

Original Research Article

Effect of body positions on lungs volume in asthmatic and non-asthmatic individuals: a cross-sectional study

ABSTRACT

Aims: The purposes of our research is to investigate the effect of different positions on lung volume by conducting pulmonary function test (PFT) values such as forced vital capacity (FVC) and forced expiratory volume in one second (FEV1) of asthmatic patients, to assess the correlation between pulmonary function and posture in adult patients with asthma and to determine the best position with higher lung volume that preferable for asthmatic patients to relieve the asthma attack and for rehabilitation approach.

Study design: Cross-sectional study

Place and Duration of Study: This study was conducted in the Reconstructive and Rehabilitative Center at University Malaysia Sarawak (UNIMAS) between December 2015 and June 2016.

Methodology: Fifteen participants with mild asthma aged between 19-25 years and fifteen healthy participants were enrolled after they had signed a written consent. Participants were selected using the inclusion criteria and Spiro Excel pc based pulmonary function test (PFT Medicaid Systems) were administered. Spirometer measurements (FVC, FEV1) were taken in the standing, sitting and supine positions. Each measurement was taken two times and the average values were analyzed. The order of the body positions is randomized.

Results: In asthmatic samples, the best position was supine with a mean±standard deviation (SD) of FEV1/FVC, 77.93±17.37, followed by sitting position, 75.37±16.37, and finally standing position, 73.63±17.08. In normal samples, the best position was standing with a mean±SD of FEV1/FVC was 90.12±5.97, followed by supine, 89.70±8.79, and lastly sitting position, 88.53±11.17.

Conclusion: Our study showed that supine is the best position for measuring FEV1 and FVC of asthmatic participants.

Keywords: Asthma, Lung volume, Body position, Spirometry, FEV1/FVC

1. INTRODUCTION

An estimated 235 million people are suffering from asthma globally and this number will reach 400 million people by the year 2025 [1]. In Second National Health and Morbidity Survey, an estimated 4.2% of Malaysians are having asthma in 1996 [2]. Although the prevalence of asthma is low among Malaysians, the cost for treatment and management of asthma is enormous and unaffordable by some families in Malaysia. It is beneficial to use the physical position as a rehabilitative methods to improve the lung function in asthmatic patients in Malaysia.

Positions determine the different lungs volumes when individual are in standing, sitting and supine position. According to Hojat b, the length and activity of respiratory muscles change in different position and hence effect the ventilation and perfusion, in particular, the maximum air exchange that occurs in response to gravity [3]. The lungs volume and muscle length-tension relationship influenced on the mean expiratory pressure and peak expiratory flow, which in turn are influenced by body positions [4-6].

Spirometry is the test, which can measure the inhalation and exhalation air volumes as a function of time [7]. In asymptomatic borderline or mild airway obstruction cases, it is the best method to identify

the lung functions of the patients. Among the spirometry measures, FEV1 is the most effective parameter to access the airway obstructions [5, 8].

Some researches which are similar to our topic were conducted but the results were different. Pierson et al, had evaluated spirometry test results of 235 individuals with normal to various severity of ventilatory impairment in both sitting and standing position and observed that the sitting value of FVC was significantly more, but the magnitudes of differences were small [9]. However, according to Townsend, FVC values in the standing position were more [10]. Since the previous conducted studies showed the various outcomes, the information regarding the best position for ventilation remains unclear.

The purpose of this research was to investigate the changes of lung function for different positions in asthmatic and non-asthmatic participants. This research was carried out by collecting two groups of participants, asthmatic and non-asthmatic, each of them consisted of 15 participants of both genders within the age group of 19-25 years. The activities for this research was conducted in the Rehabilitation Clinic at the Faculty of Medicine, UNIMAS. The results were collected once the samples perform the spirometer test in three different positions: standing, sitting and supine.

The best position for ventilation in asthmatic patients is still need to explore in Malaysia to improve the lung function as a rehabilitation approach. Our research group decided to carry out a research study to determine body position that bring about bigger lungs volume by using FVC as an indicator. Thus, the determined body position can be used as a rehabilitative approach for asthmatic patients in Malaysia.

