

EFFECT OF DIFFERENT SITTING POSTURES ON PULMONARY FUNCTION IN YOUNG HEALTHY INDIVIDUALS

Dr. Jumana J. Vanwala*, Dr. Sweetly Shah, Dr. Neeta Vyas.

Gujarat, India.

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*Correspondence for
Author

Dr. Jumana J. Vanwala
Gujarat, India.

ABSTRACT

Introduction- Spirometry is physiological test that measures how an individual inhale or exhales Volumes of air as a function of time. Neck pain & back pain are very common condition in young individuals due to their abnormal sitting postures like slumped sitting & slouched sitting. So purpose of this study is to see whether these abnormal sitting postures affect their pulmonary function or not. **Aims and objective-** To determine the changes in pulmonary function in young healthy individuals with variation in sitting postures. **Method-** Ethic's

approval and written informed consent of the 90 subjects was taken prior to study. In this study male & female between age group of 18 to 24 years with normal BMI (18.5 to 22.9kg/m^2), good posture, nonsmokers & willing to participate were included. Subjects who have $\text{BMI} < 18.5$ or $> 22.9\text{ kg/m}^2$ poor posture, any orthopedic, cardiovascular or neurological disease and doing gym training, yoga or pranayam were excluded. Each participant was given three different sitting postures-Slumped, Upright, Slouched. 30 seconds rest period was provided in between the postures. **Outcome measures-** FEV_1 (forced expiratory volume) % of predicted, FVC (forced vital capacity) % of predicted, PEF (peak expiratory flow) % of predicted, MVV (maximum voluntary ventilation) % of predicted **RESULT-** Statistical analysis was done by SPSS version 16. One way- ANOVA test was applied to determine difference of pulmonary function in three different postures. Pulmonary function was better in upright posture but p value is not significant in any of the postures. **CONCLUSION-** There is no effect on pulmonary function in upright, slumped and slouched sitting postures in young healthy individuals' in the age group of 18 to 24 years.

KEYWORDS: pulmonary function, slumped posture, slouched posture.

INTRODUCTION

Normal health is state of complete physical, mental and social well-being and not merely the absence of disease or infirmity.^[1] Young is considered as 15 to 24 year old male & female according to standard provisional classification for age.^[2] Postural changes can occur in healthy populations due to habitual lifestyle factors, age or in association with pathology, pain, or injury.^[3] Habitual postures that overstretch extensor muscles and shorten flexor muscles can lead to structural changes with potentially permanent negative impact on physical functioning and quality of life.^[4] Many respiratory conditions are noted because of structural deformities which could have been prevented rather by correcting the abnormalities in posture in early phase of development. One important fact of developing abnormal posture in young healthy individuals is their faulty sitting positions most of the time. Young individuals have to sit for long hours in lectures as well as on computers & during reading,^[4] writing & even when driving vehicles & they usually assumes different kinds of sitting postures. Correct posture is the position in which minimum stress is applied to each joint.^[5] Faulty posture is any static position that increases the stress is applied to each joint.^[5]

Slouch and slumped sitting positions are most commonly used by them. Slumped posture is defined as relaxed sitting posture generally involves an abnormal degree of thoracic kyphosis with abducted scapula and forward position of head.^[6] Slouched sitting is defined as the LoG is posterior to the spine and hips and body is being supported by the back of chair.^[7] There are chances of development of back and neck pain secondary to this abnormal sitting postures. Furthermore, as respiratory muscles also have postural functions. Changes in postural alignment affect position, range of motion and coupling patterns of the spinal and rib articulations, which influence compliance via changing articular range of motion available for respiration. Given the complex anterior and posterior articulations of the thoracic spine and ribcage, it is reasonable to speculate that alignment changes in one plane will have the potential to affect the three-dimensional shape and motion of the chest wall during breathing. It is well documented that changes in body position (supine vs. standing vs. prone) alter pulmonary function and the relative contribution to the rib cage and abdomen to ventilation.^[3] Since long, pulmonary function test is used mainly for the diagnostic purposes in respiratory conditions.^[8] Spirometry is a physiological test that measures how an individual inhales or exhales volumes of air as a function of time. The primary signal measured in spirometry may be volume or flow.^[9] There are changes due to BMI on pulmonary function.^[10] There is also diurnal variation in pulmonary function.^[11] 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. The seated leaning forward position is the optimum posture for the patients to generate maximum inspiratory pressures and to obtain greatest subjective relief of dyspnoea.^[12] A previous study showed decreased activity of scalene and sternocleidomastoid muscles in a forward leaning position.^[13] In contrast another study indicated that a forward leaning position with arm support allowed accessory muscles (i.e. pectoralis minor and major) to contribute significantly to rib cage elevation, and arm and head support contribution to inspiration in the forward leaning position.^[14]

