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Physiology

Effect of Various Postures on Forced Vital Capacity and Forced Expiratory Volume in One Second in Male Medical Students

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Abstract **Original Research Article**

The change in body posture can affect the resting length of respiratory muscles and the vestibular system contributes to altering the respiratory muscle activity during movement and change in the posture. Ideally, Spirometry is done in sitting posture until the subject is unable to do so. The aim of our study was to investigate the effect of different posture on pulmonary function test parameters like FVC & FEV_1 in male medical students. The mean age, height and weight of the all participants were 21± 2 years, 61 ± 6 Kg and 172 ± 5.4 cm. Forty male participants, aged between 17-25 years were enrolled after they had signed a written consent. Spirometer measurements (FVC & FEV_1) was taken in Standing, Normal Sitting, Kyphotic Sitting, Slumped Sitting and Supine postures. Each measurement was taken three times and the average values were analysed and the data were compared by One-way ANOVA and POST HOC Test statistically. There was significant difference in the lung function variables across all the body postures. ($p<0.05$) FVC and FEV_1 were found to be higher in the standing posture as compared to normal sitting & supine posture. FVC and FEV_1 were significantly lower only in supine posture ($p<0.05$) as compared to standing and normal sitting posture.
Keywords: Pulmonary Function Test, COPD, Posture, Lung function, Postural changes, Forced Vital Capacity.

Introduction

Posture is a balanced arrangement of body structure determined by the position of all body segments at a given moment [1]. Body posture has long been identified as a very important factor having an impact on lung volumes [2]. In addition, body positions are clinically important even in the healthy population because they are often used during treatment resuscitation, everyday activities and surgical procedures [3]. Pulmonary function tests are used in the investigation and monitoring of patients with respiratory pathology such as Chronic Obstructive Pulmonary Disease, Asthma, Interstitial Fibrosis, Obliterative bronchiolitis, Cough, Wheeze, Pulmonary Vascular Disease and Breathlessness etc [4].

The Present research work was done to evaluate the influence of posture in medical students on the variables of Pulmonary Function Tests, specially the Forced Vital Capacity (FVC) and Forced Expiratory Volume in One Second (FEV_1) because students spend a recognisable duration on benches in school and colleges. They have to assume different postures like Standing, Sitting (Normal, Kyphotic and Slumped) and Supine position according to their individual comfort which alters the lung volume and functions [5].

Materials and Methods

In this study, we selected 40 apparently healthy, non-smoking male medical students of Dr S.N. Medical College, Jodhpur,Rajasthan during the year of 2018-19. Institutional ethical clearance was obtained before commencement of the study. An informed consent was taken from each subject during the study. The participants were first given an explanation about the purpose and procedure of the experiment.

Inclusion Criteria

- Male age between 17 years to 25 years
- BMI between 18 Kg/m^2 to 25 Kg/m^2
- Have full range of motion of spine with no pain.

Exclusion Criteria

- Age below 17 years and above 25 years.
- BMI < 17 Kg/m^2 and > 25 Kg/m^2
- The subjects excluded from the study are smokers, obese individuals, having history of respiratory or cardiac diseases, any airway disorders or thoracic,

abdominal, chest wall deformities such as kyphosis, scoliosis, rib fractures, non-co-operative subjects.

The anthropometric data i.e. height, weight, body mass index (BMI), waist circumference of the subjects was taken followed by measurements of blood pressure and heart rate.

For Pulmonary function tests electronic spirometer (Spiro Excel PC/Laptop based spirometer, Medicaid Systems) was used which is capable of giving highly accurate and reliable test result. It consists of an ergonomic handset with digital turbine transducer which was connected directly to a PC/Laptop's USB port. The test was carried out in a place convenient and comfortable for the subjects. Demonstration of tests was shown to the subject. For measuring forced vital capacity, firstly subjects were asked to close nostrils by nose clip and inhale to their maximum capacity and then after clicking the start button in FVC test menu, exhale forcefully into the sensor as hard as and for as long as possible and take full and unhurried inspiration in continuation through the mouth without leaking air in between lips and mouth piece of the spirometer. The results were displayed as predicted, observed and percentage of predicted values and graphics of various lung volumes and capacities on screen and recorded in laptop. This procedure was repeated and the best of three readings was considered for analysis. The parameters which measured were Forced Vital Capacity (FVC) and Forced Expiratory Volume in One Second (FEV_1). The same parameters were measured in different posture viz. standing, slumped sitting, normal sitting, kyphotic sitting and supine postures in same subject and recorded.

Statistical analysis

Mean and standard deviation of Forced Vital Capacity (FVC) and Forced Expiratory Volume in One Second (FEV_1) of all subjects were calculated by Microsoft Excel. The data were compared by One-way analysis of variance (ANOVA) in "Open Epi" software and Post Hoc test. The statistical analysis among different postures was done by Post Hoc test. The $p<0.05$ was considered as statistically significant.

