muscle strength (p<0.05).

Conclusion: While superiority of one intervention cannot be concluded due to lack of a control group, using suspension type of exercise can be beneficial in improving the scapular muscle strength as compared to traditional exercise therapy, while both methods have similar effect on pain, function, and scapular stability in patients with NSCNP and scapular dyskinesia.

Keywords: chronic neck pain, scapular dyskinesia, suspension system
Мета: неспецифический хронический бед при NSCNP — серьезная проблема для здоровья. Дископатия — один из факторов, которые ведут к NSCNP. Относительно нового метода реабилитации при дископатии — инновационный подход, предлагаемый в настоящем исследовании. Мета этого рандомизированного клинического исследования — изучить влияние тренировки лопаточных мышц с использованием подвески на улучшение боли, функции и стабильности лопатки.

Резюме: Это было квази-экспериментальное клиническое исследование с двумя группами. Изучалось влияние метода подвешивания на улучшение боли, функции и стабильности лопатки. Было проведено двенадцать сеансов в течение шести недель, и были оценены показатели до и после вмешательства. Критерий Манна-Уитни не показал статистически значимой разницы между двумя группами после вмешательства в отношении обезболивания, функционального улучшения или стабильности лопатки (p>0,05). С другой стороны, было продемонстрировано статистически значимое улучшение боли у пациентов с NSCNP и дископатией в группе подвешивания, в то время как оба метода имели одинаковое влияние на боль.

Ключевые слова: хроническая боль в шее, дископатия, подвесная система,

Аннотация

Эльсадат С. Солиман, Нурхан Хаттаб, Мохамед Абдельмегид, Эман Камель. Эффект тренировки лопаточных мышц с помощью подвесной системы у пациентов с неспецифической хронической болью в шее и лопаточной дископатией: рандомизированное клиническое исследование

Цель: Не специфическая хроническая боль в шее (НХБШ) представляет собой серьезную проблему для здоровья. Дископатия является одним из факторов, способствующих NSCNP. Упражнения — относительно новый метод, применяемый в реабилитации дискфункции лопатки. Цель этого рандомизированного клинического исследования — изучить влияние тренировки лопаточных мышц с использованием подвесной системы на улучшение боли, функции и стабильность лопатки.

Материалы и методы: Это было квазиэкспериментальное клиническое исследование с двумя группами до и после тестирования, проведенное в амбулаторной клинике. В этом исследовании приняли участие 52 пациента с диагнозом NSCNP и дископатией. Их средний возраст составил 24,46±5,32 года. Они были рандомизированы для выполнения либо упражнений на растяжку и ручного сопротивления лопатки (группа А), либо тренировки лопаток с использованием подвесной системы (группа В). Исследователи измерили интенсивность боли с помощью числовой шкалы оценки боли (NPRS), функцию с помощью индекса инвалидности шеи (NDI), силу м'язів лопатки за допомогою ручного динамометра и стабильность лопатки за допомогою тесту бічного ковзання лопатки (LSST).

Результаты. Тест Манна-Уитни не показал статистически значимой разницы между двумя группами после вмешательства на короткий промежуток времени (p<0,05). Вместе с тем было продемонстрировано статистически значимое улучшение боли у пациентов с NSCNP и дископатией в группе подвешивания, в то время как оба метода имеют одинаковое влияние на боль, функцию и стабильность лопатки у пациентов с NSCNP и дископатией.

Ключевые слова: хроническая боль в шее, дископатия, подвесная система,
Introduction

Chronic neck pain affects between 10.4% and 21.3% of office and computer workers, making it one of the most prevalent disorders that physical therapists treat [1]. Pain in the neck is defined as coming from an area that is bordered superiorly by the nuchal line, laterally by the lateral edges of the neck, and inferiorly by an imagined transverse line passing through the T1 spinous process [2]. It frequently has a significant impact on daily living and necessitates the utilization of several healthcare resources [3].

Neck pain can have a significant impact on one's quality of life. It could lead to significant medical expenses, time away from work, and incapacity [3]. The non-surgical approaches to treat persistent neck pain seem to be the most advantageous for patients [4].

Neck pain is a multifactorial in etiology, meaning that there is no single element that causes it; rather, a number of factors interact to do so, with pain acting as a symptom of each [5]. Numerous risk factors can increase the likelihood of neck pain; some of these risk factors are variable that cannot be changed, such as age, gender, and heredity [6]. Numerous structures, including the bone, discs, ligaments, joints, muscles, and fascia—all of which are innervated by nociceptors or pain fibers—can cause neck discomfort [7].