Although chronic obstructive pulmonary disease (COPD) is most closely associated with a decrease in pulmonary function, it is also associated with secondary problems, such as weight gain and a sedentary lifestyle. Such secondary problems further potentiate changes in pulmonary function, stimulating a vicious cycle of worsening pulmonary function, increasing weight and sedentariness. Commonly, those with COPD sit for long periods of time. Some may be confined to wheelchair use. Moreover, those who sit for long periods often assume a slumped posture, resulting in an increase in thoracic kyphosis. This slumped, kyphotic posture has been postulated to be deleterious to some patients, especially those diagnosed with COPD. It has also been shown to be associated with a decrease in both lung volume and maximal inspiratory pressure in elderly persons. This is an important consideration for those with COPD.^[15] Pulmonary function tests that measure lung volume and capacities are performed to evaluate the mechanical function of the lungs. Lung volume and capacities are related to a person's age, weight, sex and body positions and are altered by disease.^[16] Forced expired volume (FEV₁), forced vital capacity (FVC) and maximum voluntary ventilation (MVV) and Peak expiratory flow (PEF) are considerable measures to see the lung function the ventilatory effect by different sitting postures. The selected measurements used in this study are considered as indicators for the integrity of respiratory system, elastic recoil of the lung and airway resistance as well as strength and endurance of the respiratory muscles.^[17] 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 due to the weight of organs on the diaphragm. Apart from this so

many studies till date has proved that poor sitting posture leads to back pain, neck pain etc but nobody has focused on pulmonary function due to poor posture. A few investigations were found to address the relationship between lung capacities in different sitting postures in young healthy individuals. So, Aim of the study is to find the effect of different sitting postures on pulmonary function in young healthy individuals.

AIMS AND OBJECTIVES

To determine the effect of different sitting postures on pulmonary function in young healthy individuals.

NULL HYPOTHESIS: H_0

There is no effect of different sitting postures on pulmonary function in young healthy individual.

ALTERNATE HYPOTHESIS: H_1

There is effect of different sitting postures on pulmonary function in young healthy individuals.

METHODOLOGY

Study Design

A cross-over study

Study Setting

S.B.B.college of physiotherapy, V.S.General hospital, Ahmedabad, Gujarat.

Study Duration

The total study duration was 6 months.

Sample Size

90 subjects

Sample size was obtained using following formula.^[18]

$n = (\sigma / \Delta)^2 (z_\alpha + z_\beta)^2$. So, minimal sample size needed for the study was 90 subjects.

Sampling Design

Convenience sampling.

Inclusion Criteria

- Male & Female between age group of 18 to 24 years
- Normal BMI¹⁹ (18.5 to 22.9 kg/m²)
- Good posture
- Non smokers
- Willing to participate

Exclusion Criteria

- BMI < 18.5 or > 22.9 kg/m²
- Poor posture
- Any orthopedic, cardiovascular or neurological disease /deformity
- Doing gym training, yoga or pranayam.

MATERIALS**FIGURE 7- MATERIALS****FIGURE 8- PFT INSTRUMENT****Outcome measures**

- FEV₁ (forced expiratory volume) % of predicted
- FVC (forced vital capacity) % of predicted
- PEFR (peak expiratory flow rate) % of predicted
- MVV (maximum voluntary ventilation) % of predicted

Methodology

90 normal young healthy individuals were taken as per inclusion criteria and informed written consent was taken. Ethical approval was obtained from the Institutional Review board, V.S.Hospital, Ahmedabad. Whole procedure was explained to the participants. Subjects were asked not to wear tight clothing and avoid eating a large meal within 2 hours of testing.^[8] Baseline height, weight, BMI, posture observation and plumb line examination

of each subject were performed. For PFT 3 sitting postures upright, slumped and slouched sitting were given. These postures were given randomly to avoid bias. In all 3 postures knees were flexed at 90° with feet fully supported. Pulmonary function test was done using Helios 401 RMS spirometer.

