BOHR

BOHR International Journal of Current Research in Diabetes and Preventive Medicine
2023, Vol. 1, No. 1, pp. 17–20
https://doi.org/10.54646/bijrdpm.002
www.bohrpub.com

Influence of Abdominal Adiposity on Pulmonary Function Test Values in Healthy Female Population with Different Body Positions

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Abstract.
Background: According to the WHO, female obesity is double that of the male population, and obesity is associated with respiratory disorders due to changes in the biomechanics of the diaphragm. Pulmonary function test (PFT) is usually done in an upright posture, but obese people might not be able to sit up during PFT. Hence, this study investigates changes in position that alter the PFT values in healthy females with abdominal fat deposition.

Method: This experimental study was done on 34 randomly selected female college students (18–25 years old) with a waist-hip ratio of $\geq$0.85 cm^2. In three distinct positions—supine, sitting, and side-lying—the forced vital capacity and forced expiratory volume in one second (FEV1) standard spirometric tests were compared.

Result: Statistical analysis was done using SPSS software. Descriptive data were found by mean and standard deviation. An analysis of variance and the Bonferroni test were applied to find a significant difference in test score between three different body positions. There is a significant difference among the tested three positions; a $p > 0.05$ was found between supine versus sitting and supine versus side-lying, whereas the mean value between side-lying versus sitting showed a statistically significant difference of $p < 0.05$.

Conclusion: Change in position has significant effects on spirometric parameters in healthy asymptomatic females with central obesity. But a statistically significant and clinically improved result was found in sitting versus side-lying position. Hence, this study suggests that adopting a side-lying position for evaluating lung function will not make much difference in PFT values.

Keywords: Overweight, central obesity, lung volume, body positioning, sitting, side-lying, supine.

INTRODUCTION

Abdominal obesity hinders diaphragmatic activity and thereby affects the pulmonary mechanics [1]. According to the WHO, female population is found to having more abdominal fat than male population [2]. Since body positioning affects lung mechanics [3], this study aimed to determine which positions improve lung mechanics. There are only a few studies done in female population with obesity; this study is aimed to find lung mechanics in females with abdominal obesity. Since the prevalence of obesity and related complications is rising, this study will benefit clinically by assisting in the choice of position for people who are obese and unable to sit up during a pulmonary function test (PFT).

METHODOLOGY

Studies have shown that abdominal adiposity affects lung even in young female population. This study was undertaken in college students [4].

Selection criteria includes healthy female population aged between 18 and 25 years with a waist-hip ratio of $\geq$0.085 cm^2 [5]. Candidates with conditions such as hemoptysis, pneumonia, recent abdominal, thoracic, and eye surgery that hinder the breathing capacity were excluded from the study [6].

STUDY PROTOCOL

Anthrapometry [6]

The candidates were subjected to anthrapometry on arrival. Standard procedures and instruments were used for the measurements.

- Age was recorded.
- On a measuring tape fixed to a wall, standing height was measured without shoes and wearing only light clothing.
- Weight was recorded without shoes and with lightweight cloths on a weighing machine.
- Body mass index was calculated using the formula: BMI = weight (kg)/(height in m^2) [7].
- Waist circumference was measured with minimal clothes and feet apart. It was done using tailor's tape at the level of umbilicus.
- When measuring the hip circumference, the greater trochanter was covered lightly with minimal clothing, the legs were brought together, and the skin fold was not compressed.
- The determined waist-hip ratio (WC/HC) served as a gauge for the distribution of fat in the midsection.

Respiratory Parameters [8]

A computerized spirometer was used for the test. After a 5–10-min period of rest and a briefing on the forced vital capacity (FVC) method (maximum inhalation followed by maximum expiration and should be sustained until requested to inhale again), the test was conducted in a quiet, private room in a standing position with the nose clip held in position on the nose. The best of the three acceptable curves was chosen as the recording after the flow, volume, and timing graphs were extracted using the criteria established by the American Thoracic Society. FVC and forced expiratory volume in one second (FEV1) were the recorded parameters for analysis.

Testing positions

Supine: Participant is made to lay down comfortably and allow to relax on a plinth. Additional elbow support was provided, as in Figure 1.

Sitting: The patient is made to sit upright with the head slightly elevated, as shown in Figure 2.

Side-lying: The participant is in a side-lying position with the head supported and head straight with the neck, as in Figure 3.

Figure 1. Subject performing PFT in side-lying position.

Figure 2. Subject performing PFT in supine position.

Figure 3. Subject performing PFT in sitting position.

PROCEDURE

Following the consent of the participants, an assessment of the candidates was taken. Candidates were informed on the preparations to be done before the test, such as to avoid strenuous exercise for 1 h prior to the test (to prevent potential exercise-induced bronchoconstriction), wear clothing that significantly restricts full chest and abdominal expansion (to prevent external restrictions on lung function), and report to the research lab, physiotherapy department. A machine and procedure were introduced to the candidates, and a self-demonstration was also performed. A tidal (normal) breath was allowed to be taken before the forced expiration. Allow the patient to inhale completely and rapidly with a pause of >1 s, continue complete expiration for a maximum of 15 s, and inspiration at a maximal flow back to maximum lung volume. Repeat the procedure until three acceptable maneuvers are obtained, according to the American Thoracic Society recommendations [9].

