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Full Length Research Paper

The Impact of Varied Sitting Postures on Pulmonary Function Volumes and Capacities in Academic Students

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The purpose of this study was to investigate changes that occur in pulmonary function when postural changes in the sagittal plane are made in a seated position in students. This cross sectional analytical study was done randomly on 20 boys from Iran, and the results of a forced expiratory manouvre in these young healthy subjects were compared according to body posture. Twenty able-bodied students boys (age 13.5±1.09 yr, height 158.25±5.65 cm and weight, 50.45±7.02 kg), participated in this study. Standard spirometric measurements forced vital capacity (FVC), forced expiratory volume in 1 s (FEV_1) and peak expiratory flow(PEF) were taken for each subject in each of 3 sitting postures: (normal, slumped and kyphotic) and standing posture. A repeated measure ANOVA and a paired t test indicated that FVC and FEV_1 value in standing posture was significantly higher than other sitting postures. In slumped sitting, FVC, FEV_1 and PEF significantly decreased from other sitting posture. But there was no significant difference for FVC, PEF and FEV_1 between the normal and kyphotic sitting postures. The results showed that FVC, FEV_1 and PEF as importance index in health of pulmonary system function, was affected by sitting posture, particularly in slumped sitting posture. Also student should prevent slumped sitting posture.

Key words: Pulmonary function, sitting, forced vital capacity, forced expiratory volume in 1 s, peak expiratory flow.

INTRODUCTION

The neck, shoulder and back pain problems are already common among school children (Salminen, 1984; Taimela et al., 1997). The recent interviews have documented an increase in health problems (Vikat et al., 2000). Students' experience showed that the problems were due to school tables and chairs (Troussier et al., 1999). School furniture forces the students into different poor sitting postures (Koskelo, 2006).

Many factors can contribute to poor lung function, including smoking habits, surgical history, asthma, allergies, chronic obstructive pulmonary disease, and obesity (Lin et al., 20060. Additionally, the connection between posture and lung performance has been proved to be significant (Baydur et al., 2001; Lin et al., 2006; Makhsous et al., 2004).

Storr-paulsen and Aagaardhensen (1994) found that in one school, children remained seated between 19 and 90 min during a 90 min double lesson, with older children sitting for longer periods of time and most of the children sitting on average for more than 60 min. Of the time spent seated, 57% was spent leaning forward (example, writing or painting) with 43% spent leaning backwards (example, looking at blackboard or reading). Studies have confirmed that various postures affect pulmonary function. (Appel et al., 1986; Manning et al., 1999). For example, the prone position in healthy subjects has been shown to cause compression of the anterior ribs, which

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kyphotic sitting



Normal sitting



Slumped sitting

Figure 1. Three sitting postures, Slumped, Normal, kyphotic are shown here.

limits the volume of air into the lungs and the ability to expel air out of the lungs (Vike et al., 2000). Nwaobi and Smith investigated the effects of a seated position in 2 different types of wheelchairs on children diagnosed with cerebral palsy. They found improvements in pulmonary function (57.7% increase in vital capacity, 51.6% increase in forced expiratory volume in 1 s [FEV1], and a 55.0% increase in expiratory time) caused by postural adjust-ments made while seated in a wheelchair with modular inserts to maintain upright posture. (Nwaobi and Smith. 1985). Lin et al. found that in standing posture all lung capacity and expiratory flow were significantly superior to those in slumped and normal WO_BPS[1] sitting, but slumped sitting significantly decreased lung capacity, expiratory flow and lumbar lordosis (Lin et al., 2006). because students are in sitting postures for prolonged pe-riods of time, it is important to know how different sitting posture affect pulmonary function. Breathing mechanics are such that compliance and lung ventilation are partially a result of thoracic mobility as well as excursion of the diaphragm. The ability of the thorax to expand during inspiration and to return to resting position during exhalation is dependent on the mobility of the thoracic spine and ribs. A change in the position of the thoracic spine, that is, scoliosis, may alter the mechanics of the chest wall, which may cause a uniform or asymmetrical change in the ability of the thorax to expand (Nwaobi and Smith, 1986). More studies relating body posture and lung volume have been performed, but they focus almost exclusively on comparisons between sitting, prone, and supine postures, and significant changes were attributed to the weight of organs on the diaphragm (Chen et al., 1990). A few investigations were found to address the relationship between lung capacities in different sitting postures in students.

