Ergonomic Based Postural Education in Neck Tension Syndrome in the School Age Computer Users

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ABSTRACT

Various musculoskeletal system disorders occur as a result of the use of computers, which have become an integral part of modern life. The most important among such disorders is known as cumulative trauma disorder presented in different forms. One of these forms recently very common devastating condition is neck tension syndrome. With increased advance in using computer the adolescent starts to complain of problems if passed undiagnosed will lead to serious chronic illnesses. No one think that using computer would be dangerous. But thousands of kids are injured each year by like tension neck, carpal Tunnel Syndrome that comes from poor posture and typing habits. Poor positioning of the body can be improved and it is never too late to start trying to correct postural problems. From this prospective, thirty preparatory school age students have been selected complaining of tension headache, with frequent sick leave with a neck posture characterized by forward neck and chin up of the actively computer user since early childhood. Each student underwent conventional plus ergonomic based program for 12 sessions. Pherenic nerve conduction velocity and latency were measured on right side in addition to the use of spirometry to measure maximum voluntary ventilation MVV. There were a significant difference in the conduction velocity between pre and post intervention during rest. Moreover, the MVV was significantly increased. The results of this study could be the bases for intervention for adolescent even with minor complains. It is crucial to consider that injuries are easy to avoid but difficult to treat.

INTRODUCTION

Cumulative trauma disorder (CTD) is physical injury resulting from the cumulative effects of repetitive stressful movements or postures. Areas commonly involved are the hand, wrist, shoulder, and neck, resulting in disorders such as carpal tunnel syndrome and neck tension syndrome. CTD is a common problem among adults, frequently the result of work-related activities. Individuals employed in computer work (jobs requiring light physical activity), are at high occupational risk for such disorders[18]. Given the prevalence of CTD, its potentially disabling effects, and the significant social and economic costs of this problem, considerable efforts have been made to inform and educate consumers, establish policies, and redesign products, with many efforts directed specifically at computer users. However, despite growing awareness and understanding of adult cumulative trauma disorders CTD, very little is known about the potential risks of computer-related cumulative trauma disorders for adolescents starting from the dynamic age at preparatory and secondary school.

The majority of studies looking at adolescent upper extremity musculoskeletal problems are related to sports injury. Several studies have looked at other health-related computer use issues, such as epileptic seizures and visual accommodation. One case report on computer games and repetitive strain injury was found. Studies examined student computer workstation setup in schools and related health risks. In addition they have considered the psychosocial aspects of computer game use, such as increased aggression, social isolation, and addiction[4]. Generally, none of the studies on adolescents to date have adequately examined usage habits, or the dealing with symptoms as being vserious if not considered.

In an effort to better understand the potential CTD risk for children and adolescents, a questionnaire was administered to a sample of students to ascertain patterns of use, self-reported physical discomfort, and behavior changes. The results where an open ended questions concerning the discomfort or unrelated complains[23].

The Pherenic nerve is the sole motor supply to the diaphragm. It arises chiefly from the fourth cervical ramus but also has contributions from the third and fifth cervical rami. It passes through the intervertebral foramina, posterior to the neck, lateral to scalenus anterior and descends posterior to the sternomastoid. In the thorax, it descends anterior to the pulmonary hilum between the fibrous pericardium and mediastinal pleura, then it traverses the diaphragm through the canal orfice, or just lateral to it, and divides into three to four branches which ramify under the surface of the diaphragm[15].

The diaphragm is a curved muscluo-fibrous sheet that separates the thoracic cavity from the abdominal cavity. It is the main inspiratory muscle accounting for 75% of the tidal volume which is achieved by its contraction during inspiration, this leads to descend of the central tendon with subsequent increase in the vertical diameter of the thorax. In the same time it elevates the lower six ribs thus, pushing forwards the body of the sternum and the upper six ribs leading to an increase in the antroposterior diameter of the thorax. The increase in the thoracic volume creates a negative pressure with suction of air from outside during inspiration[12].

The diaphragmatic function is affected by several diseases either muscle diseases, neuromuscular diseases or neural diseases. In diaphragmatic affection, the accessory muscles come into action and the therapeutic efforts were directed towards restoring a more normal diaphragmatic pattern that alleviates dyspnea[5,17,21].

The anatomical feature of cervical spine has characteristics quite different from these of the thoracic or lumber spine, although the embryologic development of the three spinal sections is quite similar. The cervical spine has a great range of motion in all directions. The cervical muscles have three basic functions, to move the head and neck by gross and fine adjustments, to suspend and move the entire shoulder girdle, and to suspend, fix and elevate the thoracic inlet. A small number of mechanoreceptors in the cervical zygapohyseal joints in the cervical spine[13,26].

The spinal joint mechanoreceptors provide information regarding static position as well as the velocity and direction of movement in the locomotor system.

Additionally, it is believed that joint mechanoreceptors play a role in the modulation of nociceptive (pain sensation) transmission from the joint, as part of the "gate control" of this transmission. Transmission of afferent impulses along large-diameter fibers causes the activation of an inhibitory neuron, through synapse with the projection neuron that relays the impulses to higher centers, causes inhibition of this projection neuron. In order to maintain a pain free state, there must be adequate balance between the afferentation from large diameter fibers (e.g., those arising from joint mechanoreceptors) and small-diameter nociceptive fibers. A disruption of this balance can allow the nociceptive afferentation to "get through the gate" and reach higher levels in the CNS to produce the sensation of pain[13].

Normal lordotic curvature is determined by the geometries of the intervertebral disc, vertebral bodies, pares interarticulares and, to a lesser extent, the pedicles. The cervical intervertebral disc are taller anteriorly than posteriorly, contributing much to the normal curve, curvature will decrease if the anterior muscles shorten, whether by contracture, spasm, or volitional contraction. It seems that shortening of the small posterior and anterior muscles in appropriate combinations could result in a temporary and modifiable loss of lordotic curvature at a single segmental joint complex[27].

The intervertebral disc makes up about one fourth of the length of the spinal column. In the cericical it is designed for range especially in young age. They are biconvex, conforming to the concavity of the vertebral bodies. Discs are avascular, they are nourished by alternate compression, dehydration and rehydration, diffusion of fluids from adjacent vertebral bodies and peripheral vessels of the annulus fibrosis. The disc is made up of the outer annulus fibrosis and the inner nucleus pulpsus[12].

Nociceptors present throughout the cervical intervertebral discs (those are receptors that are excited by noxious stimuli). Their greatest concentration appears to be in the posterolateral portion of the disc, and they can be found as deep as the middle third of the annulus. These nociceptors have been shown to have direct reflex relation to spinal muscles, and probably play an important role in producing spasm[28].