RESULTS

The average age, weight and height body mass index and waist circumference of participants were 21 ± 2 years, 61 ± 6 Kg and 172 ± 5.4 cm, 20.51 ± 1.87 and 31 ± 2 respectively (Table 1). A total of forty male medical students were recruited.

Table-1: Mean Anthropometric Parameters

Parameters	N=40(Mean ± SD)
Age (Years)	21 ± 2
Weight (Kg)	61 ± 6
Height (cm)	172 ± 5.4
BMI (Kg/m^2)	20.51 ± 1.87
WC (cm)	31 ± 2

Table 2 & Fig. 1 presents FVC values across all five selected body postures. The analysis of one-way ANOVA demonstrated a statistically highly significant difference ($P < 0.01$).

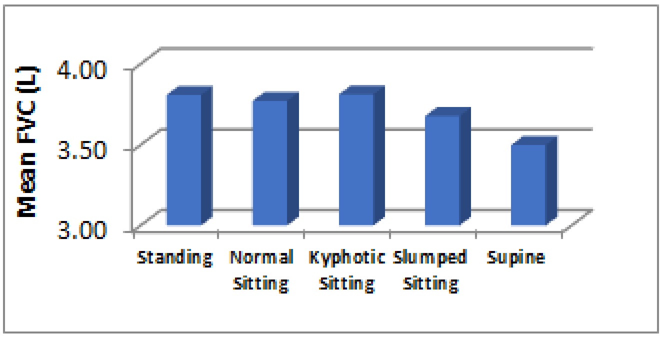

Fig-1: Comparison of mean FVC

Table-2: Comparison of FVC (L) between different postures (ANOVA)

Postures	FVC (Mean ± SD)	Anova	
		F-value	p-value
Standing	3.81 ± 0.53	3.39	< 0.01 HS
Normal Sitting	3.77 ± 0.48		
Kyphotic Sitting	3.81 ± 0.45		
Slumped Sitting	3.68 ± 0.40		
Supine	3.50 ± 0.37		

Note: - HS = highly significant

Table No. 3 shows comparison of forced vital capacity between different postures by POST HOC TEST. It reveals that FVC was significantly lowered in supine posture as compared to normal sitting, standing and kyphotic sitting posture respectively. Similarly, significantly lower FVC was observed with slumped sitting posture on comparing with standing posture.

Table-3: Comparison of FVC (L) between different postures (POST HOC TEST)

			P-value
NORMAL SITTING	V/S	STANDING	> 0.05 NS
NORMAL SITTING	V/S	SLUMPED SITTING	> 0.05 NS
NORMAL SITTING	V/S	KYPHOTIC SITTING	> 0.05 NS
NORMAL SITTING	V/S	SUPINE	< 0.05 S
STANDING	V/S	SLUMPED SITTING	< 0.05 S
STANDING	V/S	KYPHOTIC SITTING	> 0.05 NS
STANDING	V/S	SUPINE	< 0.01 HS
SLUMPED SITTING	V/S	KYPHOTIC SITTING	> 0.05 NS
SLUMPED SITTING	V/S	SUPINE	> 0.05 NS
KYPHOTIC SITTING	V/S	SUPINE	< 0.01 HS

Note: - NS = nonsignificant, S = significant, HS = highly significant

Table No. 4 & Fig. 2 show effect of posture on FEV_1. Kyphotic sitting posture shows highest FEV_1 then it gradually declines with standing, normal sitting and slumped sitting postures. Lowest value of FEV_1 was observed with supine posture. All the values of FEV_1 were significantly differ in each posture. (p <0.01)

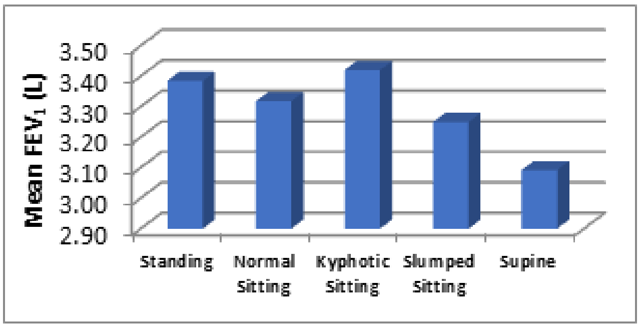

Fig-2: Comparison of mean FEV_1

Table-4: Comparison of FEV_1 (L) between different postures (ANOVA)

Postures	FEV_1 (L) (Mean ± SD)	Anova	
		F-value	p-value
Standing	3.39 ± 0.47	4.60	< 0.01 HS
Normal Sitting	3.32 ± 0.35		
Kyphotic Sitting	3.42 ± 0.30		
Slumped Sitting	3.25 ± 0.26		
Supine	3.09 ± 0.34		

