Original Article

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The Impact of Chronic Neck Pain on Respiratory Functions among Female University Students

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Abstract:

Objective: Students with chronic neck pain have several issues that could constitute susceptibility to respiratory dysfunction. So, this current study was conducted to investigate the impact of chronic neck pain on respiratory function among female university students.

Material and Methods: In this cross-sectional study, 60, female University students voluntarily participated, and were divided into two groups: 30 students with chronic idiopathic neck pain (age=21.9±2.2 years, height=160.7±6.5 cm, weight=71.9±8.5 kg, body mass index (BMI)=28±3.6 kg/cm^2), and 30 healthy students as the control group (age=21.5±2.1 years, height=163.5±6.8 cm, weight=69.5±11 kg, BMI=26.2±5 kg/cm^2). Both groups were investigated using a Spirometer (One-Flow™ Forced Vital Capacity (FVC) Kit, USA, Granbury). Descriptive statistics and Multivariate analysis of the variance test were both used to compare both groups.

Results: Students with chronic neck pain were found to have statistically significant reductions in Peak Expiratory Flow and the Forced Expiratory Volume in one second (FEV1)/FVC ratio (p-values=0.043 and 0.000, respectively). However, FVC (p-value=0.372) and FEV1 (p-value=0.840) revealed no statistically significant differences between both groups.

Conclusion: Respiratory dysfunction, with chronic neck pain mainly manifests as respiratory weakness and hypocapnia. Studying the hypothesis of neck pain, and its possibility of causing respiratory dysfunction in these subjects gives rise to important clinical implications concerning the assessment and treatment of patients with chronic neck pain.

Keywords: chronic neck pain, respiratory functions, Spirometer

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Introduction

Chronic neck pain (CNP) is the most recurrent musculoskeletal problem.[1] It is expected that 70.0%-80.0% of people agonize from neck pain at some time in their lives[2], and some of these inhabitants may experience permanent and frequent pain.[3] For the largest part of the previous century, neck pain was of secondary interest in relation to lower back pain. However, the increasing occurrence of neck pain during this century is a result of the increased use of mobile phones, tablets and computers.[3]

Patients with CNP may experience several associated problems, which may result from neck pain experiences; such as, reduced endurance and strength of neck muscles as well as limitation of neck joint movements.[4] Kapreli et al.[5] proposed that patients with CNP might also have respiratory disturbances, in which pain may increase the respiratory rate as a noxious stimulus; whereas, drugs for pain inhibition may suppress it. Furthermore, posture alterations, muscle imbalances, and segmental instability caused by strength reduction of the neck muscles may result in thoracic spine instability that may cause changes in the rib cage. Biomechanics and breathing pattern alterations can also be caused by increased neck muscle fatigability, and decreased range of neck movement; potentially resulting in further rib cage mechanic changes. These changes in rib cage mechanics can finally lead to dysfunction of respiratory muscles.

Furthermore, the deficits accompanying CNP may directly influence respiratory muscle function, due to the common use of sternocleidomastoid, trapezius, and scaleni or indirectly through a change in rib cage mechanics.[6] Although, all of these changes in respiratory function of patients with CNP are supported by a scientifically valid rationale, they have not been investigated. Their examination remains of high scientific and clinical interest for obtaining better insight into the impact of neck pain on the quality of life and health of sufferers.[7]

Peak Expiratory Flow (PEF), Forced Vital Capacity (FVC), Forced Expiratory Volume in one second (FEV1), FEV1/FVC ratio represented the basal respiratory function in this study.[8,9] The reduction of respiratory flows, through the detection of these parameters, represents the neuromuscular weakness that may be associated with musculoskeletal disorders; such as CNP.[10] A Spirometry is a common device used to examine pulmonary functions, and deliver information concerning the presence of pulmonary functional abnormalities.[11,12]

Further examination of the potential connection between CNP and respiratory abnormalities could provide information that could significantly influence assessment, rehabilitation, and drug prescription in these patients. During rehabilitation, potential disturbances of respiratory function should also be taken into consideration when designing appropriate exercises for both the neck and respiratory system.[5]