Scapular dysfunction is one of the causes that might cause neck pain [8]. The shoulder complex and cervical spine are significantly impacted by a number of multi-jointed muscles, including the levator scapula, trapezius, pectorals major and minor, and rhomboids. The length and strength of these scapular stabilizers can alter how the neck rests [9]. Patients who had experienced neck discomfort for more than a year exhibited poor scapular position on the side of their necks that was giving them pain [10].

The soft tissue component, particularly the cervical soft tissue, is crucial to the spine's stability. Extremely significant is the part that muscles play in keeping the spine stable. Furthermore, it has been demonstrated that muscular spasms are the body's attempt to stabilize a potentially unsteady spine [11]. To support the cervical spine and shoulder girdle, which is effectively treating neck pain, reeducation of the scapular girdle-supporting muscles, such as the middle, lower trapezius, and serratus anterior, should be carried out [12]. Scapular function training has been shown by Kamonseki et al [13] to lessen neck pain sufferers' pain thresholds.

The cervical spine directly affects the stability of the scapula and the stabilizer muscles. It was discovered that inadequate scapular stabilization would put too much strain on the cervical spine [14]. Stabilization procedures are meant to increase the proximal muscle groups' strength and stability in response to altering stresses [15].

When compared to performing the identical exercise on a stable surface, employing a suspension system for scapular training enhances the activation of the scapular muscles [16]. Muscles are triggered by the unstable base of support since the patient is suspended from the handles of the straps by their hands or feet while the other set of extremities are in touch with the ground. One or more straps are connected to one or more anchor points to make up the suspension system. [17]. There is a gap in literature regarding the use of suspension-type exercises in patients with NSCNP and scapular dyskinesia. Therefore, the purpose of this study was to study the effects of scapular muscles training using a suspension system and stretching exercise on improving pain, function, muscle strength, and scapular position in patients with NSCNP and scapular dyskinesia.

Materials and methods

Study design, setting, and ethics in research.

This pre-posttest investigation involved two groups and a prospective quasi-experiment. We were unable to hide the intervention from the participants or the researchers due to the intervention's nature. However, the two experimental groups were chosen at random from among the participants. Consequently, we used a quasi-experimental design. The study was conducted at the outpatient clinic of Mnouf general hospital, Mnoufa, Egypt. It received approval from Cairo University's Faculty of Physical Therapy's institutional review board (approval number: P.T.REC/012/00403), approval date September 11th, 2022, and was registered on clinicaltrials.gov (registration number: NCT05894304). The investigations included in the study were carried out in compliance with the ethical guidelines set forth in the 1975 Helsinki Declaration, and participants gave their informed consent before any data was collected.
Participants

Fifty-two male and female patients were randomized to receive either manual scapular resistance (group A, n=26) or scapular training using a prefabricated suspension system (group B, n=26). Both groups received stretching exercises for neck muscles in addition to their assigned treatment. Subjects between the ages of 18 and 35 who have non-specific chronic neck pain that has been localized to the cervical and periscapular areas for at least three months and who also have scapular dyskinesia met the inclusion criteria.

Subjects were excluded if they have history of previous neck surgery, recent or old fractures, Cognitive impairment and inability to understand the scale, systematic inflammatory disease e.g., rheumatoid arthritis and ankylosing spondylitis, neck pain with radiculopathy or neuropathy, and scapular dyskinesia due to other pathology such as shoulder impingement.

Sample size calculation and reporting of the clinical trial

To detect an effect size of Cohen’s d= 0.80 with 80% power (alpha= 0.05), G*power software (version 3.1.9.7) suggested we needed 52 participants (26 in each group) in an independent sample t-test. A flow diagram according to the Consolidated Standards of Reporting Trials statement is presented in figure 1 to illustrate the progression of this clinical trial [18].

Assessment procedure

After giving their agreement, subjects were checked to see if they were qualified to take part. Then, their demographic information was gathered. Following clearance, the individual was asked to report a number to represent the degree of pain severity on a scale from 0 to 10, where 10 represents the most severe pain [19].