Table-5: Comparison of FEV_1 (L) between different postures (POST HOC TEST)

			P-value
NORMAL SITTING	V/S	STANDING	> 0.05 NS
NORMAL SITTING	V/S	SLUMPED SITTING	> 0.05 NS
NORMAL SITTING	V/S	KYPHOTIC SITTING	> 0.05 NS
NORMAL SITTING	V/S	SUPINE	< 0.05 S
STANDING	V/S	SLUMPED SITTING	> 0.05 NS
STANDING	V/S	KYPHOTIC SITTING	> 0.05 NS
STANDING	V/S	SUPINE	< 0.01 HS
SLUMPED SITTING	V/S	KYPHOTIC SITTING	> 0.05 NS
SLUMPED SITTING	V/S	SUPINE	< 0.05 S
KYPHOTIC SITTING	V/S	SUPINE	< 0.01 HS

Table No. 5 shows comparison of FEV_1 between different postures. It reveals that supine posture has significantly lower FEV_1 as compared to standing, normal sitting, kyphotic sitting and slumped sitting posture respectively.

Discussion

The average age, weight and height body mass index and waist circumference of all 40 male participants were 21 ± 2 years, 61 ± 6 Kg and 172 ± 5.4 cm, 20.51 ± 1.87 and 31 ± 2 respectively (Table No. 1).

The study results demonstrated significant changes in lung function variables across various body postures. In our study FVC was almost similar between standing and kyphotic sitting posture. Then FVC gradually decreases highly significant ($p<0.01$) in normal sitting, slumped sitting and supine posture [Table No.2]. This is due to an increase in the diameter of the main airway in the standing position. When a person is upright, the vertical gravitational gradient is at the maximum, the anterior – posterior diameter of the chest wall is greater and the compression of the lung and the heart is minimized. [6] The results are consistent with the other studies which have examined the change in FVC when changing postures from standing to supine in young adults as shown in Table No. 6.

Table-6: Comparison of present study with other study

Studies	Postures			
	Standing	Normal Sitting	Supine	p-value
Present Study [13]	3.81 ± 0.53	3.77 ± 0.48	3.50 ± 0.37	< 0.01
Jibril Mohammed *et al.* [7]	3.35 ± 0.31	3.07 ± 0.29	2.60 ± 0.30	< 0.01
Anand K Patel *et al.* [10]	3.90 ± 0.2	4.04 ± 0.2	3.72 ± 0.24	< 0.01
Lathadevi V Ganapathi *et al.* [11]	3.71 ± 0.34	3.50 ± 0.42	3.28 ± 0.43	< 0.01
Ganeswara Rao Melam *et al.* [6]	2.5 ± 0.6	2.3 ± 0.6	2.0 ± 0.5	< 0.01
Fang Lin *et al.* [9]	4.26 ± 1.02	4.13 ± 1.01	3.89 ± 1.04	< 0.01

To assess FEV_1, fast forced expiration is necessary. In the present study, FEV_1 was significantly higher ($p<0.01$) in standing posture and significantly lower in supine posture. [Table No. 3] This may be due to increase in thoracic cavity volume and the effect of gravity on the abdominal contents caudally within the abdominal cavity which increase the vertical diameter of thorax and enabling the inspiratory muscles to expand the unrestricted thorax in all directions [7]. Similar results were observed in the studies done by various authors as shown in Table no 7.

Table-7: Comparison of present study with other study

Studies	Postures			
	Standing	Normal Sitting	Supine	p-value
Present Study [13]	3.39 ± 0.47	3.32 ± 0.35	3.09 ± 0.34	< 0.01
Jibril Mohammed *et al.* [7]	2.31 ± 0.68	1.98 ± 0.28	1.52 ± 0.23	< 0.01
Anand K Patel *et al.* [10]	3.48 ± 0.2	3.60 ± 0.2	3.25 ± 0.18	< 0.01
Lathadevi V Ganapathi *et al.* [11]	3.04 ± 0.33	2.70 ± 0.33	2.51 ± 0.38	< 0.01
Ganeswara Rao Melam *et al.* [6]	2.0 ± 0.5	1.9 ± 0.6	1.7 ± 0.5	< 0.01
Baghery Hojat *et al.* [8]	2.58 ± 0.50	2.45 ± 0.50		< 0.01
Fang Lin *et al.*	3.42 ± 0.85	3.31 ± 0.90		< 0.05

Conclusion

In this study, we assessed the deleterious effect of incorrect postures on pulmonary function tests parameters in male medical students and found that although the Forced Vital Capacity and Forced expiratory volume in one second (FEV_1) were higher in the standing posture and lower in supine posture but if we see the results, we found that these values were decreased more in kyphotic and slumped sitting than normal sitting posture. So, we should make aware people to sit in correct posture. Further research with larger number of subjects with varied age group with different postures is required for applying these results to be effective for society.

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