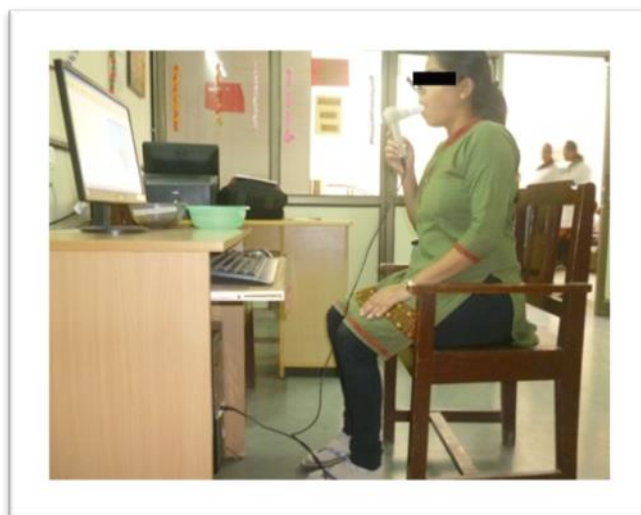


FIGURE 9- SUBJECT PERFORMING PFT IN UPRIGHT POSTURE



FIGURE 10-SUBJECT PERFORMING PFT IN SLUMPED POSTURE



FIGURE 11-SUBJECT SUBJECT PERFORMING PFT IN SLOUCHED POSTURE

PFT was performed for FVC, FEV₁ and PEF procedure, subjects were asked to assume given posture. Then nose clip was attached and subjects were asked to inhale completely and rapidly with a pause of, 1 s at TLC. Mouth piece was placed in the mouth and asked to close lips around the mouthpiece. They were then asked to exhale maximally until no more air can be expelled while maintaining posture. This was repeated minimum three times and not more than eight times.^[9]

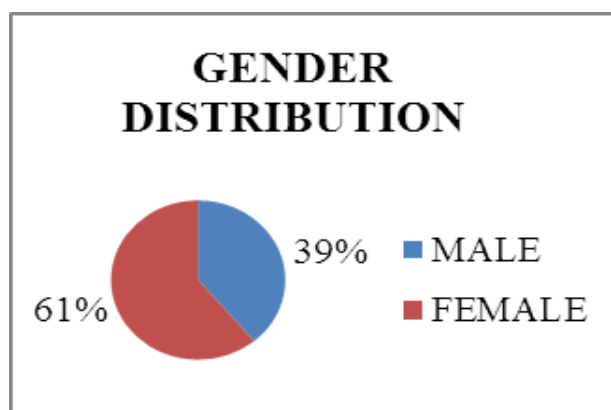
MVV testing was done by asking the subject to have a nose clip and to maintain airtight seal around the mouthpiece. They were asked to perform at least three resting tidal breaths, followed by breathing as rapidly and deeply as possible.^[9] These were carried out for each subject in each posture and vigorous coaching was given throughout the maneuver. A brief rest of 30 seconds between trials was used to minimize the fatigue effect on the respiratory muscles.^[20,21,22] PFT maneuvers of all the subject were taken in the afternoon session from 3 to 5 pm.

RESULTS

Statistical analysis was done using SPSS version 16 and excel 2007. One-way ANOVA (analysis of variance) was applied to see the difference of pulmonary function in upright, slumped and slouched posture. Total 90 subjects participated in the study. Among them there were 35 male and 55 female.