Several studies had shown diaphragmatic function affection with subsequent pulmonary function deterioration. The patient's most common complaint is dyspnea. Dyspnea is the clinical term used for describing shortness of breath or breathlessness. The American Thoracic Society defines dyspnea as a term used to characterize a subjective experience of breathing discomfort that consists of qualitatively distinct sensations that vary in intensity. This was due to delayed conduction velocity in the Pherenic nerve as a result of Pherenic nerve root compression[16]. Minute volume (Tidal volume X respiratory rate) is the major contributing factor in arterial oxygenation. The tidal volume is composed of dead space volume (150 ml), which is not participating in gas exchange, and ventilation (350 ml) which is the effective ventilation at alveolar level. The aim for proper minute ventilation is to decrease the dead space ventilation by eliminating bronchial secretions and broncho spasm; this was associated with augmentation of alveolar ventilation which is governed by two factors, an internisc factor which is alveolar elasticity and an extrinsic factor which is the respiratory muscles. For which breathing exercises are prescribed to augment the rate and depth of ventilation[26].

Choosing the right location for computer monitor on the desk or workspace can be a difficult decision. Yet if not positioned correctly, monitor can cause neck pain, shoulder pain, or even eye strain. Concluded that overall good flexibility in boys and good endurance strength in girls may contribute to a decreased risk of tension neck.

For the back health in an ergonomically based program, the authors devised an educational program consisting of a theoretical lecture about 45 minutes in length follwed by two practical sessions lasting about 30 minutes each on two-week period. The aim of the program was to give the subjects an understanding of simple ergonomic principles[18].

Were there any changes in Maximum Voluntary ventilation (MVV) and Pherenic nerve conduction time after postural education in school age student with cervical tension syndrome.

Purpose of the Study:

The main purpose of this study was to investigate the changes in, maximum voluntary ventilation and Pherenic nerve conduction time after application of postural education program in school age computer user boys.

Significance of the Study:

The entire population has cervical tension that is asymptomatic. Symptomizaiton occurs only late in the course of illness which varies from mild upper cervical pain and headache and sensorymotor dysfunctions. There is a clear relationship between the pulmonary function estimated by pulmonary function tests and the motor unit of respiration consisting of the anterior horn cell, Pherenic nerve root, Pherenic nerve, neuromuscular junction and the muscle, which is the diaphragm, estimated by the nerve conduction velocity studies. Any lesion in the course of this motor unit will lead to subsequent affection of the pulmonary function[20].

This study aimed to add a new modality in the physical therapy program for the management of patients with diaphragmatic affection due to Pherenic nerve root compression secondary to cervical dysfunction. For diaphragmatic muscle strengthening, physical therapy programs in the form of breathing exercise, weights, incentive spirometry are used. In this study work station design considerations, including postural correction for the neck faulty position was studied as a new modality to improve the diaphragmatic function through its mechanical effect. Many people think straightening up is important only for appearance. Although good posture does project confidence, strength and poise, it is also important because it contributes to our health and well-being.

Hypotheses:

It was hypothesized that there would be no difference in Pherenic nerve conduction time and maximum voluntary ventilation after postural education program in school age computer users with cervical tension syndrome.

SUBJECT, MATERIAL AND METHODS

Subjects

This study was conducted on 30 boys students suffering from neck tension syndrome complaining of recurrent tension headache. The boys were selected from preparatory schools. The Pherenic nerve conduction studies were conducted at Institute Of Post-Graduate Childhood Studies, Ain Shams Uni. (Special Needs Care Center). Their ages ranged from 12.50 to 16.8 years with a mean of 14.66 years, their weight ranged from 35 to 58 kg, with a mean of 46.91kg, and their height ranged from 1.55m to 1.78m. With a mean of 1.67m. The students were examined carefully by a neurologist, they suffered from variable symptoms such as occipital headache, tingling sensation, referred pain to neck, shoulders and arms, decreased muscle stretch reflex, and motor weakness. More over, recent report of recurrent sick leave, inability to continue regular studying hours. All students were non-smokers nor passive smokers, they were not suffering from diabetes or hypertension and they were chest and cardiac free.

Instruments for data collection:

- A hand-held computerized spirometer, model: (Discovery Spirometer) was used in evaluation of ventilatory functions in the form of maximum ventilatory ventilation (MVV) Fig. (1).

Fig. (1): Hand-held computerized spirometer.

- Electromyogram appliance, SystemPlus for brainQuick, EvoQuick, MyoQuick by Micromed, ISA 1002, Two Channel, Ver. 1.02.1030. Italy model:)was used in nerve conduction studies of Pherenic nerve. Electrodes: Surface electrodes for both stimulating and recording. Fig. (2).

Fig. (2): Electromyogram appliance.

- Height and weight scale was used to measure the height and weight of each patient to identify homogenous versus heterogeneous subject characteristics.

Procedures

Procedure was started in the following steps, which were explained for each subject before participation. Maximum volumetric ventilation (MVV) and Pherenic nerve conduction studies were obtained from all students before receiving their treatment program, as a base line result. Then, all of them received 12 sessions, day after day, in the form of hot packs, ergonomic based program for the neck and therapeutic neck exercises beside their routine at computer work station wither at school, play station or at home.

MVV measurement:

Using a hand-held computerized spirometer, to test the maximum voluntary ventilation, from sitting position, with supported trunk and arms. Placed a nose clips around the nose to prevent air from pacing through nose. The subject put the mouth-piece firmly into his mouth and breathed few times before started the examination procedure then he was instructed to breathe as deeply and rapidly as possible for 15 seconds, the volume expired was extrapolated to yield the flow rate in liters per minute, the subject performed 3 trials successively and the mean taken and recorded.

Pherenic nerve conduction studies:

These studies were conducted by a specialist.

While the subjects lye in supine position, the Pherenic nerve was stimulated along the posterior border of the sternocleidomastoid muscle at the mid portion of that muscle, on a line with the upper border of the thyroid cartilage.

The diaphragmatic compound muscle action potential was recorded with an active surface electrode placed in the midline over the inferior part of the sternum, 5 cm above the xiphoid process. The reference electrode was placed 16cm inferiorly laterally on the lower costal margin.

Ground electrode was placed on the sternum, midway between the stimulating and recording electrodes.

Pherenic nerve evoked responses:

The wave form was analyzed for; Latency in millisecond, Amplitude in microvolt and duration of the evoked response. These measurements were analyzed during rest, inspiration and expiration, Fig. (3).

Fig. (3): Obtained compound muscle action potential.

Then the subjects started the ergonomic based ergonomic intervention program which consisted of: hot packs, isometric exercises of neck muscles and education including recovery time rule and stretch in addition to postural education.

Intervention phase

(1) Hot Packs:

The heated pack was placed in a bath towel, and was applied to the patient's neck while he was in setting position, the temperature of the pack should not exceed 44^{o}C, or according to patient's tolerance, duration of application was 20 minutes.