STATISTICAL ANALYSIS

Statistical analysis was done using SPSS software. Descriptive data were found by mean and standard deviation. An analysis of variance and the Bonferroni test were used to find a significant difference in test score between three different body positions ($p < 0.05$).

RESULT

This study is an attempt to find the best possible position to get PFT values in young, healthy females with abdominal adiposity.

Participants of the study show common characteristics in terms of age, height, weight, BMI, WC, HC, and WHR (Table 1). The participants consist of both lean and overweight female students with WHR ≥0.85.

Better airflow was found in the sitting position, then side-lying, and finally the supine position. This study also found the mean difference between the positions, which showed a clinically significant result between sitting and side-lying positions. Additionally, the majority of studies have neglected the side-lying position, in which the patient could be more comfortable than the supine position. So, the current study evaluates the effect of side-lying in addition to supine and sitting.

Table 1. Characteristics of the participants.

	N	Minimum	Maximum	Mean	Std. Deviation
Age (years)	34	19.00	23.00	20.6364	1.08450
Height (cm)	34	149.00	172.00	158.2576	5.68732
Weight (kg)	34	39.00	82.00	56.1515	10.52117
BMI (kg/m$^{2)}$	34	16.90	30.00	22.3242	3.27710
Waist circumference (cm)	34	70.00	96.50	82.4848	8.13892
Hip circumference (cm)	34	85.00	112.00	91.6545	7.35532
Waist hip ratio (cm)	34	.85	.97	.8936	.03498

Table 2. Ratio in different body positions.

	Sitting	Side-lying	Supine
Mean	0.8730	0.9042	0.8953
Standard deviation	0.0055	0.03776	0.06881
N	34	34	34

Table 3. Comparing ratio between the three positions.

	Mean Difference	p-value	Result
Sitting vs. side-lying	0.031	0.000	p<0.05 sig
Sitting vs. supine	0.022	0.217	p>0.05 sig
Side-lying vs. supine	0.009	1.000	p>0.05 sig

FEV1/FVC Ratio in Different Positions

FEV1/FVC ratio in side-lying position shows a higher mean value of 0.9042 ± 0.03776 compared to sitting and supine positions (0.8953 ± 0.068 and 810.8730 ± 0.03776, respectively) (Table 2). Ratio among different positions shows a significant p-value of <0.05 between the three positions.

$F = 5.534$, $p = 0.031$; here, $p < 0.05$ and therefore there is significant difference in ratio between the three positions.

Sitting versus side-lying analysis shows a higher value for side-lying (0.031) when compared to sitting versus supine (0.22) and side-lying versus supine (0.009) (Table 3).

Even though the FEV1, FVC, and FEV1/FVC ratios were found to be significant between supine, sitting, and side-lying, a statistically and clinically improvement effect was found in sitting versus side-lying position.

The data show that a higher FEV1/FVC ratio is seen in side-lying, supine, and least in sitting, which indicates that sitting is the best position to get good PFT values, but the FEV1/FVC mean difference between sitting versus side-lying showed a statistically significant value. Hence, this study results show that side-lying is also a good position to obtain better breathing parameters.

DISCUSSION

The present study results showed a better FEV1/FVC ratio in the side-lying position compared to sitting and supine positions. A mean value analysis shows a statistically and clinically improvement effect in sitting versus side-lying position. It is supported by the finding of Sally Krieg et al. that in younger adults, a relatively uniform craniocaudal distribution of ventilation in the nondependent lung is in a side-lying position [10].

In the present study, FEV1 was significantly higher ($p < 0.01$) in sitting position compared to side-lying and supine positions. The findings are in line with those of earlier research that looked at how young people's FVC changed as their posture changed from standing to supine. Punamiya et al. [11] and Moreno et al. [12] found similar changes when the posture changed from sitting to lying positions. Studies prove that when the body assumed a more erect posture, better respiratory measures were obtained. This may be due to an increase in thoracic cavity volume and the effect of gravity on the abdominal contents caudally within the postures. 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 heart is minimized. The increase in spirometric values in sitting position was attributed to the descent of the diaphragm for the extra volume of air inspired during forced vital capacity maneuver that had the highest lung volumes [11, 12].

Studies analyzing the effects of side-lying positions by Manning F et al. (1993) and Sally Krieg et al. (2007) find that in sitting position, more ventilation was distributed to the dependent (middle and basal) regions of both lungs than to the nondependent (apical) regions. In side-lying position, more ventilation was distributed to the dependent lung than to the non-dependent lung. This finding is relevant to the present study [10, 13].

LIMITATIONS

The study population is smaller. It is not possible to generalize the results to obese children. Further research in this field is needed to evaluate the lung function in a large number of healthy obese females. Extending the study to male population will help to generalize the findings.

CONCLUSION

The current study supports the idea that adopting side-lying positions in obese females will provide a significant PFT result.

Additionally, side-lying can be considered an alternative position to PFT for those with obesity who are unable to complete the procedure due to difficulty in sitting. This will provide a test value similar to sitting in healthy obese females.

CONFLICTS OF INTEREST

All authors declare that they have no conflicts of interest.

AUTHORS' CONTRIBUTIONS

Corresponding author contributed to the implementation of the research, analysis of the results to the writing of the manuscript. Author 2 supervised the findings of the work.

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