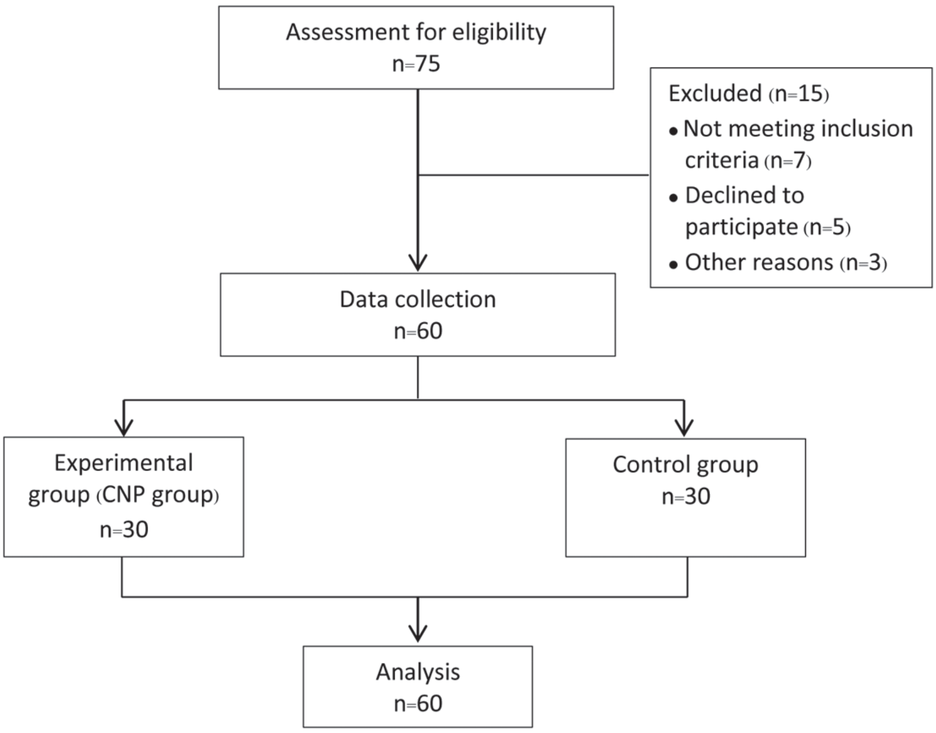
However, there is a lack of knowledge regarding the effect of CNP on respiratory function. Therefore, the purpose of this current study was to investigate the difference in respiratory function between CNP and normal (without neck pain) female university students. The null hypothesis stated that: there is no difference in respiratory function between the subjects with CNP and subjects without CNP.

Material and Methods

A cross-sectional study was conducted to investigate the impact of CNP on respiratory functions PEF, FVC, FEV1, FEV1/FVC ratio through the comparison between subjects with CNP and subjects without CNP. All examinations were conducted by an appropriately skilled physiotherapist. Although calculation of sample size showed that for a large effect size (d_0.8), 27 subjects were required for each group, with a power analysis of 80.0% (hypothesis with two-tail, p-value=0.050), using G*power software, more subjects were recruited for each group, so as to improve the statistical analysis accuracy and power.

In this study, 60, female students from Physical Therapy College, Cairo University, voluntarily participated and were then assigned into two equal groups, according to the inclusion and exclusion criteria. There were 30 students in the experimental group (with CNP) (age=21.9±2.2 years, height=160.7±6.5 cm, weight=71.9±8.5 kg, body mass index=28±3.6 kg/cm^2) and 30 students in the control group (age= 21.5±2.1 years, height=163.5±6.8 cm, weight= 69.5±11 kg, body mass index=26.2±5 kg/cm^2) as shown in the flow diagram Figure 1.