The neck disability index (NDI) was used to assess the subjects' functional state. A popular self-reported outcome measure for evaluating functional limits in neck pain patients is the NDI. It comprises 10 items, each of which must be answered on a 0–5 Likert scale. With a maximum raw score of 50, a higher score indicates a more severe disability. The NDI has well-established psychometric features in the literature [20]. For each NDI item, subjects were instructed to select the response that most accurately reflected their condition. After that, scores were added up, and the final score was determined.
The subject was then assessed for scapular strength using a handheld dynamometer. For the lower trapezius muscle test, the patient lay on his stomach with his arm in a 150-degree scaption and his thumb was pointing up. On the postero-lateral corner of the acromion, the dynamometer was mounted. And the examiner stabilized the hip on the opposing side while emulating the subject's force. The movement of the scapula was depression and adduction [21].

During the serratus anterior muscle test, the patient lay on his stomach with his arm in a 150-degree scaption and his thumb was pointing up. On the postero-lateral corner of the acromion, the dynamometer was mounted. And the examiner stabilized the hip on the opposing side while emulating the subject's force. The movement of the scapula was depression and adduction [21].

For the middle trapezius muscle test, the patient lay on his back with his arm 90 degrees abducted and his elbow 90 degrees flexed. On the postero-lateral acromion corner, the dynamometer was set up. He was told to "squeeze your shoulder blades together" in order to retract his scapula. While emulating the patient's force, the examiner stabilized the opposing scapula [21].

The patient was positioned in a seated position with his arms at his sides for the upper trapezius muscle test. Over the largest portion of the muscle, the dynamometer was positioned midway between the lateral acromion and mastoid, and the patient asked to push the dynamometer up [21]. All strength assessment is shown in figure 2.

For the assessment of scapular stability, the investigators proceeded with determining how far the scapular inferior angle to the corresponding spinous process for both right and left scapula the lateral scapular slide test (LSST) is performed in three postures. The arms were in resting position with both arms at side, arms on his hip with shoulder abducted 45 degree and internally rotated, and shoulder abducted 90 and full internally rotated (figure 3) [22].

Fig. 2. Scapular strength assessment. A: lower trapezius, B: serratus anterior, C: middle trapezius, D: upper trapezius
Intervention

Subjects in group A received the manual scapular resistance two sessions per week for six weeks e. The following three exercises were performed according to Ekstrom et al [23]: (1) Resisted scapular protraction, (2) resisted scapular retraction with shoulder external rotation, and (3) weighted scapula retraction and downward rotation Y-shape.

Before starting the exercises, the patient was given instructions on how to perform the three exercises, and visual aids with detailed exercise instructions were also supplied, along with a compliance log. Each of the exercises was completed by all individuals bilaterally for three sets of ten repetitions, with a minute of rest in between sets.

Subjects in group B received scapular training using a prefabricated suspension system therapy two sessions per week for six weeks. The following four exercises were performed (1) kneeling scapular protraction, (2) supine scapular retraction, (3) sitting scapular depression, (4) supine row (figure 4).

Before starting the exercises, the individual was given directions on how to perform the four exercises, and a compliance diary in addition to a picture with detailed exercise instructions was given. With sixty seconds of rest in between each set, each exercise was completed by each participant three times for a total of ten repetitions.

Statistical analysis

The statistical package for social sciences (SPSS) computer program for Windows, version 27 (IBM SPSS Inc., Chicago, IL, USA), was used to analyze the data. For continuous data, descriptive statistics were expressed as mean standard deviation, and for categorical variables, as frequency distribution (%). Using the Shapiro-Walking statistical test, the data's normality was evaluated. The Mann-Whitney test was used to compare the two groups' discomfort, function, muscle strength, and scapular stability before and after the intervention. The 0.05 alpha level was chosen.
Results

The Shapiro-Wilk test revealed a mixture of normally and non-normally distributed variables (table 1) with non-normally distributed variables predominate. Therefore, after visual examination of the histograms and QQ plots, it was decided that non-parametric tests were more appropriate.

Table 2 displays demographic information and the difference between the two groups at baseline (pre-intervention). The mean age, body mass index, and all other examined variables for the subjects did not significantly differ between the two groups ($p>0.05$). The sex distribution amongst the groups did differ significantly ($p = 0.003$).

With the exception of scapular muscle strength, all variables examined post-measurement showed no significant difference between the two groups, even though there was a significant difference within group for both groups from pre to post intervention (table 3 and figure 5).