TABLE-1 THE GENDER DISTRIBUTION

GENDER	FEMALE	MALE
IN PERCENTAGE	61%	39%

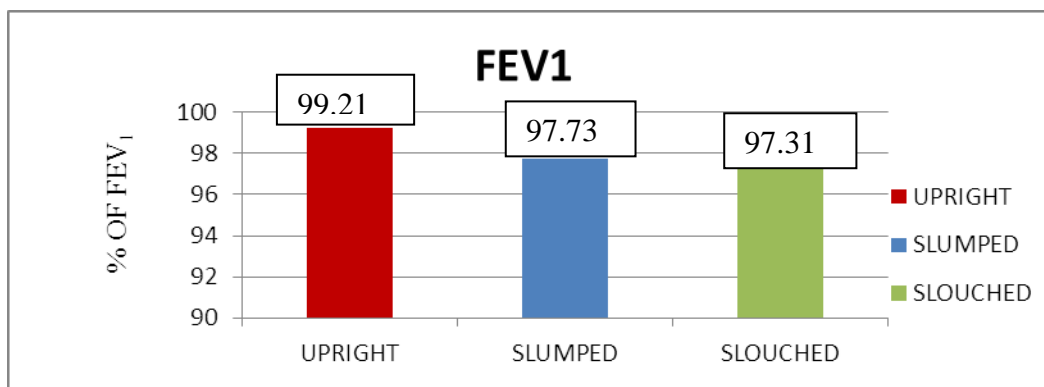
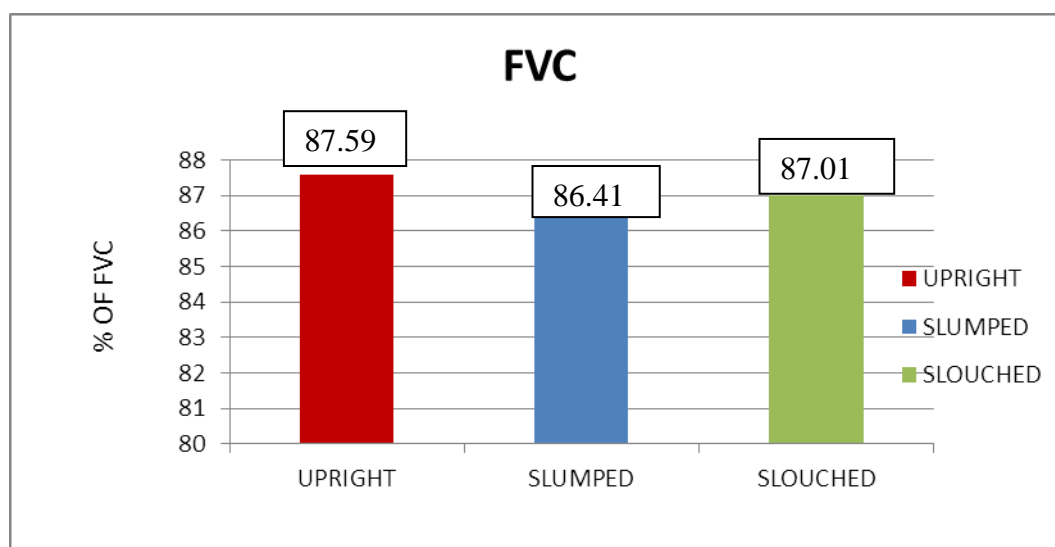
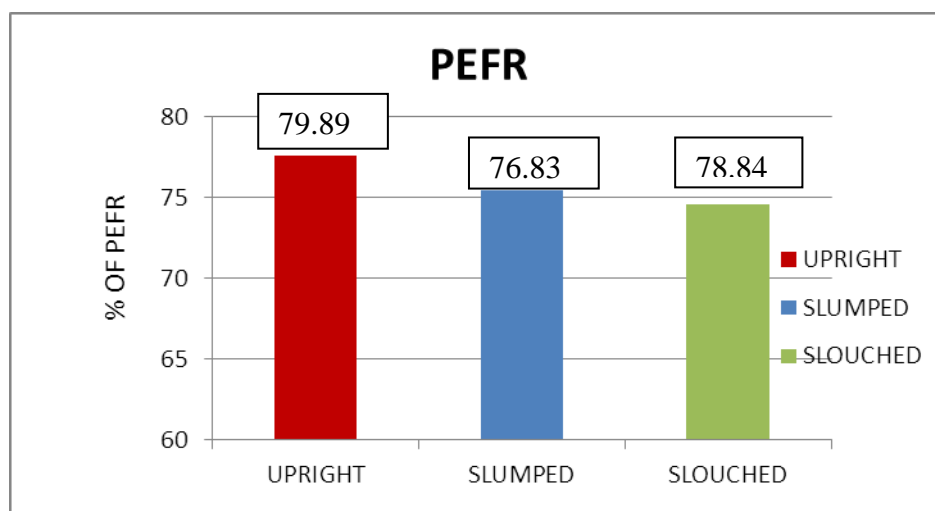
GRAPH 1- PIE CHART SHOWING THE GENDER DISTRIBUTION IN THE STUDY.**TABLE-2 DEMOGRAPHIC DATA OF THE SUBJECTS IN THE STUDY.**

