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Effect of Dynamic Neuromuscular Stabilization Breathing Exercises on Respiratory Function of Sedentary Students with Poor Posture

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ABSTRACT

Aims Dynamic neuromuscular stabilization approach, as functional mechanisms, evaluate and activate the local spinal stabilizers to optimize the performance of posture and respiratory for both prevention and rehabilitation. But the outcomes of this approach remain unclear. So the aim of this study was to evaluate the change in respiratory function in response to DNS breathing exercises in sedentary students with poor posture.
Materials & Methods This experimental study was carried out on 26 poor posture sedentary male students that were selected by purposive sampling method. First, a pretest of the respiratory function including Maximum voluntary ventilation (MVV), Forced expiratory volume in first second (FEV1), Forced vital capacity (FVC), and FEV1/FVC ratio were done for each participant. DNS breathing exercise protocol was trained for 6 weeks (6 sessions per a week) and after completion of training, post-test was performed from all parameters. The statistical analysis was performed by SPSS 16 software and paired-sample T test.
Findings After 6 weeks, significant improvements were observed compared to baseline in spirometry parameters including MVV, FEV1, FVC, and FEV1/FVC ratio ($p<0.001$).
Conclusion DNS breathing exercise is an effective protocol to improve respiratory function.

Keywords Dynamic Neuromuscular Stabilization; Breathing Exercise; Respiratory Function

CITATION LINKS

[1] The current problem of school children-lack of ... [2] Risk factors of postural defects in children ... [3] The impact of deep muscle training on the quality of ... [4] Faulty posture and selected ... [5] Effects of back and respiratory muscle exercises on posture ... [6] Breathing pattern disorders and ... [7] Respiratory weakness in patients with chronic neck ... [8] Effect of different upright sitting postures on spinal-pelvic ... [9] Mechanism of the increased rib cage expansion ... [10] Assessment and treatment of muscle imbalance: the Janda ... [11] Postural activity of the diaphragm is reduced in humans ... [12] Stabilizing function of the diaphragm: dynamic MRI ... [13] The effect of lumbar stabilization exercise on the pulmonary ... [14] Relation of faulty respiration to posture, with clinical ... [15] Exercise programme for schoolgirl with poor ... [16] Investigation of associations between recurrence of major depressive ... [17] Development of a screening protocol to identify individuals with ... [18] Reliability and validity of the Tegner and Marx activity rating scales in Iranian ... [19] Standardisation of ... [20] Postural-locomotion function in the diagnosis and treatment of movement ... [21] Effects of dynamic neuromuscular stabilization on lumbar flexion kinematics and ... [22] Dynamic neuromuscular stabilization & sports ... [23] Developmental kinesiology: three levels of motor control in the ... [24] Effects of shoulder girdle dynamic stabilization exercise on ... [25] Effect of Raja Yoga meditation on pulmonary functions of young ... [26] Methods for assessing responsiveness: a critical review ... [27] Spinal stiffness changes throughout the respiratory ... [28] Motor control exercises of the lumbar-pelvic region improve respiratory ... [29] Pulmonary function of Indian athletes and sportsmen: comparison ... [30] Statistical power analysis for the behavioral ... [31] Effect of 12 weeks of slow breathing exercise practice on ... [32] Changes in pulmonary function and peak oxygen consumption in response to interval aerobic ... [33] Acute effects of deep breathing for a short duration (2-10 minutes) on pulmonary functions in healthy ... [34] Testing procedures for abdominal muscles using the muscle ... [35] Effect of short term 'Pranayam' practice on breathing rate and ventilatory functions of ... [36] Effects of respiratory-muscle exercise on spinal ... [37] Mechanics of the respiratory ... [38] Combined effects of pranayama and suryanamaskar on dynamic spirometric ... [39] Role of regular yoga practice in improvement of various ... [40] Motor control: translating research into clinical ...

Introduction

The contemporary sedentary lifestyle leads to increased functional disorders of the musculoskeletal system and poor posture[1]. Since the posture describes the mechanical impact of the sense of movement, as well as the balance and coordination of the musculoskeletal system[2], any blemish in the alignment can alter the function of numerous segments or specific organs as well[3]. So that even localized and temporary postural defects also have a significant influence on spirometry parameters[4].

Researchers reported that thoracic hyper kyphosis and malalignment of the chest significantly impaired the mechanics of the respiratory system, dwindle lung volumes[5], and alter the motor control strategy[6]. Additionally, respiratory malfunction that results from movement impairment of the rib cage and thoracic alignment[5], affects the mechanical efficiency of the respiratory muscles. Consequently, reduces the activation of these muscles especially the capability of diaphragm force generation[5]. Dimitriadis *et al*. reported that weakness of the flexor and extensor neck muscles and the upper back extensor muscles have negative effects on the inspiratory capability[7].