Both groups had the following inclusion criteria: i) both groups were female university students. ii) they did not engage in any physical activities. iii) the neck pain group spent at least 6 hours per day in front of a computer. iv) the neck pain group had idiopathic chronic neck pain [at least two years in duration, with a pain level of more than 5 out of 10 on the visual analogue scale]. v) both groups did not take any kind of medication that inhibited pain for at least 6 months. The exclusion criteria for both groups included: i) any spinal or chest surgery. ii) smoking history. iii) whiplash injuries, traumatic or neurological neck pain, and neuromusculoskeletal pain in any other body areas. iv) morbidity obesity (body mass index>40 kg/cm^2). v) permanent abnormalities of the thoracic cage or vertebral column. vi) serious cardiac, pulmonary, mental, or metabolic disorders. Before the data collection, each subject signed an approved consent form from the review board of Physical Therapy College, Cairo University (No. P.T.REC./012/002891).



CNP=chronic neck pain, n=number

Figure 1 Study flow diagram

All variables of interest were measured using a Spirometer One-Flow™ FVC Kit (USA, Granbury), which is associated with software (3141200 One-Flow Software). This tool is a small, light, and handheld spirometer: as shown in Figure 2. It consists of a disposable mouthpiece, universal serial bus cable, and software that can be used by medical professionals for screening and monitoring of lung functions (PEF, FVC, FEV1, FEV1/FVC ratio); additionally, up to 100 of each measurement can be stored. The reliability and validity of the Spirometer has been detected and confirmed by different studies; therefore, use of a handheld spirometer in research studies appears justified.[13,14]

Weight and Height Scale, Mechanical Column Type for Adults (NET brand WS2010, Capacity: 0-160 kgs, with 100 g graduations with eye-level sliding weights, and height measuring rod, range 75 to 200 cm/division 5mm large non-slip platform) was used to detect the height and weight of subjects within each group.

All the demographic data (age, weight, height, body mass index) were recorded for both groups; experimental and control (healthy subjects) groups, as shown in Table 1. The study was conducted from April, 2020 to June 2021 in Physical Therapy laboratory. The demographic data were collected while the subjects were wearing comfortable and light clothes. In addition, all subjects in both groups were barefoot, for more accurate measurements.

After signing the consent form, each student stood straight, looking forward, with their chins slightly lifted. Standing tends to improve lung function and volume as well as improve the movement of the rib cage and respiratory muscles' function. All measurements were conducted under the same environmental factors, with the same temperature and humidity. This is provided by the spirometer guidelines; as per the recommendations of the American Thoracic Society/European Respiratory Society.[15] The spirometer encompassed four respiratory tests (PEF, FVC, FEV1,

Figure 2 Spirometer One-Flow™ Forced Vital Capacity Kit

FEV1/FVC ratio). Each participant was asked to seal their lips around the tube-shaped mouthpiece in such a way that the tongue nor teeth did not hinder the air stream from the tube of the Spirometer. At the same time, each subject was requested to use a nose clasp in all measurement stages to avoid any possible air outflow. Moreover, each subject was encouraged to exert maximal effort throughout each measurement.

After a short explanation of the maneuver, the students were directed to breathe in a normal manner into the mouthpiece. At which time, after a short time period of 5-25 seconds, the device provided a sound signal to the students' to inhale fast, and as forcefully as possible to achieve their total lung volume, and then to exhale fast and as forcefully as possible to the achieve residual lung volume in a comfortable manner. PEF, FEV1, and FVC were detected from the maximum of three trials, and the value of the FEV1/FVC ratio was calculated consequently. The time between the beginning of the test and the device sound signal was reliant on the time required for the student to attain a steady breathing maneuver. During the process, the students' were encouraged verbally to inspire or expire with a constant flow. The process was repeated three times, with 30 seconds of rest between the trials. The data that appear on the device screen was collected and recorded in the datasheet, in preparation for analysis. The respiratory parameters (PEF, FEV1, FVC, FEV1/FVC ratio) were compared between the experimental (students with CNP) and control groups (students without CNP), who had statistically non-significant demographic data, and who were examined under the same environmental conditions.