Based on the hypothesis that the pulmonary function may be decreased when the student's remains seated in poor, slumped and kyphotic postures, research was carried out to evaluate the relationship between the lung capacity measures and sitting postures, which were chosen as slumped, normal and kyphotic sitting postures. The evaluated lung capacity measures were the forced vital capacity (FVC), peak expiratory flow (PEF), and forced expired volume in one second (FEV_1).

METHODS

Twenty able bodied subjects (age 13.5±1.09 years, weight 50.45±7.02 kg, height 158.25±5.65 cm) participated after giving informed consent. A spirometer system (Quark b2, COSMED, Rome, Italy) was used to measure the FVC, PEF and FEV1 of each subject. All subjects had full range of motion of the spine with no pain induced when assuming the testing postures. The 3 sitting postures included normal, slumped and kyphotic sitting (Figure 1) and standing posture as a reference value, in all seated postures, knees were flexed at 90° with feet fully supported. The normal sitting was defined as the subject sitting in chair with the lumbar support remaining flat, correspondingly. A Slumped posture was defined as the subject sitting in the normally configured chair allowing the pelvis to be positioned in the middle of the seat pan, with the trunk/spine reclining posteriorly against the backrest, and kyphotic sitting, subject seated in the chair and lean to forward and lay down their fore arms on the desk.

In this study, we used common furniture in school for measuring respiratory variable of subject. The study was approved by the institutional review board of Shirvan Islamic Azad University.

[1]seat without ischial support

Protocol

Each subject was transferred to the desk and seat in one of the postures. He was then asked to take the deepest breath possible (without the spirometer) and exhale hard into the transducer tube of the spirometer. Exhalation continued until no more air flow was produced. This was repeated in other postures and three trials were then recorded for each of the 4 postures. A brief rest of 30 s between trials was used to minimize the fatigue effect on the respiratory muscles. The posture testing sequence was randomized according to a randomization schedule generated beforehand.

Data analysis

After each subject completed the breathing measurements, we selected their highest values among the 4 trials in each posture. Then comparisons for the average values of FEV1, FVC, and PEF were made between the normal, WO-BPS, and slumped postures. The WO-BPS posture included sitting with the buttocks all the way back into the seat while the BPS was tilted downward 20° with respect to the front part of the seat. To test the effect of posture on a subjects VC, EFV1, PEF, we used analysis of variance (ANOVA) with the repeated measures, with the repeated variable being the posture (3 sitting postures and 1 standing posture). This analysis was first completed with the posture effect repeated over the 4 different postures to test the overall effect that posture had on the VC, EFV1, and PEF. When significance was found, paired t- test were done to test posture effect on each of the LC-EF parameters between each possible pair of posture combinations. The significance level was less than 0.05.

RESULTS

The overall average values of the FEV1, FVC, PEF, across all subjects for the slumped, normal, kyphotic and standing postures are given in Table 1. It clearly shows that the participant's posture influenced the airflow during the participant's breathing test. Participants had the best VC, EFV_1, PEF, when in the standing posture, then in the normal sitting posture, followed by the khyphotic sitting posture. All VC, EFV_1 and PEF data collected showed that the slumped posture revealed decreases relative to normal, kyphotic and standing postures, but when compared, the parameters in the normal posture with the kyphotic posture FVC (P=0.516), FEV1 (P=0.629), PEF (0.314) were not statistically significant. Also the changes in PEF between the normal sitting vs. standing and kyphotic sitting vs. standing were not significantly different.

DISCUSSION

The results of this study suggest that there is a difference in measures of pulmonary function between the 3 sitting postures. Also these finding show that there is a significant decrease in FVC, FEV1 and PEF when a subject is slumping.