2. MATERIAL AND METHODS

This research was carried out by collecting two groups of participants, each of them consist of 15 participants of both genders within the age group of 19-25 years who had asthma were chosen to participate in this research study. Group number one consisted of asthmatic participants exclusively, while group number two consisted of normal participants as control group. These asthmatic participants were recruited from Universiti Malaysia Sarawak (UNIMAS) who had been diagnosed as asthmatic patient by the UNIMAS clinic, while the normal participants were recruited around UNIMAS campus. In order to recruit asthmatic participants, we gained the ethical approval from the UNIMAS clinic to get their medical information and received the formal informed consent from the participants. They were filtered before proceeding with this research study. We excluded patients with active infection, had medication within the past 6 weeks, with cardiovascular and neurovascular diseases, restrictive lungs diseases, or had history of abdominal or thoracic surgery, and smokers. This was to prevent uneventful things from occurring. The activities for this research were conducted in the Rehabilitation Clinic at the Faculty of Medicine, UNIMAS.

We used the Spiro Excel pc based pulmonary function test (PFT Medicaid Systems) for measurement of lung function in each individual. "Force expiratory volume in one second (FEV1) was the volume of air exhaled in the first second under force after a maximal inhalation. Forced vital capacity (FVC) is the total volume of air that can be exhaled during a maximal force expiration effort" [5].

Before conducting the activities, we conducted briefing and gave a demonstration to the participants on how to perform the spirometry test. Measurement of FVC and FEV1 of the participants in several positions, i.e, supine, sitting and standing, were investigated. The order of the body positions were not randomized for each participant and it was carried in order, of the standing position, then followed by sitting and supine.

In order to ensure that the positions were standardized, the patients had to:

- a) Sat on a chair with their trunks extended, hip and knee flexed at right angle, and their arms being supported on a table [Sitting position]
- b) Lay on a bed with a pillow supporting the head with both of the legs extended [Supine position]
- c) Stood erectly with their arms being supported on a table [Standing position]

The researchers measured their FEV1 and FVC at these positions for two times and the average values were taken for analysis. These activities were conducted with the participants in a fasting state to avoid encumbering the diaphragm movement with gastric contents. For each position, independent T-test was used to analyze the outcomes. T-test compares the means between two unrelated groups on the same continuous, dependent variable, which in our research, we compare the lung function of asthmatic samples and normal samples, in same position.

3. RESULTS

Fifteen asthmatic participants and fifteen non-asthmatic participants were included in this study. The mean age and standard deviation (SD) of participants were 22.60±1.99 in normal group and 22.33±1.95 asthmatic patient group. The 33.33% of the participants are male and 66.67% of the participants are female in both groups. The demographic data of participants were shown in Table 1.

Table 1: Demographic characteristics of normal (n = 15) and asthmatic patients (n = 15)

Characteristics	Normal Frequency (%)	Asthmatic Frequency (%)
Age		
(Mean±SD)	22.60±1.99	22.33±1.95
Gender		
Male	5 (33.33%)	5 (33.33%)
Female	10 (66.67%)	10 (66.67%)

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The FEV1/FVC findings were analyzed for both asthmatic and non-asthmatic participants to evaluate the effect of three different positions on lung function. In normal samples, the best position was standing with a mean±SD of FEV1/FVC was 90.12±5.97, followed by supine, 89.70±8.79, and lastly sitting position, 88.53±11.17. In asthmatic samples, the best position was supine with a mean±SD of FEV1/FVC was 77.93±17.37, followed by sitting position, 75.37±16.37, and finally standing position, 73.63±17.08.

Independent T-test was used to compare Lung volume (FEV1/FVC) between normal and asthmatic patients in standing, sitting and supine position. At standing position, normal sample had statistically significantly higher FEV1/FVC (90.13±5.97156) than asthmatic sample (73.63±17.08) with P value 0.002. Similarly, at sitting position, normal sample had significantly higher FEV1/FVC (88.53±11.17) compared to asthmatic sample (75.37±16.37), P value 0.016. Normal sample had significantly higher FEV1/FVC (89.70±8.79) than asthmatic sample (77.93±17.37), P value 0.029 at supine position.