Both mean and standard deviation were calculated for all variables of interest, using the Statistical Package for Social Sciences (SPSS), version 20.0. The exploration of data was performed, before statistical analysis, to clean the data of any outlier. Descriptive statistics were conducted, and the test of normality was proved by the Shapiro-Wilk test for demographic data and for each variable of interest (p-value>0.050). Multivariate analysis of the variance test was used to compare the mean of each variable of interest (PEF, FVC, FEV1, and FEV1/FVC ratio) between both groups (experimental and control groups). Data analysis was significant at p-value<0.050.

Results

Demographic data and pulmonary function characteristics

The mean and standard deviation of demographic data of both groups (30 control and 30 experimental) are represented in Table 1. These showed no statistically significant differences in age, weight, height, and BMI (p-value>0.050). Frequencies and percentages of PEF, FVC, FEV1, and FEV1/FVC ratio for both groups are demonstrated in Table 2.

MANOVA of pulmonary function variables (PEF, FEV1, FVC, FVC/FEV1 ratio) between both groups:

The MANOVA test showed a statistically significant difference between both groups in PEF. This difference was in favor of the control group, because the average value of PEF is greater than the corresponding average value of the experimental group (p-value=0.043). In addition, there was no statistically significant difference between both groups in FEV1, with a p-value=0.840. Moreover, the MANOVA test of FVC showed no statistically significant difference between both groups, with a p-value=0.372. Furthermore, the test showed a statistically significant difference in the FEV1/FVC ratio between both groups. This difference was in favor of the control group because its average is greater than the corresponding average of the experimental group (p-value=0.000). All means and S.D. are demonstrated in Table 3.

Table 1 Demographic data of neck pain and control groups (mean±S.D.)

Demographic variables	CNP group=30 Mean±S.D.	Control group=30 Mean±S.D.	p-value	t-value
Age (years)	21.9±2.2	21.5±2.1	0.512	0.66
Weight (kg)	71.9±8.5	69.5±10.9	0.339	0.96
Height (cm)	160.7±6.5	163.5±6.8	0.106	-1.64
BMI (kg/cm^2)	28±2.6	26.2±5.0	0.118	1.59

CNP=chronic neck pain, BMI=body mass index, S.D.=standard deviation

*Significant level at p-value<0.050

Table 2 Frequencies and percentages of pulmonary function test variables for both groups

Variables of pulmonary function test	CNP group=30		Control group=30	
	Frequency	Percentage (%)	Frequency	Percentage (%)
PEF-zones	2	6.7	0	0.0
Less than 50	14	46.7	10	33.3
50 to 100	8	26.7	9	30.0
100 to 150	5	16.7	6	20.0
150 to 200	1	3.3	5	16.7
200 and over				
FEV1-zones	8	26.7	6	20.0
Less than 1	16	53.3	17	56.7
1 to 2	4	13.3	6	20.0
2 to 3	1	3.3	1	3.3
3 to 4	1	3.3	0	0.0
4 and over				
FVC-zones	4	13.3	6	20.0
Less than 1	14	46.7	16	53.3
1 to 2	11	36.7	8	26.7
2 to 3	1	3.3	3	10.0
3 and over				

CNP=Chronic Neck Pain, PEF=Peak Expiratory Flow, FEV1=Forced Expiratory Volume in one second, FVC=Forced Vital Capacity

Table 3 MANOVA test for pulmonary function variables of both groups

Pulmonary function test variables	CNP group=30 Mean±S.D.	Control group=30 Mean±S.D.	p-value	f-value
PEF	105±52	135±64	*0.043	4.12
FEV1	1.50±0.80	1.47±0.58	0.840	0.04
FVC	1.71±0.62	1.56±0.63	0.372	0.81
FEV1/FVC ratio	0.81±0.12	0.96±0.04	*0.000	48.67

CNP=chronic neck pain, PEF=peak expiratory flow, FEV1=forced expiratory volume in one second, FVC=forced vital capacity, S.D.=standard deviation