Blair and Hickam (1955) found that functional residual capacity was lower in the seated position than in the standing position, and still lower in the recumbent position. Townsend (1984) found slightly higher FEV1 and FVC values in standing subject than in sitting posture. Makhsous et al. (2004), reported that slumped posture significantly reduced the lung capacity, compared with that of normal and WO-BPS postures. Lin et al. (2006), concluded that slumped posture has significantly lower values of lung capacity and expiratory flow and in the standing were significantly superior to those in slumped, normal and WO-BPS sitting postures. Our study corroborates these results because it demonstrates that subjects showed overall better lung function in the standing posture than in the slumped, normal and kyphotic sitting postures. This indicates that subjects could achieve larger lung volume during inspiration, perform more efficient expiratory muscle contraction, and experience less air flow obstruction within airways of all sizes when in a standing posture. When compared with normal and kyphotic sitting postures, standing posture is significantly superior on FVC and FEV1 but there is not significant in PEF between standing posture with normal and kyphotic sitting postures. It is possible to achieve the condition of airflow in large airways that is similar to those provided in the standing posture. Our subjects had the lowest average spirometric indices while in slumped sitting; the difference in these indices between the slumped posture and other sitting postures showed statistical significance. In young healthy subjects with a normally positioned dia-phragm, the slumped sitting posture results in increased intra-abdominal pressure by approximating the ribs to the pelvis, making it difficult for the diaphragm to descend caudally during inspiration (Landers et al., 2003). Crosbie and Myles (1986) hypothesized that the inability of the diaphragm to descend may negatively affect lung function. They found a significant decrease in FEV1 and vital capacity when subjects maintained a half-lying slumped posture, compared with other positions. In addition, Duru et al. (2000) reported that sitting caused an increased compression of abdominal viscera and limitation of downward movement of the lungs. Another possible reason for the slumped posture, given the lowest FVC, FEV1 and PEF readings, may be the position of the head posture. Hellsing (1989) has shown that the size of the free airway is affected by the head flexion and exten-sion. In addition, placing the head and neck in proper alignment reduced airway obstruction, which helped to increase pulmonary function.

Lin et al. (2006) found lowest lumbar lordosis recorded in the slumped posture. They reported that significant differences in lumbar lordosis in different posture may account for the changes in pulmonary capacity between the postures. Also the result of this study has not showed significant different in VC and EFV1 between normal and

Table 1. Average VC, EFV_1 and PEF measurements for 20 participants.

Posture	FVC(L)	FEV1(L)	PEF(L/s)
Slumped	2.39±0.445	2.33±0.438	5.01±0.254
$p^{\times}$	0.003	0.004	0.007
$t_{19}{}^{\times}$	3.467	3.292	3.050
p^{+}	0.000	0.000	0.000
$t_{19}{}^{+}$	-4.187	-4.381	-4.634
$p^{\star}$	0.000	0.000	0.002
$t_{19}{}^{\star}$	-5.142	-3.10	-3.596
Normal	2.523±0.505	2.45±0.50	5.50±0.30
p^{+}	0.516	0.629	0.314
$t_{19}{}^{+}$	0.659	0.491	-1.034
$p^{\star}$	0.003	0.011	0.430
$t_{19}{}^{\star}$	-3.460	-2.814	0.807
Kyphotic	2.498±0.433	2.44±0.096	5.58±0.24
$p^{\star}$	0.000	0.013	0.645
$t_{19}{}^{\star}$	-3.479	-2.732	-0.468
Standing	2.699±0.481	2.58±0.50	5.67±0.32
$p^{\star}$	0.000	0.000	0.003
$F^{\star}$	14.98	11.152	6.60

Note. Values are mean ± SD (N=20).LC-EF For the slumped, normal, khypotic sitting, and standing postures given. Significance (p) and t or F value for comparison of each LC-EF parameter between postures is listed. × p (t) is the significance difference as compared with normal posture. ✚ p (t) is the significance difference as compared with kyphotic posture. ⋆ p (t) is the significance difference as compared with standing posture. ✦ p (F) is the significance of repeated-measures ANOVA for posture effect.

kyphotic sitting posture that may be reasoning by normalization of subjects or sufficient desk or table with anthropometric dimensions subjects.

Examination of our study brought to light several limitations. One limitation was that our sample size was small. The other limitation in the study was the posture effect of VC, EFV1 and PEF in consecutive posture changes over a short time in the able-bodied subjects.

Conclusion

VC, EFV1 and PEF as important indexes in health of pulmonary system function, is affected by sitting pos-tures. Particularly in slumped sitting, the slumped sitting posture has significantly lower values of VC, FEV1 and PEF than the normal, kyphotic and standing postures in able-bodied subjects. Thus, a physical education and health teacher can emphasize the use of standard school furniture, thereby refusing the continuous sitting postures and changing the seats' physical activity and isometric contraction during sitting position.

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