Recently, due to non-ergonomic working and studying conditions, sedentary lifestyles, and emotional and nervous tension in contemporary modern life and strongly linked with spinal impairment[8], having plans for the prevention of spinal alignment and respiratory function disorders should be regarded. Therefore, recognizing factors and actions to improve diaphragmatic efficiency is crucial. Several studies have shown the relationship between the diaphragm and intercostal muscle activity with respiratory and postural function[9]. Numerous researchers believe that correct posture is an imperative requirement for normal respiratory function[4].

The ideal spinal and rib alignment into training can be integrated and proper respiratory stereotype serves both breathing and spinal stability[9]. Moreover, retraining and correcting a faulty breathing pattern should be considered to the success of any corrective and rehabilitation programs addressing the movement system. So, in order for having effective breathing exercise, the corrective program should be trained in various conditions[10]. These goals can be achieved by dynamic neuromuscular stabilization (DNS) approach that is founded on developmental kinesiology models[11]. While the supported joints and all segments are brought into a functionally central position, at training precise muscle coordination by locating the subjects into different developmental positions is one of the most fundamental purposes of the DNS approach. Moreover, the combination of spinal stabilization and breathing pattern during daily activities is regarded[12, 13].

If the breathing pattern is abnormal, then there will be no normal pattern of movement[14]. So taking part in rehabilitation schedules that affect respiratory muscles is crucial for the sedentary persons, notably those with poor posture, to deal with these postural, muscular and respiratory alterations. The aim of DNS breathing exercise - as a prerequisite for an integrated correction program - is to achieve the improvement of respiration and the coordination of local and global muscle complexes. Hence, the aim of this study was to evaluate the change in respiratory function in response to DNS breathing exercises in sedentary students with poor posture.

Materials and Methods

This experimental study was carried out on 26 poor posture sedentary male students that were selected by purposive sampling method.

Inclusion criteria were consisted of: aged between 19-23 years old, Body Mass Index (BMI) between 19-25 Kg/m^2, being non-smoker and poor posture score between 11–15 points[15]. Exclusion criteria included deformity of the chest, having background diseases (respiratory, neurologic, neuromuscular and cardiovascular), vestibular defects, former cardiac or thoracic surgery, and spinal postural alignment or upper and lower limb pathologies.

Before the start of the study, all participants signed an informed consent form and they could give up the study at any time.

The distinct initial screening was according to the standardized method[15]. The assessment was visually performed by a qualified examiner between 8:00 AM to 12:00 PM, which we believed would minimize the influences of natural intra-individual postural changes that may occur during the day. To screen the posture correctly, the participants wore shorts and were without shoes or socks[16].

A standard survey was utilized to determine the activity level of volunteers. The survey, alike to the Persian translation of the Tegner activity scale, is scored from a high of 10 (competitive sports) to a low of 1 (sedentary)[17]. All participants were in the sedentary level. The Persian-version of these instruments has acceptable psychometric properties for Iranian patients with knee injuries[18].

Before and after the training program, respiratory function was assessed via spirometry tests (Quark-PFT; Italy). The evaluated parameters were maximum voluntary ventilation (MVV), Forced expiratory volume in the first second (FEV1), Forced vital capacity (FVC), and FEV1/FVC, in standing position based on American Thoracic Society (ATS) and the European Respiratory Society (ERS)[19].

The participants performed six sessions per week (3 sessions of supervised exercise and 3 sessions of home-based exercise) of the DNS abdominal breathing or diaphragmatic breathing exercise. First of all, verbal signs, manual ushers and visual feedback were given during the intervention in order to participants learned how to adjust the pelvis, spine, ribcage, scapula alignment as well as abdominal wall shape in various positions[20, 21].