(2) Isometric exercises of neck muscles:

Isometric exercises were performed to improve the muscle strength after being stretched by manual positioning and check at the end of range of motion. These exercises were applied from the first session and continued till the end of the program. . One or two times demonstrative times were applied by the researcher to ensure the repeatability by the patient .The following directions of neck exercises were chosen:

A. Neck Flexion:

With one hand of the patient placed on the subject's forehead, and he was instructed to press his head forward against maximal resistance, Fig. (4).

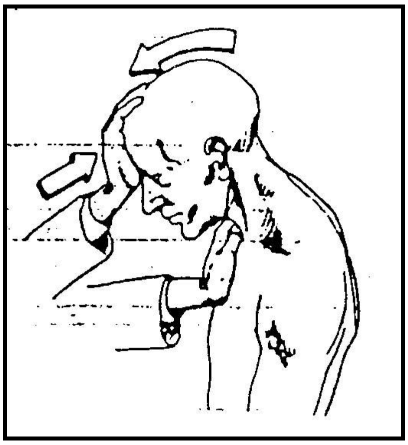

Fig. (4): Hand's positions for neck flexion isometric exercise.

B. Neck extension:

The hand was placed on the back of the subject's head, who was instructed to push backward against maximum resistance, fig. (5).

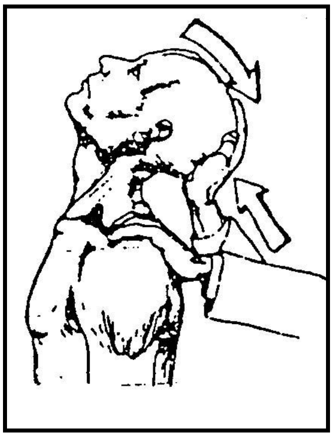

Fig. (5): Hand's positions for neck extension isometric exercise.

C. Neck side-bending:

The hand was placed on the side of the head and instructed the subject to press his head side- ward against maximum resistance, then repeat that on the opposite side, fig. (6).

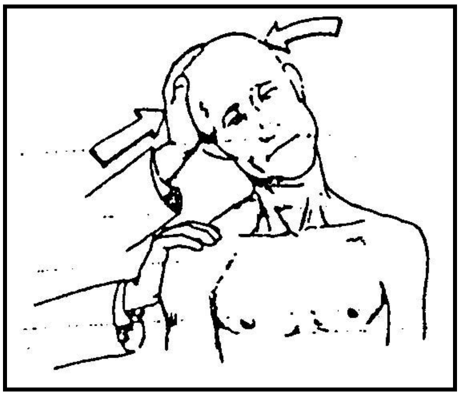

Fig. (6): Hand's positions for neck side-bending isometric exercise.

D. Neck rotation:

The hand was placed on the cheek, and the subject turned his head towards the hand against maximum resistance, then repeated this on the opposite side, Fig. (7).

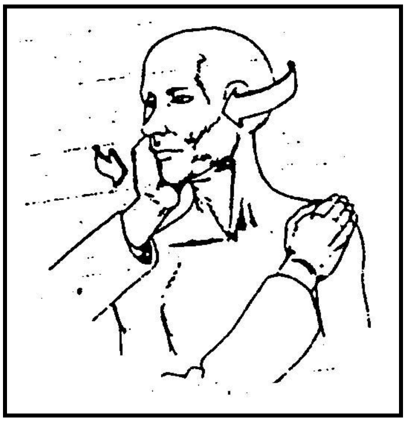

Fig. (7): Hand's positions for neck rotation isometric exercise.

Each direction of exercises was repeated 5 times, each time divided into 6 second isometric contraction and 6 seconds relaxation, these exercises were repeated three times per day.

All students were encouraged to perform these exercises at home.

(3) Ergonomic based program for the neck[4,22,23]:

The following instruction was stated to each student:

To stand up straight! Not to slouch! Hold head up! it's never too late to start improving posture with good practices.

i. Models of simple, quick work-station exercises designed to prevent injury, strengthen and stretch muscles and give daily energy. Perform a stand up-sit down squat five times each hour. Reach with arms towards the ceiling each time. This will work and stretch every muscle in body, raise heart rate and keep brain sharp.
ii. While sitting, rotate the neck in circles both directions. Then hold it to the right and then to the left. Finally hold your chin on your chest. Do this a few times a day to thoroughly stretch your neck.
iii. For relive of neck tension , turn head slowly from one side to the other. Hold each turn to the count of three. Repeat motion five times in each direction.
iv. For back, sit straight up with hands on waist. Gently lean from one side to the other. For the upper back squeeze shoulder blades together for 10-20 seconds twice daily.
v. For eyes, shut them tight and open wide. Do five times, twice a day.
vi. For forearms, clench fists and put arms straight out in front . Bend wrist up and feel the stretch in forearm. Bend wrists down and feel the opposite stretch. Hold for 5-10 seconds, twice daily.
vii. Contract abdominals for about 10-30 second five times a day.
viii. Do some deep breathing off and on throughout the day. This relieves both mental and physical stress.

It is normal to experience fatigue and pain from a sit down job. Try some of the suggestions. Change workstation posture, make workstation adjustments and perform simple workstation exercises.

Recovery time: the child should have with each half an hour five minutes breaks every half hour. Meantime do stretch and change of position keeping chin in.

- Work station proper design consideration.

- Concerning the head position adjust the height of the child or the monitor so he is able to view it without bending his neck upward. Adjustability of the chair was used to elevate the child in the chair. The child is allowed to look with a sight angle about 15 degrees.
- The typical office chair isn't designed for users under 5 feet tall, so notice that child doesn't seem to fill the seat out the way an adult would. Most experts agree that kids can sit for about an hour in adult-sized chairs without any discomfort. For longer periods of sitting, it's recommended that make the chair better fit with the child.

If the chair is adjustable, try lowering the arm rests, raising the seat pan, and pushing the lumbar support forward. If your chair doesn't have these adjustments, you can place a pillow under your child's bottom and behind his lower back. If child's feet dangle in this position, put a footrest (or box) under his feet for support. Sitting perfectly upright isn't recommended; let your child relax and keep slightly open angles while receiving proper support from the modifications you've made.

Since kids often sit in adult chairs, they tend to look up at the monitor, tilting their head back in a position that can cause neck pain. Child's eyes should be level with or just slightly above the top of the monitor, about 24 inches away. (Make sure that you don't raise his chair so high that his feet are unsupported).

Their monitor should be directly in front of them, and not off to the side.