Fig. 4. Scapular training using a prefabricated suspension system. A: kneeling scapular protraction, B: supine scapular retraction, C: sitting scapular depression, D: supine row
Test of normality using Shapiro walking test

<table>
<thead>
<tr>
<th>Variables</th>
<th>Shapiro-wilk value in exercise group</th>
<th>Shapiro-wilk value in suspension group</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age (years)</td>
<td>0.811**</td>
<td>0.867**</td>
</tr>
<tr>
<td>Gender</td>
<td>-</td>
<td>0.524**</td>
</tr>
<tr>
<td>Body mass index</td>
<td>0.847**</td>
<td>0.922*</td>
</tr>
<tr>
<td>Pain (points)</td>
<td>0.848**</td>
<td>0.754**</td>
</tr>
<tr>
<td>Neck disability index (points)</td>
<td>0.850**</td>
<td>0.843**</td>
</tr>
<tr>
<td>Upper trapezius strength (N)</td>
<td>0.941</td>
<td>912*</td>
</tr>
<tr>
<td>Serratus anterior strength (N)</td>
<td>0.880**</td>
<td>0.956</td>
</tr>
<tr>
<td>Middle trapezius strength (N)</td>
<td>0.880**</td>
<td>0.933</td>
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<tr>
<td>Lower trapezius strength (N)</td>
<td>0.871**</td>
<td>0.956</td>
</tr>
<tr>
<td>Scapular stability test position 3- arms abducted to 90 degrees (cm)</td>
<td>0.783**</td>
<td>0.806**</td>
</tr>
<tr>
<td>Scapular stability test position 2- arms at hips (cm)</td>
<td>0.915*</td>
<td>0.910*</td>
</tr>
<tr>
<td>Scapular stability test position 1- arms at the sides (cm)</td>
<td>0.896*</td>
<td>0.878**</td>
</tr>
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*Significance at p-value 0.05
**significance at p-value 0.01
Abbreviations: † N: Newton, ‡ cm: centimeter

Subjects’ demographics and difference between both groups at baseline (pre-intervention)

<table>
<thead>
<tr>
<th>Indicators</th>
<th>Exercise group (n=26)</th>
<th>Suspension group (n=26)</th>
<th>Mann-Whitney U test value</th>
<th>p-value</th>
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<tr>
<td>Mean rank</td>
<td>Mean rank</td>
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<td></td>
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<tr>
<td>Age (years)</td>
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<tr>
<td>Pain (points)</td>
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<tr>
<td>Neck disability index (points)</td>
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<tr>
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<td>0.818</td>
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<tr>
<td>Middle trapezius strength (N)‡</td>
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<td>26.02</td>
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<td>0.818</td>
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<tr>
<td>Lower trapezius strength (N)‡</td>
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<td>25.90</td>
<td>322</td>
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<td>Scapular stability test position 3- arms abducted to 90 degrees (cm) ‡</td>
<td>25.67</td>
<td>27.33</td>
<td>316</td>
<td>0.666</td>
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<tr>
<td>Scapular stability test position 2- arms at hips (cm) ‡</td>
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<td>27.00</td>
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<td>Chi square=9.1</td>
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Abbreviations: † N: Newton, ‡ cm: centimeter
### Table 3

<table>
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<tr>
<th>Indicators</th>
<th>Exercise group (n=26)</th>
<th>Suspension group (n=26)</th>
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<th>p-value</th>
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<tr>
<td></td>
<td>Mean rank</td>
<td>Mean rank</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pain (points)</td>
<td>24.96</td>
<td>28.04</td>
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<td>0.437</td>
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<tr>
<td>Neck disability index (points)</td>
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<td>4.5</td>
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<td>38.69</td>
<td>21</td>
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<td>26.63</td>
<td>26.37</td>
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<td>Scapular stability test position 2- arms at hips (cm) ¥</td>
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<td>24.88</td>
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<td>Scapular stability test position 1- arms at the sides (cm) ¥</td>
<td>25.1</td>
<td>27.9</td>
<td>301.5</td>
<td>0.494</td>
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</table>

Abbreviations: § N: Newton, ¥ cm: centimeter

### Abbreviation
- NDI: neck disability index
- U trap: upper trapezius
- M trap: middle trapezius
- L trap: lower trapezius
- LSST 3: Scapular stability test position 3- arms abducted to 90 degrees
- LSST 2: Scapular stability test position 2- arms at hips
- LSST 1: Scapular stability test position 1- arms at the sides
- ¥ (N): Newton
- € (cm): centimeter

### Fig. 5
Comparison between the two groups post-intervention
The study goal was to compare a prefabricated suspension system exercise to traditional exercise therapy in treatment of NSCNP and scapular dyskinesia. Patients in both groups had significant changes in outcomes, there was a great reduction in pain intensity, an improvement in functional deficits, an increase in scapular muscle strength, and improvement in scapular stability in both groups.