Table 1) DNS breathing exercise protocol

Exercise description
Week 1 (Sessions 1-6)
Supine breathing exercise
Crocodile Breathing
breathing exercise 90/90
Week 2 (Sessions 7-12)
Prone position: elbow support (3 months old position)
Supine position 90/90: arm outside the body (3 months old position).
Supine position 90/90: hand on the abdomen (4 months old position).
Creeping position (one hip and knee in flexion): elbow support, ASIS and medial epicondyle of the opposite knee (4.5 months old position)
Week 3 (Sessions 13-18)
Rolling pattern (ipsilateral) position (5 months old position)
Supine position 90/90: hand on the knee (5 months old position)
Prone position: hand and knee support (elbow is extension) (6 months old position)
Supine position (hip and knee in 45-degree flexion): hand on the foot (6 months old position)
Week 4 (Sessions 19-24)
Quadruped position (the angle between trunk and hip is 120 degree) (7 months old position)
Quadruped position (the angle between trunk and hip is 90 degree) (7 months old position)
Oblique sit position (side plank) with arm and lateral knee support (7 months old position)
oblique-sitting position with hand support(elbow is extended) (8 months old position)
Week 5 (Sessions 25-30)
Crawling position (9 months old position)
Sitting position (Keep the spine upright and elongated) (10 months old position)
Side-lying (side plank) with hand, lateral knee and opposite foot support (10 months old position)
Raising position (Keep the spine forward and elongated and one leg kneeling) (11 months old position)
Week 6 (Session 31-36)
High kneeling position (Keep the spine upright and elongated and one leg kneeling) (11 months old position)
Bear position (12 months old position)
Squat position (12 months old position)
Standing position (initial standing position) (13 months old position)
Sets
Set 1
10 repetitions
1 second inhale: 2 second exhale
60 -90 second rest period
Set 2
15 repetitions
2 second inhale: 4 second exhale
60 -90 second rest period
Set 3
20 repetitions
3 second inhale: 6 second exhale
120 -150 second rest period

Moreover, to motivate the participants to take part in practice sessions regularly, they were taught how the repetition of impaired movements, poor posture and sustained alignments may affect neuromusculoskeletal health. In the first week, all participants have personally trained the breathing exercise program (3 patterns). Another weeks (2 to 6), the developmental stabilization patterns of a healthy infant based on the DNS approach were done in each exercise session per week (Table 1). Inhalation and exhalation were done respectively through the nose and the mouth. Also, during the diaphragmatic breathing, the ribcage movement was visible in all dimensions (360 degrees)[20, 22-24]. Home exercises were taught and the ability to perform them was controlled in each session.

Exercise intensity was based on developmental positions automatically proper activation stereotype of stabilization and breathing of natural postural-locomotion patterns as defined by developmental kinesiology. This aim can be achieved via the activation of the stabilizers when placing the participants in developmental positions of an infant at third three months of developmental age to 13 months, as performed in this study[20, 22-25]. The protocol was implemented under the supervision of a trainer. The participants performed the exercises and the trainer corrected the performance if necessary. Besides, the participants represented their consent not to attend other courses or physical activities.

The statistical analysis was performed by SPSS 16 software. All parameter outcomes were evaluated for each participant and then mean and standard deviation (Mean±SD) were computed by descriptive statistics test in pre and post session. Kolmogorov-Smirnov test was utilized to examine the normality distribution of data. So to compare the pre and posttest data, paired-sample t-test was used. Moreover, percentage change was calculated as “(posttest - pretest)/pretest) ×100” and the effect size computed with G Power 3.1 software[26].

Findings

The mean of age, weight, height, and BMI in participants was 20.6±1.2 years, 70.9±1.7 Kg, 178.6±4.6 cm, and 22.1±3.2 Kg/m^2 respectively.

After 6 weeks there was a significant difference between the mean of the pre- and post-test of spirometry parameters including MVV, FEV1, FVC, and FEV1/FVC ratio ($p<0.001$; Table 2).

Table 2) Comparison of the mean of spirometry parameters from baseline to the 6th week ($p<0.001$)

Parameters	Pre-test	Post-test	Changes (%)	Effect size
MVV (L/min)	141.0±30.4	178.0±21.5	26.2	1.32
FEV1 (L)	4.0±0.5	4.7±0.5	16.4	1.11
FVC (L)	4.4±0.6	5.0±0.7	12.6	0.81
FEV1/FVC (L)	0.92±0.07	0.95±0.05	3.2	0.49

Discussion

According to the results of this study, six weeks of DNS breathing exercises with emphasis on the integrated spinal stabilizing system (ISSS)[22, 27], precise muscle timing and coordination to have movement efficiency and breathing technique[12, 20, 22] shown statistically and clinically significant amelioration in the spirometry values (MVV, FVC, FEV1, FEV1/FVC ratio).

Among respiratory maneuvers, MVV is more likely to be considered as a dynamic ventilation test because the reduction of MVV in neuromuscular and cardiovascular diseases, as well as those suffering from airway stenosis, is obvious. The increase in MVV from 141.0±30.4 to 178.0±21.5 (26.2% increased, $p<0.001$) was statistically and clinically significant. Similar results were reported in Bezzoli *et al*. who examined the effect of lumbo-pelvic motor control exercises on pulmonary function in obese individuals[28]. Increasing MVV is associated with low airway resistance and enhanced respiratory muscle strength and coordination[29]. However, the present study indicates probably developed respiratory muscle strength and coordination and better oxygen availability lead to increase the MVV.