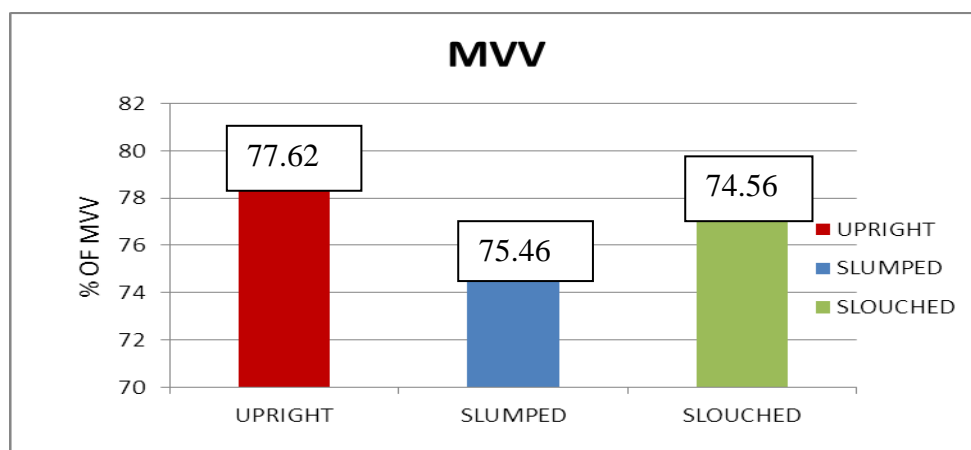
VARIABLE	MEAN \pm SD
Age (years)	21.49 \pm 1.819
Height (cm)	165.94 \pm 9.081
Weight (kg)	57.07 \pm 8.240
BMI (kg/m ²)	20.68 \pm 1.60

TABLE-3 MEAN, SD AND P VALUE OF FEV₁, FVC, PEFR AND MVV FOR THREE DIFFERENT SITTING POSTURES.

	UPRIGHT Mean \pm SD	SLUMPED Mean \pm SD	SLOUCHED Mean \pm SD	P VALUE	Interpretation
FEV ₁ (%)	99.21 \pm 13.523	97.73 \pm 13.608	97.31 \pm 15.953	0.650	Not significant
FVC(%)	87.59 \pm 12.305	86.41 \pm 11.857	87.01 \pm 11.893	0.806	Not significant
PEFR(%)	79.89 \pm 17.611	76.83 \pm 18.300	78.84 \pm 16.980	0.499	Not significant
MVV(%)	77.62 \pm 16.147	75.46 \pm 15.683	74.56 \pm 14.848	0.399	Not significant

Following bar graphs are showing the difference in each outcome measure in three different sitting postures.

GRAPH 2- COMPARISON OF FEV₁ IN THREE DIFFERENT SITTING POSTURES**GRAPH 3- COMPARISON OF FVC IN THREE DIFFERENT SITTING POSTURES****GRAPH 4- COMPARISON OF PEFR IN THREE DIFFERENT SITTING POSTURES**

GRAPH 5 –COMPARISON OF MVV IN THREE DIFFERENT SITTING POSTURES

INTERPRETATION

From the graph we can say that pulmonary function is better in upright posture than slumped or slouched posture, although there is no statistically significant difference of mean value in any of the postures for pulmonary function and p value is >0.05 . So, the null hypothesis is accepted.