- If child frequently works from papers or a textbook, consider using a document holder. These allow him to support books and papers closer to the monitor, and at a more ergonomic angle. Positioning documents close to the screen will minimize the amount the child has to turn or twist his head while working.
- Childhood is also the time when most eye conditions (such as nearsightedness) tend to develop, so if child is leaning in to see the monitor, so their eyes have to be checked.
- Consider using a good quality, glass anti-glare screen, which can help your child avoid squinting and eye strain.
- If the adult and child are both using the same computer workstation there is a need to an adjustable keyboard tray; this helps the workstation adjust comfortably to either size. Proper posture is also extremely important; help kids learn what's known as "neutral" posture. Their arms should lay close to their body (not outstretched or reaching to the side), their elbows should be at a 90 deg. or greater angle (this is known as an "open angle.
- Kids have small hands, but most end up using their parents' keyboards. This can be uncomfortable at best, and dangerous at worst. A few companies make smaller "kid-sized" keyboards that may be helpful for younger children (these keyboards have smaller keys and shorter distances between the keys). Many companies also make miniature mice for small hands. Children may find a trackball easier to negotiate, so you may want to try both.

The students allowed practicing applying these principles in their normal life style at home at school or at play station.

At the end of 12 sessions of ergonomic based program, all symptoms including occipital headache, neck and shoulder pain, tingling sensation were considerably relieved as described by the students. MVV and Pherenic nerve studies were recorded once again to get the post-treatment results, these tests were performed by the same therapist and in the same situations of the pretreatment tests. The pre-treatment data were compared with the post-treatment data and were statistically analyzed.

Durations of Study:

The clinical part of this study had been conducted approximately in 10 months started from September, 2006 till June, 2007.

RESULTS

This study comprised students suffering from neck tension syndrome using computer on a regular bases for different purposes. The data was collected from students before and after application of treatment program and classified into pre-and post-treatment values. These values were statistically analyzed by using paired "t" test, unpaired "t" test and correlation coefficient in the following tables:

I- Descriptive analysis of the sample:

Table (1) showed that, the patients' age ranged from12.5 to 16.8 years with a mean 47.66 ±5.1, their weight ranged from 35 to 58kg, with a mean 46.9 ±7.6, and their height ranged from 1.55 to 1.78m. with mean 1.67 ±3.08.

Table (1): The mean ±SD, minimum and the maximum values of the age, weight and height of the sample.

Item	Mean	±SD	Minimum	Maximum
Age/y	14.66	5.19	12.5	16.8
Weight/kg	46.91	7.63	35.00	58.0
Height/m	1.67	3.08	1.55	1.78

$\bar{X}$: Mean SD: Standard Deviation Y: Year kg: Kilogram m: meter

II- Comparison between the pre-and post-treatment values of the right Pherenic nerve:

As shown in Table (2), and Fig. (8), the measurement of the mean of the latency of the right Pherenic nerve in milliseconds at rest showed statistical insignificance difference between the pre-and post-treatment values; it was 8.09 ±1.5 and after treatment, it became 8.44 ±2.07,P > 0.05. The mean of latency during inspiration changed from 9.96 ±2.35 before treatment into 9.43 ±2.47 after treatment which is statistically non-significant as P > 0.05. On measuring the latency during expiration, one could notice that, the change in mean values from 9.61 ±2.19 before treatment into 8.67 ±1.93 after treatment with P value > 0.05 which is also statistically non significant.

Table (2): The differences between the pre and post-treatment values of the latency in milliseconds of the right Pherenic nerve during rest, inspiration and expiration.

Item	Pre	Post	"t" value	P value	Significance
	$\bar{X}$ ±SD	$\bar{X}$ ±SD			
Rest	8.09 ±1.5	8.44 ±2.07	0.91	0.377	NS
Inspiration	9.96 ±2.35	9.43 ±2.47	0.664	0.517	NS
Expiration	9.61 ±2.19	8.67 ±1.93	1.35	0.198	NS

$\bar{X}$: Mean SD: Standard Deviation "t" value: Paired t value P value: Probability value
NS: Nonsignificant P value > 0.05

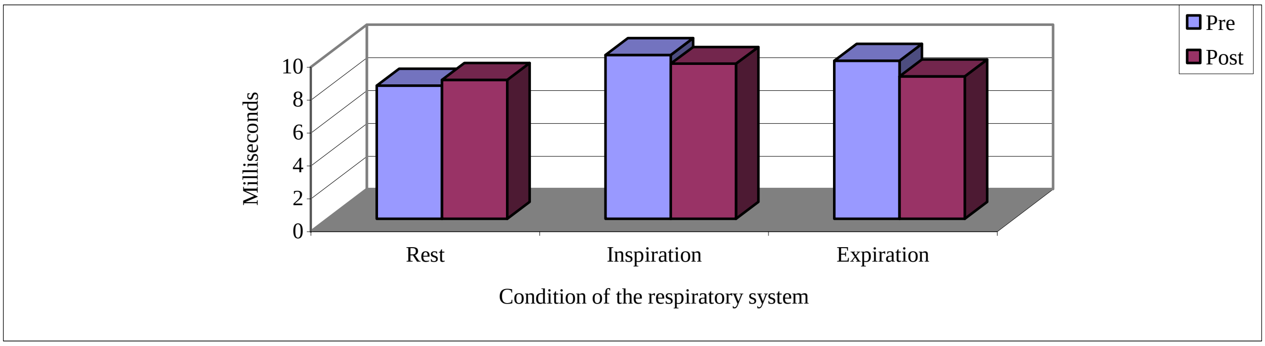

Fig. (8): The differences between the pre-and post-treatment mean values of the latency of the right Pherenic nerve during rest, inspiration and expiration.

Concerning the amplitude of the pherenic nerve, as shown in Table (3), and presented in Fig. (9), the measurement of the mean of amplitude of the right Pherenic nerve in microvolt at rest showed statistical significance difference between the pre-and post-treatment values; it was 278.33 ±225.68 and after treatment, it became 560.2 ±433.46, P < 0.05. The mean of amplitude during inspiration changed from 321.44 ±400.74 before treatment into 497.04 ±360.99 after treatment which is statistically non-significant as P > 0.05. On measuring the amplitude during expiration, one could notice that, the change in mean values from 362.05 ±320.39 before treatment into 1041.27 ±1268.09 after treatment with P value > 0.05 which is also statistically non significant.

Table (3): Shows the differences between the pre and post-treatment values of the amplitude in microvolt of the right Pherenic nerve during rest, inspiration and expiration.