The incremental changes in the two factors of FVC and FEV1 were 12.6% and 16.4%, respectively. In addition, the effect size of the exercises in two factors was 0.81 and 1.11, indicating a change of approximately four-fifths the baseline standard deviation considered as large[30]. These changes can be related to neuromuscular coordination and the more activity and desirable of the diaphragm muscle as the main respiratory muscle that plays a stability role as well as other respiratory muscles[31, 32].

Positive effects in the FVC may also show alterations in lung compliance[33]. Malatova and Drevikovska demonstrated that weakness and poor coordination of the diaphragm may lead to lumbar instability and impairment of its movement patterns. Conversely, loss of lumbar region stability due to poor posture and improper direction has a negative effect on the function and efficiency of respiration[34].

The results were consistent with the findings of Bezzoli *et al*. that examined the effects of pelvic lung motor control exercises on pulmonary function in obese people[28]. Dinesh *et al*. and Joshi *et al*. also found that Pranayama exercises improve respiratory function by increasing FVC and FEV1[31, 35]. Sivakumar *et al*. also investigated the effect of deep interpretation exercises on lung function, which was consistent with the results of the present study (FVC)[33]. Moreover, similar and comparable results have been reported by Obayashi *et al*. that confirms the effect of breathing muscle exercise on ameliorating respiratory function[36]. FVC and FEV1, are included of the most critical pulmonary function maneuvers. An obstruction in the respiratory airways or weakness and imbalance between the respiratory muscles (diaphragm, intercostal muscles, and abdominal muscles) alter the values of FVC and FEV1. The lumbar-pelvic deep cylinder including the diaphragm, transverse abdominal, and pelvic floor muscles, modulate the intra-abdominal pressure regarded as an important requirement to provide stability and respiration. Abdominal tension also raises the diaphragm inspiration performance on the ribs through two components insertional and oppositional force[37].

Increased residual volume is a result of expiratory muscle deficiency, as well as neuromuscular insufficiency, along with diminished lung elasticity and limited FVC levels[32]. Before participating in the DNS breathing exercises program the mean FEV1/ FVC ratio was reported 0.92 liters, which indicates the optimal ventilation function of the participants [32]. However, the incremental changes in this ratio after the exercise period increased by 3.2% and the effect size of 0.49 (average effect size) was statistically significant ($p<0.05$).

These results were consistent with the findings of Bezzoli *et al*., Kondam *et al*., and Kumar *et al*.[28, 38, 39]. Bezzoli *et al*., who investigated the effects of motor control exercises on the respiratory function of the lumbar muscles, as one of the defective factors in sedentary and obese people, reported significant enhancement of respiratory function factors in the experimental group[28]. Motor control exercises can be significantly used as a strategy that uses the central nervous system to control and coordinate the muscle contraction of all muscle groups involved [40]. This process is dependent on sensory systems and motor components, including muscles, ligaments, joints, and fascias, as well as neuro-cognitive processes[28]. Kondam *et al*. confirmed the effect of Pranayama exercises on the FEV1/FVC ratio by examining the effect of yoga exercises (Pranayama and Surya Namaskar) on the pulmonary function of a young person in a 6-month period[38]. In addition, the Kumar *et al*. study, which was performed on 55 medical students, showed a significant effect of yoga exercises on pulmonary function[39]. This seems to be achieved by increasing and improving the maximum expiratory pressure that results from the upgraded strength of expiratory muscles. Moreover, in the second stage ameliorating these factors can be as a result of promoting the coordination of respiratory muscles and the alignment of the spine and chest. The normal and neutral position of the spine facilitate the function of exhaled muscles (transverse abdomen, intercostal muscles, pelvic floor muscles, and external oblique).

DNS is a functional approach view that integrates brain stimulation with manipulation, mobilization, postural awareness, breathing training and education to achieve optimal, global body function[33, 34]. Moreover, can be regarded as a “neutral” and "optimal" alignment of the head and neck, spinal, thorax, and pelvis and strongly recommends that a healthy sensorimotor system is required to design an optimal function that sets the joints in centration[22, 23]. The outcome of joint centration is minimal mechanical stress on relevant passive tissues and dwindles the over activation of superficial muscles[22].

The protocol also discusses the spirometric values. To educate the participants about the integration of a proper pattern of breathing and alignment within the daily living activities is one of the main goals of DNS breathing exercises. Our study proves confident respiratory results can be taken by appointing DNS breathing exercises. It is suggested that clinically it is crucial to regard DNS breathing exercises based on ideal ontogenetic patterns may be utilized to accomplish optimal for student's subjects especially when the improvement influence is proposing to develop with weakened respiratory function.

Conclusion

DNS breathing exercise is an effective protocol to improve respiratory function. Moreover, DNS breathing exercise with a focus on the integrated spinal stabilizing system (ISSS) and breathing techniques can serve as an effective instructive approach to prevent risks of malalignment.

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