DISCUSSION

The present study was done to find out and compare the pulmonary function in slumped, slouched and upright sitting posture. There were 90 young healthy individuals who participated in the study. Pulmonary function of all the individuals was tested by means of FEV₁, FVC, PEFR and MVV. The p value for FEV₁, FVC, PEFR and MVV was 0.650, 0.806, 0.499 and 0.399 respectively. According to statistical analysis upright sitting posture is better than slumped sitting and slouched sitting posture but p value shows that there is no statistically significant difference in pulmonary function among three different sitting postures. Lee L et al, 2010³ concluded in her study that thoracolumbar extension i.e. used in slouched posture and slump postures had opposite effects on end expiratory diameters. Diameters upper AP, axilla AP and axilla Lateral were greater in thoracolumbar extension compared to slump. Conversely, lower lateral and abdominal AP diameters were less in thoracolumbar extension than in slump posture. Motion changes during breathing were opposite for upper AP, axilla AP, and lower lateral diameters; upper AP and axilla AP motion were less in thoracolumbar extension and lower lateral motion was greater in thoracolumbar extension. There were no differences of axilla lateral and abdominal AP diameters during breathing between thoracolumbar extension and slump. So, from this it can be said that the flexibility of the respiratory apparatus in people without respiratory disease or limitations in

chest wall mobility to adapt regional chest wall mobility to the changes in joint orientation and muscle activation associated with subtle changes in posture in order to maintain constant respiratory function.

Ogiwara S, 2002.^[23] suggested that strength of ventilatory muscle does not change with change of posture. Both the inspiratory and expiratory muscle strength showed no change with alteration of body positions, hence support the null hypothesis. This finding suggest that the ventilatory muscles of healthy individuals seems to work efficiently in any posture. Specifically the length-tension relationship of these muscles seems to remain constant regardless of any change in body position. According to Barnas GM et al.^[24] slumped position may actually serve to support the diaphragm with the help of the rigid abdominal wall, as is seen in seated forward leaning postures, placing it at a mechanical advantage along the length-tension curve to assist in maintaining pulmonary function.

A study by Landers M.^[15], also found no difference between two sitting posture (slumped and upright) in patients with COPD and they suggest that upright posture is not beneficial because a slumped posture may have actually placed the characteristic flattened diaphragm in a more advantageous biomechanical position than would an upright posture.

On the contrary, Crosbie WJ and Myles S^[25] found that slumped posture show a general decrease in pulmonary function as has been reported in the literature among healthy subjects and they explained that in young healthy subjects with a normally positioned diaphragm, 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. Another study by Makhsous M et al, 2004.^[22] also suggest that slumped posture compress organs and impede diaphragm movement. There are studies which suggest that there are changes in pulmonary function in subjects with different body mass index. Hence, subjects who had normal body mass index were only selected. Literature also says that there is diurnal variation in pulmonary function. So, to avoid variation due to it, time is kept constant for pulmonary function testing. To avoid the carry over effect or learning effect the postures were given randomly to the subjects and wash out period was also given. Although no clear differences emerged in pulmonary function, one should consider that there may be other damaging consequences from a slumped posture, which may influence

quality of life. A prolonged slumped posture causes thoracic malformation, which may lead to decreases in motor function and range of motion in the upper extremities. In addition to potential motor function problems and musculo-skeletal pain, the slumped position may also expose the anterior portion of the vertebrae in the thoracic spine to sustained, abnormal compression, leading to possible wedge fractures.^[26]

In upright sitting, the vertical gravitational gradient is maximal, anteroposterior diameter of chest wall is greatest and compression of heart and lung is minimal. The shortened position of diaphragmatic fibres is countered by an increase in the neural drive to breathe in upright posture.^[27] so, upright sitting posture should be preferred.

CONCLUSION

There is no effect on pulmonary function in upright, slumped and slouched sitting postures in young healthy individuals' in the age group of 18 to 24 years.

LIMITATION

3D digitization system^[28] was not used during PFT maneuver, which is a biomedical model that allow detailed, quantitative description of head, neck, lumbar and pelvic postures during different sitting postures. This model also enabled a distinction to be made between upper and lower cervical motions. Male and female in the study were not equally distributed.

FUTURE STUDIES

Further study can be done in different pulmonary conditions. Study can be done by using 3D digitization system, on different BMI and on different age group.

CLINICAL IMPLICATION

Although pulmonary function is not statistically significant in different sitting postures, mean values are better in upright sitting posture. So, upright sitting posture should be preferred.

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