Variable	Pre	Post	"t" value	P value	Significance
	$\bar{X}$ ±SD	$\bar{X}$ ±SD			
Rest	278.33 ±225.68	560.2 ±433.46	2.33	0.035	S
Inspiration	321.44 ±400.74	497.04 ±360.99	1.73	0.106	NS
Expiration	362.05 ±320.39	1041.27 ±1268.09	2.05	0.06	NS

$\bar{X}$: Mean SD: Standard Deviation "t" value: Paired t value P-value: Probability value
NS: Nonsignificant P value > 0.05 S: Significant P value ≤ 0.05

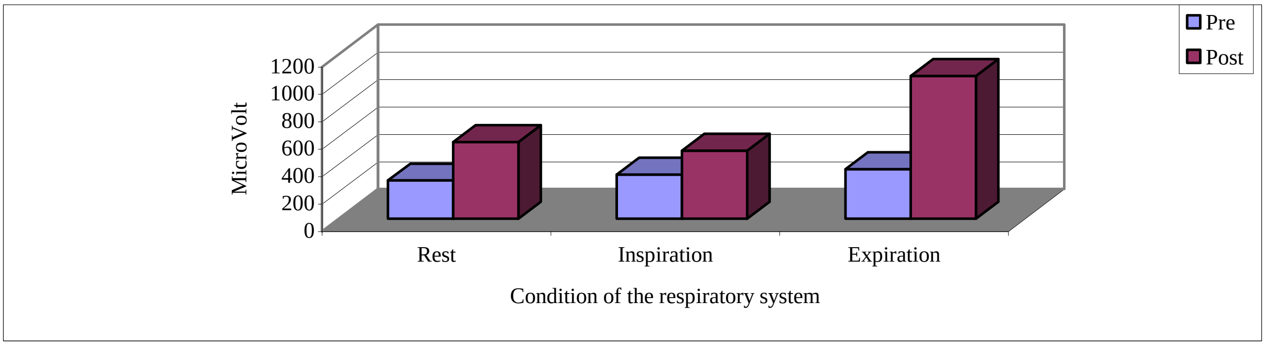

Fig. (9): Shows the differences between the pre-and post-treatment mean values of the amplitude of the right Pherenic nerve during rest, inspiration, and expiration.

As shown in table (4), and fig. (10), the measurement of the mean of the duration of the right Pherenic nerve in milliseconds at rest showed statistical insignificance difference between the pre-and post-treatment values; it was 5.41 ±2.32 and after treatment it became 6.21 ±2.11, P > 0.05. The mean of duration during inspiration changed from 6.43 ±3.4 before treatment into 7.12 ±4.54 after treatment which is statistically non-significant as P > 0.05. On measuring the duration during expiration, one could notice that, the change in mean values from 7.38 ±3.01 before treatment into 9.18 ±4.96 after treatment with P value > 0.05 which is also statistically non significant.

Table (4): Shows the differences between the pre and post-treatment values of the duration in millisecond of the right Pherenic nerve during rest, inspiration and expiration.

Variable	Pre	Post	"t" value	P value	Significance
	$\bar{X}$ ±SD	$\bar{X}$ ±SD			
Rest	5.41 ±2.32	6.21 ±2.11	0.88	0.393	NS
Inspiration	6.43 ±3.4	7.12 ±4.54	0.49	0.631	NS
Expiration	7.38 ±3.01	9.18 ±4.96	1.22	0.234	NS

$\bar{X}$: Mean SD: Standard Deviation "t" value: Paired t value P-value: Probability value
NS: Nonsignificant P value > 0.05

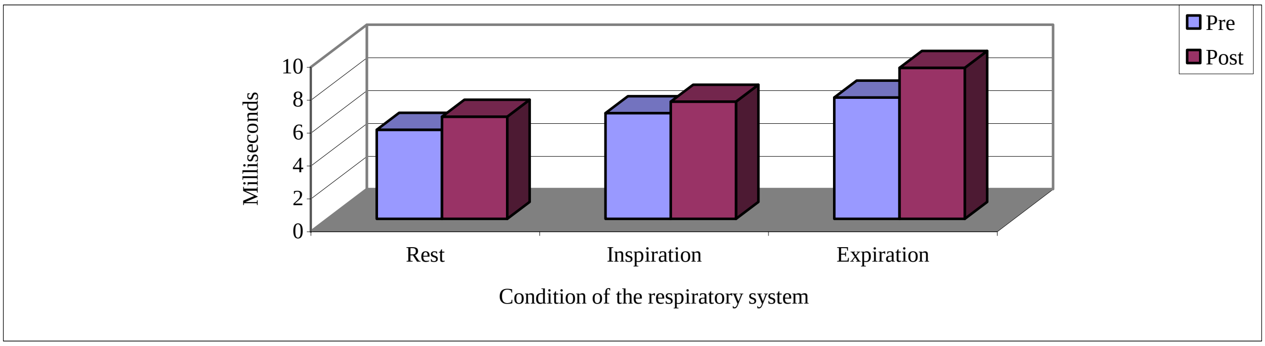

Fig. (10): Shows the differences between the pre-and post-treatment mean values of the duration of the right Pherenic nerve during rest, inspiration and expiration.

III- Comparison between the pre-and post-treatment measurements of spirometry:

As shown in Table (5), and presented in fig (11), The mean of maximum voluntary ventilation changed from 97.53 ±19.36L/M before treatment into 115.41 ±26.85 L/M after treatment which is statistically highly significant as P < 0.05.

Table (5): The differences between the pre and post-treatment values of maximum ventilatory volume (MMV) in Liter/Minute.

Item	Pre	Post	"t" value	P value	Significance
	$\bar{X}$ ±SD	$\bar{X}$ ±SD			
MVV	97.53 ±19.36	115.41 ±26.85	3.15	0.007	HS

$\bar{X}$: Mean SD: Standard Deviation "t" value: Paired t value P-value: Probability value
HS: Highly significant P value ≤ 0.007 MVV: maximum ventilatory volume

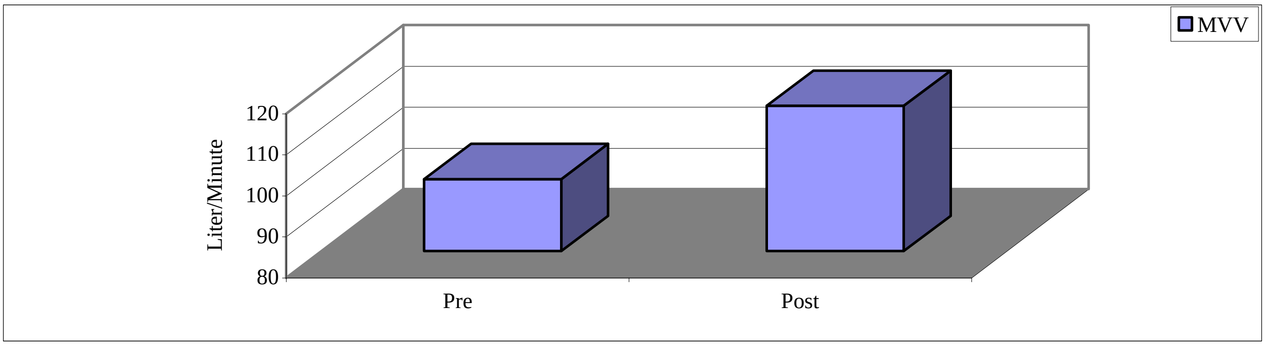

Fig. (11): The differences between the pre-and post-treatment mean values of the maximum ventilatory ventilation (MVV).