*Significant level at p-value<0.050

Discussion

The findings of this current study revealed that subjects with CNP had a significant reduction in PEF, and FVC/ FEV1 ratio, while showing no statistically significant difference in both FEV1 and FVC. The reduction of PEF came in agreement with the findings of a controlled study conducted by Dimitriadis et al.[7], which indicated that subjects with CNP have a significant reduction in maximum expiratory flow. The reduction in respiratory flows of subjects with CNP may chiefly be attributed to the reduced effort, due to neuromuscular weakness, phobia from new pain experience, and movement suppression; due to pain. Furthermore, Jung et al.[16] confirmed the reduction of PEF with the change of neck posture via prolonged use of a smartphone. Moreover, this study detected a reduction in the FEV1/FVC ratio, and the cause was related to a slumped posture when in seated or standing postures. This was the same as in the CNP group of our study that spends at least 6 hours per day in front of a computer, which may contribute to them maintaining the same slumped posture during standing. A study was conducted by Dimitriadis et al.[10], which showed a reduction in PEF in the subjects with CNP in comparison with healthy subjects; although this reduction did not reach a significant level. This may return to the chronicity of neck pain subjects, who had neck pain for >6-months in duration, with pain complaints once a week only; although PEF was significantly correlated with pain intensity and neck muscle strength. Also, the BMI of the subjects in that current study was higher than in this study; as in that the subject can be classified as overweight (BMI >25–30 kg/m^2).[17]

Significant reduction in FEV1/FVC ratio is an obvious index of pulmonary dysfunction, predominantly when a pulmonary obstruction is present[18,19], while the reduction of PEF can be detected in both obstructive and restrictive pulmonary disorders.[18,12] Alternatively, there was no other proof from the results of this current study of any other significant changes in Spirometric values in subjects with CNP. The findings of our study showed no change in the FEV1 nor FVC; these findings are in agreement with Kapreli et al.[20], who found no changes in these two Spirometric indices. This indicated the subjects of our study with CNP suffer from obstructive lung disease, rather than restrictive lung disease, which affects the pulmonary function. This may return to the inhibitory effect of pain on normal lung function. Reduction in FEV1/FVC ratio and PEF are precise indicators of obstructive pulmonary disease; however, in restrictive lung diseases; such as, spinal deformation affecting the expansion of the chest wall, relative decline of both the FEV1 and FVC leaves the PEF and FEV1/FVC ratio near normal values.[21,22]

The findings of this study give rise to important clinical implications regarding the evaluation and management of respiratory symptoms in subjects with CNP. It provides several suggestions for the rehabilitation of such respiratory symptoms. More specifically, several inspiratory muscle training devices are available.[23] These devices can provide different degrees of resistance during patients breathing. Exercising with these devices has been found to increase the strength of respiratory muscles.[23] Thus, the respiratory function of subjects with CNP may be improved by the use of such equipment; as they may help to improve the strength, endurance, and coordination of their respiratory muscles as well as inhibiting the pain.[24] Another potential intervention for subjects with CNP could be exercises for increasing lung volumes and peak expiratory flow. Considering the fact that the current literatures do not provide enough evidence, t regarding the respiratory dysfunction in subjects with CNP, further research is required. This should be mainly directed towards optimizing treatment protocols and developing classification systems for improving the clinical reasoning of respiratory dysfunctions. Some drawbacks were detected in this study. Chiefly among them being the female sample, rather than the application on both genders, which makes the findings of this study limited to the selected sample.

Conclusion

According to the statistical results of this current study, there were significant reductions in PEF and FEV1/FVC ratios in students with CNP; however, there were no significant changes in the values of FEV1 and FVC between both groups. This respiratory dysfunction of subjects with CNP mainly manifested as respiratory weakness and hypocapnia. Studying the hypothesis of neck pain, and its possibility of causing respiratory dysfunction in these patients gives rise to significant clinical implications regarding the evaluation and treatment of subjects with CNP, so as to improve their respiratory functions.

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Conflict of interest

There is no conflict of interest that can be decelerated

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