Table 2: Descriptive statistics of lung volume (FEV1/FVC) in standing, sitting and supine positions of normal (n = 15) and asthmatic patients (n = 15)

	Normal		Asthmatic	
	Mean±SD	Min - Max	Mean±SD	Min - Max
Standing	90.12±5.97	81.50 – 100.00	73.63±17.08	42.50 – 100.00
Sitting	88.53±11.17	63.00 – 100.00	75.37±16.37	39.00 – 94.00
Supine	89.70±8.79	72.50 – 99.50	77.93±17.37	46.50 – 100.00

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Table 3: Lung volume (FEV1/FVC) in standing, sitting and supine positions between normal (n = 15) and asthmatic patients (n = 15)

	Normal Mean±SD	Asthmatic Mean±SD	95% Confidence Interval of difference	P value
Standing	90.12±5.97	73.63 ±17.08	-26.34 – -6.66	0.002
Sitting	88.53±11.17	75.37±16.37	-23.65 – -2.69	0.016
Supine	89.70±8.79	77.93±17.37	-22.23 – -1.31	0.029

P value <0.05 is significant

4. DISCUSSION

Globally, more than 200 million people are suffering from asthma, however, current available methods of treatment are not able to prevent and treat the disease manifestations completely [1, 11]. Finding the best position for ventilation in asthma patients are beneficial as we will be able to incorporate it in the rehabilitative measures for the asthmatic patient management. First, the body position that gives highest FEV1/FVC in normal participants was standing, follow by sitting and the lowest in supine position (Table 2). The results were consistent with others in which the changes of FVC in young adults were examined in different positions. The increase in main airway diameter, the highest vertical gravitation gradient and the wider anteroposterior diameter of thoracic wall in standing posture might have effect on improvement of lungs function. The lesser compression on lungs and heart while standing might favor to result the positive impact on individual's FEV1/FVC [5]. A study was conducted with normal participants and revealed that the respiratory pattern was highly influenced by the positions from sitting to supine or prone positions [12].

We have to stress that the order of testing in each position was not randomized and was carried in order, where the standing position was done first, followed by sitting and supine. Therefore, it can be argued that supine has the lowest value of FEV1/FVC due to airway irritation caused by repeated testing and that the lower value is the consequences of the testing sequence [9]. However, this argument would not explain why those samples with asthma had highest FEV1/FVC while lying in supine position in our research. For asthmatic participants, the lungs function is the best when supine, followed by sitting and the lowest is standing position (Table 3). In this study, spirometric values were slightly lower in sitting position as compared to supine position. Considering the insignificance of the differences found, however, the spirometry result can also provide the susceptible to wrong interpretation if it is conduct in standing or supine position. The supine position might be the most suitable for those who are unable to sit and need to perform spirometry, however, the attention must be paid to interpret the result carefully [13].

The supine position was found to be the best posture to improve lungs function of asthmatic patients in our study. Since that was the participants' first time dealing with the spirometry, they could have done some incorrect postures such as not fully supporting their hands on the table in both sitting and standing positions. It could also be because they felt uncomfortable during standing position due to the limitation of space at the room where the researchers conducted the experiment as compared to supine position in which they felt more comfortable because their body were fully relaxed and were well-supported. Therefore, this affects their FEV1/FVC ratio reading resulting in higher ratio during supine position. Moreover, close kinetic chain (CKC) posture effect, might also contribute to this study outcomes. Studies had revealed that the close kinetic chain exercise (CKCE), where the distal segment of the body is opposed by the fixed external resistance, resulted the better improvement in anterior cruciate ligament reconstruction [14-16]. Similarly, CKC posture might also have effect for the improvement of respiratory muscle function and oxygenation.

Overall, non-asthmatic participants had greater lung function volume compared to asthmatic samples. The respiratory muscle recruitment due to the airflow obstruction in asthma patients can result to the adaptive hypertrophy of these muscles. Since these respiratory muscles are under repeated tension, they lose the flexibility and become shorter in length [17].

5. CONCLUSION AND RECOMMENDATION

Spirometry has been used to investigate the effect of body positions on lungs volume in both non-asthmatic and asthmatic participants. This research highlights that the standing position is the best to improve pulmonary function in non-asthmatic participants, whereas the supine position is the best in asthmatic participants. Although there might be discrepancy, this unique finding provided the insight for consideration of effect of “close kinetic chain posture” in asthmatic patients to improve the lung volume and oxygenation.

Further studies about close kinetic chain posture in asthmatic patients should be continued to evaluate it's impact on the pulmonary function. Larger studies which include wider age range and larger sample size on both normal and patients with respiratory diseases should be conducted to identify the best posture as a rehabilitative approach.

175 **CONSENT**

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177 All authors have declared that written informed consent was obtained from all the participants.
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179 **ETHICAL APPROVAL**

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181 Approval to conduct the study was obtained from Research Committee, Universiti Malaysia Sarawak
182 (UNIMAS).
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229 **DEFINITIONS, ACRONYMS, ABBREVIATIONS**

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231 **APPENDIX**