IV- Correlation between right Pherenic nerves' amplitudes and spirometric measurements:

As shown in Table (6), and demonstrated in Fig. (12), the correlation coefficient between the pre-treatment amplitudes of the right Pherenic nerve during inspiration and the pre-treatment values of maximum voluntary ventilation MVV was (r = 0.777) which means a highly significant positive correlation as P value < 0.001 and it was of direct proportional nature. It also noticed that, the correlation coefficient (r = 0.889) between the post-treatment amplitudes of the right Pherenic nerve during inspiration and the post-treatment values of MVV, i.e., there was a highly significant positive correlation (P value < 0.0001) and of direct proportional nature.

Table (6): Shows the correlation coefficient between the amplitude and MVV in right Pherenic nerve during inspiration.

Nerve	Related variables	Correlation coefficient "r"	P value	Significance
Right	Pre value of MVV & amplitude	0.777	0.001	HS
Pherenic	Post values of MVV & amplitude	0.889	< 0.0001	HS

P value: Probability value NS: Nonsignificant P value > 0.05 MVV: Maximum Voluntary Ventilation
HS: Highly Significant P Value < 0.05

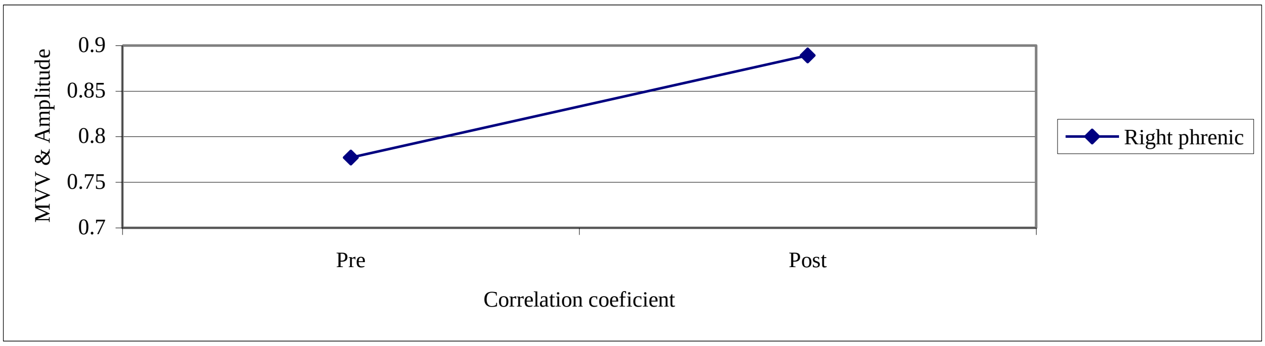

Fig. (12): Shows the correlation coefficient between the amplitude and MVV in right Pherenic nerve during inspiration.

DISCUSSION

The aim of this study was to describe objectively the effect of ergonomic based ergonomic intervention on the Pherenic nerve and maximum voluntary ventilation function.

In this study, twelve sessions of physical therapy program including hot packs, postural education and isometric neck exercises were applied to 30 boy students, suffering from neck tension with complains of occipital headache, neck and shoulder pain, and referred pain to either upper limbs. Maximum voluntary ventilation (MVV) and Pherenic nerve conduction studies were tested before and after treatment program which lasted for four weeks.

The results of this study showed considerable relief of patients' symptoms including occipital headache, neck and shoulder pain, tingling sensation and referred pain to arms were considerably relieved.

Preston and Shapiro, (20), identified the latency as the time from the stimulus to the initial compound muscle potential (CMAP) deflection from base line. Latency represents three separate processes: (1) the nerve examine among adolescents The prevalence of neck/shoulder, low back, and arm pain within different sociodemographic groups and (2) the association of neck/shoulder, low back, and arm pain with computer use, physical activity, depression, and stress.

In this study, attempt to investigate cumulative effects of hazardous use of computers on daily life and the effectiveness of training and exercise programs in the management of neck problem at school where computers are widely used. Similar study in different population (4) where fifty patients with CTD between the ages 25 and 50 were recruited for the study and were randomized into two groups. The complaints of patients with CTD had appeared after they had started working in this job and they reported that their complaints were related to their occupation.

The patients complained of head, neck, shoulder, back and wrist pains and most of them were diagnosed as Myofascial Pain Syndrome (MPS) and Carpal Tunnel Syndrome (CTS). The first group was given mobilization, stretching, strengthening and relaxation exercises five days a week for a period of two months following a training course. The second group was given a training course only. Both groups were assessed in terms of the following outcome criteria before and after the treatment: Numeric Rating Scale (NRS) and Pain Disability Index for pain; Tiredness Scale for tiredness; and Beck Depression Scale for depression. At 2 months, the treatment group was observed to have experienced statistically significant improvements in NRS ($P < 0.001$), pain disability index ($P < 0.05$) and Beck depression scale ($P < 0.05$) values as compared to the control group. Concluding to the effectiveness of mobilization, stretching, strengthening and relaxation exercises reduce pain and depression levels.

In a school-based questionnaire survey in 2002 and 2003 of neck/shoulder, low back, and arm pain, computer use, physical activity, depression, and stress. The survey was given to 3485 adolescents aged 12 to 16 years who attended secondary schools in Amsterdam, Netherlands[9]. They reported the overall prevalence of neck/shoulder, low back, and arm pain was 11.5%, 7.5%, and 3.9%, respectively. The prevalence of neck/shoulder pain was higher among girls and adolescents not living with both parents. The prevalence of low back pain also was higher among girls. Depressive symptoms were associated with neck/shoulder pain, low back pain, and arm pain. The stress experienced was associated with neck/shoulder pain and with low back pain. This study strengthens the findings that musculoskeletal pain is common among adolescents and is associated with depression and stress but not with computer use and physical activity.

Concerning the most important active ventilatory function test, the maximum voluntary ventilation (MVV), which measures the ability of the subject to breath in and out rapidly and deeply as much as possible usually for about 15 seconds. This test depended mainly on the strength and endurance of diaphragmatic muscle as well as the volume of air respired in each cycle. This was supported by Fonburg and Sicilian[8] who stated that one of the earliest indications of diaphragmatic muscle weakness is a reduced maximal voluntary ventilation.

The results of this study showed highly significant difference between the pre-and post-treatment values of MVV, with a percentage of improvement about 18.33%, which revealed an improvement in diaphragmatic function after completing 12 sessions of postural education.