Clinical improvements in pain, function, muscle strength and scapular stability were seen in our patients, marginally favoring the suspension exercise group despite the fact that post-treatment assessments did not reveal a statistically significant difference between the two groups. This offers minimal evidence for the therapeutic application of suspension system exercise, even in the absence of statistical significance. May be due to the intervention’s brief duration, there was no statistically significant difference between the two groups. The result might have been different if the intervention period had been longer than six weeks [24].

The current study’s findings are consistent with those of previous study by Dannelly et al [25] who discovered that sling training activities increased upper body strength. This study’s findings on increased muscular strength are likely the result of training-induced brain changes. The increase in muscle strength in this group is probably the product of neural adaptations that were generated over the period of six weeks, as suspension training predominantly includes neuromuscular training. Strength frequently depends not just on muscle mass but also on the neurological system [26].

In addition, in congruent with our study, other studies support the use of suspension system as a good device used in improving pain in different cases [27]. You et al [28] divided the individuals randomly into a sling group and control group to examine the benefits of six weeks of sling exercise training on pain, disability, and muscular strength for clients with LBP. The findings demonstrated that the sling group, but not the control group, saw a substantial improvement in pain, impairment level, and muscle strength. Furthermore, Park et al [29] discovered that in female patients with neck discomfort, sling-based thoracic physical exercise has been demonstrated to be beneficial in lowering pain, restoring function, and boosting quality of life.

In addition, Minoonejad et al [30] studied how sling training affected an athlete with scapular dyskinesia’s functional stability, proprioception, and strength of their shoulder muscles. By dividing patients into sling group and control group; the findings suggest that sling training can help in treating conditions brought on by scapular dyskinesia and increase the scapula’s functional stability.

In contrast to our findings, Lee et al [31] compared the activation of the upper trap, lower trap and serratus anterior in patients with scapular dyskinesia during push up exercise with and without sling. The findings suggested that upper trap activity was significantly higher in sling training which is not favorable in dyskinesia patients. We think this did not happen with our patients as they performed different sling training targeting the other scapular stabilizers beside the push up exercise using sling in addition to stretching exercise.

As a consequence of our research, we found no discernible differences between the exercise group and the suspension group regarding pain intensity, NDI and scapular stability tests, but there was significance difference between suspension and exercise group in muscle strength. Results showed that the suspension system had more significant muscle strength than the exercise group. This may be attributed to those performing exercises using suspension system increases muscle activation compared to same exercises performed on stable surface [32]. In addition, lack of control group makes it harder to be certain that the insignificant difference that exists between the two groups is due to both interventions is similar or because of other variables.

The result of Özdemir et al [33] supports the finding of our study. They looked at how well scapular stabilization exercises helped individuals with persistent neck discomfort and scapular dyskinesia. The findings demonstrated that adding scapular stabilization to regular physiotherapy is a successful way to reduce discomfort and improve functional status. Similarly, Andersen et al. [34] concluded that the training group that received random scapular training experienced less discomfort than the control group. Furthermore, Chuachan et al [35] discovered that scapular exercise for six weeks might reduce pain and the neck disability index score while increasing scapular muscle strength.

In randomized controlled research by Yildiz et al [36], patients were allocated at random to one of two groups; the intervention group received neck-focused exercise and scapular stabilization exercise, whereas the control group received neck-
focused exercise only, in order to examine the effects of cervical and scapular stabilization exercise on non-specific neck pain. Although there was no obvious difference in scapular kinematics between the intervention and control groups after 6 weeks of training, both groups’ VAS and NDI ratings had dramatically improved. We think that these findings are due to their patients had non-specific chronic neck pain without scapular dyskinesia. We believe that the improvement in our study may be due to scapular dyskinesia is the main contributing factor of pain in our patients. Despite the fact that there are many studies in the literature looking at how scapular stabilization exercises and scapular-thoracic muscle training affect patients’ quality of life and scapular dyskinesia or chronic neck pain, there are still few studies looking at these effects on functional status. As a result, we think that our research may add to the body of knowledge in this field.

Conclusions

Based on the result and considering the limitations, using suspension-based exercise therapy is beneficial in improving the scapular muscle strength as compared to the traditional exercise therapy, while both methods have similar effect on pain, function, and scapular stability in patients with NSCNP and scapular dyskinesia.

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Conflict of interest

The authors declare that they have no competing interests.

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