Pherenic nerve conduction studies were conducted in this study to show, in an objective way, any differences in the Pherenic nerve parameters after application of the physical therapy treatment. Also, they were used to confirm objectively any changes that occurred in data obtained by spirometry. This concept supported by Cherniack et al.,[3] who stated that Pherenic nerve conduction studies would assess the diaphragmatic muscle function in a more objective manner than usage of spirometry, in which, the subject was required to volitionally perform difficult breathing maneuvers in order to obtain reliable data.

Three parameters including "latency, amplitude and duration" were tested in Pherenic nerve conduction studies for right Pherenic nerves conduction time from the stimulus site to the neuromuscular junction (NMJ), of the same patient before and after the physical therapy program. The time delay across the neuromuscular junction, and the depolarization time across the muscle. It was reported that that the CMAP amplitude is most commonly measured from baseline to the negative peak. CAMP amplitude reflects the number of muscle fibers that ultimately fire. Low CMAP amplitudes most often result from loss of axons (as in a typical axonal neuropathy). They, also, stated that CMAP duration is measured from the initial deflection from baseline to the first baseline crossing. Duration is primarily a measure of synchrony (i.e., the extent to which each of the individual muscle fibers fire at the same time). Duration characteristically increases in conditions that result in slowing of some motor fibers but not others (e.g., in a demylinating lesion)[19].

The result of this study showed non-statistical significant differences between pre- and post-treatment latencies and duration of right Pherenic nerves, but on analyzing the results of amplitudes, it showed a significant difference "statistically" between the pre-and-post-treatment means amplitudes of right Pherenic nerve during rest. But, the pre-treatment means of amplitude of right Pherenic nerve during inspiration and expiration was obviously improved numerically but not statistically, this could be attributed to the small number of the sample of this study and to its heterogeneous obtained data.

It was noticed that the amplitude was affected, which indicated axonal lesion of the Pherenic nerve root due to compressive lesion resulted from cervical tension and the change in the neck posture. This opinion was potentiated by Preston and Shapiro[20], who stated that reduced amplitude with normal distal latency and conduction velocity is the primary abnormality associated with axonal lesions[24] provided the largest and fastest conducting axons remain intact. Mild slowing of conduction velocity and distal latency may occur if the largest and fastest conducting axon are lost.

The improvement of amplitudes of Pherenic nerves could be attributed to the effect of tension relieve and the change in neck posture which caused decompression of the Pherenic nerve roots with subsequent improvement of Pherenic nerve function[10].

This opinion was supported by Cherniack et al.,[3] who stated that exercises and proper positioning decreases the pressure on the nerve and increases the blood circulation to the nerve, reduces edema[25] and allows the nerve to return to normal function.

In this study, the correlation between mean values of right Pherenic nerves' amplitudes and mean values of MVV during inspiration was highly significant. Improvement of MVV is expected to change consequently attributed to improvement of the diaphragmatic strength and endurance resulted from improvement of the right Pherenic nerve amplitude. Finally, it is obvious from the previously mentioned findings that, in case of, application of ergonomically based postural program causes improvement of diaphragmatic motor nerve amplitude with subsequent improvement of diaphragmatic muscle function (tested by MVV).

In a way to explain mechanical changes it is of importance to consider the posture of the body linked with activity. Center of gravity normally falls through our body and moves through specific bony landmarks. In normal, correct posture everything is balanced, Yet there are a number of things that happen to us throughout life that result in posture changing. When the body shifts and poor posture sets in, the bones are improperly aligned and muscles, joints and ligaments take more stress and strain than intended[18].

Computer use is the aggravating cause of a significant number of injuries related to posture and positioning. One of the first things that happens with computer use is the user's head starts to move forward. Once the head moves forward, posture is thrown off and the body compensates for the shift. The neck moves forward, the shoulders become rounded and a compensatory sway in the back develops. The result of this poor posture is pain, muscle aches, tension and headaches.

Pherenic nerve stimulation (PNS) can assess airflow dynamics of the upper airway (UA) during wakefulness in man[1]. Using PNS, aiming to assess the impact of neck flexion and mouth opening in promoting UA instability measurements were made during nasal breathing in seven healthy subjects (ages = 23-39 yr; one woman). Surface diaphragm electromyogram, esophageal pressure referenced to mask pressure[2], and flow were recorded during diaphragm twitches with neck in neutral position and mouth closed and then with neck flexion and/or mouth opening. The researchers concluded that the position of the neck has a discernible impact on the flow behavior through the nonphasically active UA faced with a negative Pd[11].

Sedentary workers are most at risk for postural problems. People who have desk jobs should be very aware of their posture. Some postural problems are caused by structural faults. Although most structural problems cannot be corrected, it is important to be aware of them to prevent them from causing more injury or deviation[22].

Treatment goals for correcting postural problems include restoring range of motion, increasing flexibility and strengthening weak muscles. These goals can be accomplished through exercises and practice. Muscle relaxation techniques, massage and stretching exercises are also used to relieve pain and muscle tension. Overall good flexibility in boys and good endurance strength in girls may contribute to a decreased risk of tension neck. High endurance strength in boys may indicate an increased risk of knee injury. Of all the things that happen to our body, poor posture is one of the easiest to correct[23].

Finally, it is obvious from the previously mentioned findings that, in case of neck tension syndrome as a cumulative trauma disorder after receiving an ergonomically based program of work station design and postural education causes improvement of diaphragmatic motor nerve amplitude with subsequent improvement of diaphragmatic muscle function (tested by MVV).

Recommendations

With the future increase in the number of classes which involve computing , as well as the popularity of home computers, there is increased concern about the health of pupils and students. Make sure to regulate child's time on the computer and encourage breaks. These frequent rests can be helpful in reducing the likelihood of Computer Vision Syndrome, and other conditions. However, since adults are better than children at remembering when to stop children need to be watch a little more closely - or monitoring software that pops up the occasional break reminder.

Kids have special needs when it comes to computers, from a smaller mouse for smaller hands to footrests that support the dangling feet of children in adult-sized chairs. Keeping kids safe means tailoring the workstation to their pint-sized frames using good products, the right setup, and healthy usage habits.

REFERENCES

1- Attali, V., Mehiris, Straus, C., Salachas, F., Arnulf, I., Meininger, V., Derenne, J., and Similowski, T.: Influence of Neck Muscles on Mouth Pressure Response to Cervical Magnetic Stimulation Am. J. Respir. Crit. Care Med., 156(2): 509-514, 1997.

2- Ayuse, T., Inazawa, T., Kurata, S., Okayasu, I., Sakamoto, E., Oi, K., Schneider, H. and Schwartz, A.R.: Mouth-opening Increases Upper-airway Collapsibility without Changing Resistance during Midazolam Sedation.

3- Cherniack, N.S., Altose, M.D. and Homma, I. Kuo.: Rehabilitation of the patient with respiratory disease, 2nd ed. McGraw. 22-24, 245-247, 1999.

4- David, E., Laura, P., Hjelm, S., Wigaeus, E. and Laura, W.: Evidence for Work-Related Musculoskeletal Disorders. Journal of Occupational & Environmental Medicine. 38(11): 1079-1080, 1996.

5- Decramer, M. and De Troyer, A.: Respiratory changes in parasternal intercostal length, J Appl Physiol 57: 1254-1260, 1984.

6- Diepenmaa, A.C., van der Wal, M.F., de Vet, H.C. and Hirasing, R.A.: Neck/Shoulder, Low Back, and Arm Pain in Relation to Computer Use, Physical Activity, Stress, and Depression Among Dutch Adolescents, pediatrics, 117(2): 412-416, 2006.

7- Douglas, M.R. and Winer, J.B.: Guillain–Barré syndrome and its treatment Expert, 6(10): 1569-1574, 2006.

8- Fonburg, B.L. and Sicilian, L.: Respiratory dysfunction in neuromuscular diseases. Clin chest Med. 15: 607-810, 1994.

9- Greene, De Joy DM. and Olejnik, S.: Work, 24(1): 41-52, 2005.

10- Isono, J.S., Tanaka, A., Tagaito, Y., Ishikawa, T. and Nishino, T.: Influences of head positions and bite opening on collapsibility of the passive pharynx, J Appl Physiol, July 1,

97(1): 339-346, 2004. Dent. Rs., 83(9): 718-722, 2004.
11- Kim, M.J., Druz, W.S., Danon, J., Machnach, W. and Sharp, J.T.: Effects of lung volume and electrode position on the esophageal diaphragmatic EMG J Appl Physiol 45: 392-398, 1978.
12- Larsen, W.J. and Larsen, J.I.: Anatomy development function clinical correlation, 1st ed. Sounders. 181-182, 2002.
13- McLain, R.F., Raiszaden, K.: Mechanoreceptor ending of the cervical, thoracic and lumbar spine. Iowa Othop J., 15: 147-155, 1995.
14- Mikkelsson, L.O., Nupponen, H., Kaprio, J. Kautiainen, H., Mikkelsson, M. and Kujala, U.M.: Adolescent flexibility, endurance strength, and physical activity as predictors of adult tension neck, low back pain, and knee injury: a 25 year follow up study ,British Journal of Sports Medicine; 40: 107-113, 2006.
15- Mothers, L.H., Chase, R.A. and Dolph, J.: Clinical anatomy principles, 2nd ed. Mosby. 200, 529-531, 1996.
16- Murphy, D.R.: Cervical spine syndroms, 1st ed. McGraw Hill. 4, 9, 11, 21, 22, 193, 200, 2000.
17- Nemer, S., Wolfgang, G., Zielinski, T.M., Scott, M., P., Benditt David, G. and Keith, L.G.: Feasibility and effects of transcutaneous Pherenic nerve stimulation combined with an inspiratory impedance threshold in a pig model of hemorrhagic shock. Critical Care Medicine. 31(4): 1197-1202, 2003.
18- Nordin, M.: Methods for studying work load with special reference to the lumbar spine, Goteborg, 1982.
19- Polat, M., Tosun, A., Serdaroğlu, G., Çağlayan, E., Karapınar, B.T., Gökben, S. and Tekgül, H.: Chronic inflammatory demylinating polyradiculopathy: an atypical pediatric case complicated with Pherenic nerve palsy The Turkish Journal of Pediatrics, 49(2): 210-214, 2007.
20- Preston, D.C. and Shapiro, B.E.: Electromyography and neuromuscular disorders 1st ed. Butterworth-Heinemann. 36-37, 2000.
21- Series, F. and Ethier, G.: Assessment of upper airway stabilizing forces with the use of Pherenic nerve stimulation in conscious humans, J Appl Physiol, 94(6): 2289-2295, 2003.
22- Smith, M.J.: Occupational stress ,handbook of human factors salvendy (Ed) wiley interscience NY 1987.
23- Sotomaya, M., Bergquest, U., Jonai, H. and Satto, S.: An ergonomic questionnaire survey on the use of computers in school, industrial health, 40(2): 135-141, 2002.
24- Thut, D., Schwartz, A., Roach, D., Wise, R., Permutt, S. and Smith, P.L.: Tracheal and neck position influence upper airway airflow dynamics by altering airway length J Appl Physiol 75: 2084-2090, 1993.
25- Verin, E., Sériès, F., Loche, C., Straus, C., Zelter, M., Derenne, J. and Similowski, T.: Effects of neck flexion and mouth opening on inspiratory flow dynamics in awake humans J Appl Physiol, 92: 84-92, 2002.
26- Wilkins, R.L., Krider, S.J. and Sheldon, R.L.: Clinical assessment in respiratory care, 4th ed. Mosby., 141-153, 2000.
27- Williams, P.L., Bannister, L.H. and Berry, M.M.: Gray's anatomy, 38th ed. Churchill Livingstone. 316-318, 1995.
28- Zhang, W. and Davenport, W.: Activation of thalamic ventroposteriolateral neurons by Pherenic nerve afferents in cats and rats Appl Physiol, 94: 220-226, 2003. First published August 23, 2002.

الملخص العربي

برنامج تدريب الهيئة المعتمد علي ميكانيكا العمل في حالات الشد
في الرقبة في الصبية في سن المدرسة من مستخدمي الكومبيوتر

أمراض الجهاز العضلي الهيكلي المتعددة التي تحدث نتيجة استخدام الكومبيوتر أصبحت جزء أساسي من الحياة الحديثة . أهم تلك الأمراض ما يعرف بالإصابات التراكمية التي قد تظهر في أنماط مختلفة .مع زيادة التوسع في استخدام الكومبيوتر في الصبية بدأت الشكوى من مشكلات لو تركت دون تشخيص تؤدي إلى علل خطيرة ومزمنة . ألاف الأطفال يصابون سنويا بمشاكل شد الرقبة وغيرها مما يحدث نتيجة سوء الهيئة والعادات الخاطئة في الكتابة علي الكومبيوتر، والوقت ليس متأخرا للتعديل . من هذا المنطلق أجريت هذه الدراسة بمشاركة 30 صبي في سن المدرسة الإعدادية ممن يشتكوا صداع ناجم عن شدة وتوتر الرقية علاوة علي سؤ هيئة الرقبة وهم من مستخدمي الكومبيوتر بكثرة .كل منهم قد تلقي برنامج تربوي في التعامل مع الكومبيوتر. تم قياس سرعة توصيل العصب المغذي للحجاب الحاجز بجانب قياس أقصي حجم للتنفس الإرادي باستخدام جهاز الرسبيروميتر. وقد وجد فرق ذو دلالة إحصائية في سرعة توصيل العصب و كذلك في مقياس التنفس . نتائج هذا البحث قد تكون أساس للتدخل في مرحلة الصبية بهدف الوقاية لان منع الإصابة أسهل من علاجها.