



## Effect of Body Positions on Lungs Volume in Asthmatic Patients: A Cross-sectional Study

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### Authors' contributions

This work was carried out in collaboration between all authors. Authors WWM, MNNH managed literature search. Authors LR, GS, NSBY, ABM managed for data collection and author HHKS performed data analysis. Authors LR, GS, NSBY and ABM wrote the initial draft of the manuscript. Authors WWM, MNNH and HHKS managed literature search and advised for initial draft of the manuscript. Author WWM wrote final draft of the manuscript. All authors read and approved the final manuscript.

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### ABSTRACT

**Aim:** The purpose of our research was to investigate the effect of different body positions on lungs volume by conducting pulmonary function test (PFT) values of the asthmatic patients. The objectives were (1) to assess the correlation between pulmonary function and posture in adult patients with asthma, (2) to determine the best position with higher lungs volume that was preferable for the 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:** The total of 30 participants was recruited in this study. Among them, 15 participants were asthmatic patients and 15 participants were non-asthmatic, control persons. All the

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participants were between 19-25 years of age and they 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 was randomized.

**Results:** In the asthmatic group, the best position was supine with a mean±standard deviation (SD) of FEV1/FVC, 77.93±17.37. Whereas, in control group, the best position was standing with a mean±SD of FEV1/FVC, 90.12±5.97.

The second best positions were sitting position in the asthmatic group (75.37±16.37) and supine position in control group (89.70±8.79). Finally, the standing position had the lowest lungs function in the asthmatic group (73.63±17.08) and sitting position in control group (88.53±11.17).

**Conclusion:** Our study showed that supine was the best position for measuring FEV1 and FVC of asthmatic participants. Therefore, supportive positions such as supine or leaning to the wall are suggested to improve pulmonary function of the patients, especially during asthmatic attack.

*Keywords: Asthma; lungs 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 were 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 method to improve the lungs function in asthmatic patients in Malaysia.

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

The best position for ventilation to improve the lungs function in the asthmatic patients is still needed to explore in Malaysia. Our research group decided to carry out a research study to determine body position that brings about bigger lungs volume by using Forced Vital Capacity (FVC) as an indicator. The purpose was to investigate the changes of lungs function for different positions in asthmatic and non-asthmatic participants. Thus, the determined

body position can be used as a rehabilitative approach for asthmatic patients in Malaysia.

## 2. MATERIALS AND METHODS

This research was carried out by collecting two groups of participants, each of them consists of 15 participants of both genders within the age group of 19-25 years. We selected that age range because our study area was in UNIMAS campus and more availability of control participants within that range. The researchers conducted this study in the Rehabilitation Clinic at the Faculty of Medicine, UNIMAS.

Group number one consisted of asthmatic participants exclusively, while group number two consisted of non-asthmatic participants as the control group. These asthmatic participants were recruited from UNIMAS who had been diagnosed as the asthmatic patient by the UNIMAS clinic. The medical officer at UNIMAS clinic confirmed the diagnosis of asthma by age of onset, clinical history of reversible and variable airways obstruction and by using spirometer 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 the history of abdominal or thoracic surgery, and smokers. This was to prevent uneventful things from occurring.

The researchers used the Spiro Excel PC based pulmonary function test (PFT Medicaid Systems) for measurement of lungs function in each individual. 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 lungs function of the patients. Among the spirometry measures, Force expiratory volume in one second (FEV1) is the most effective parameter to access the airway obstructions [5,8]. It 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 a 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 was not randomized for each participant and it was carried in order, of the standing position 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 recorded for analysis. The participated were in a fasting state to avoid encumbering the diaphragm movement with gastric contents. The results were collected once the samples performed the spirometer test in

three different positions: standing, sitting and supine.

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 lungs function of asthmatic samples and normal samples, in the 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.

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 Lungs volume (FEV1/FVC) between normal and asthmatic patients in standing, sitting and supine position. At standing position, the 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, the normal sample had significantly higher FEV1/FVC (88.53±11.17) compared to asthmatic sample (75.37±16.37), P value 0.016. The 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 1. Demographic characteristics of normal (n = 15) and asthmatic patients (n = 15)**

Characteristics	Normal frequency (%)	Asthmatic frequency (%)
<b>Age</b>		
(Mean±SD)	22.60±1.99	22.33±1.95
<b>Gender</b>		
Male	5 (33.33%)	5 (33.33%)
Female	10 (66.67%)	10 (66.67%)

#### 4. DISCUSSION

Globally, more than 200 million people are suffering from asthma, however, currently available methods of treatment are not able to prevent and treat the disease manifestations completely [1,9]. 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, followed 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 an effect on improvement of lungs function. The lesser compression on lungs and heart while in standing might result in the positive impact on individual's FEV1/FVC [5]. A study conducted with normal participants revealed that the respiratory pattern was highly influenced by the positions from sitting to supine or prone positions [10]. The supine has the lowest value of FEV1/FVC due to airway irritation caused by repeated testing and the consequences of the testing sequence [11].

Some researches had conducted similar topics on body positions and lungs volume but the results were different from our project. Pierson et al, had evaluated spirometry test results of 235 individuals with normal to various severity of ventilation 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 [11]. However, according to Townsend, FVC values in the standing position were more [12]. Since the previously conducted studies showed the various outcomes, the information regarding the best position for ventilation remains unclear. However, in this study, the asthmatic patients had highest

FEV1/FVC while lying in supine position, which was followed by sitting and the lowest, was standing position (Table 3).

The supine position was found to be the best posture to improve lungs function of the 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. Meanwhile, the researchers conducted the experiment of 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, closed kinetic chain (CKC) posture effect might also contribute to this study outcome. The closed kinetic chain posture is the position of the body where the distal segments of the body are opposed by the fixed external resistance. Studies had revealed that the closed kinetic chain exercises (CKCE) in resulted the better improvement in anterior cruciate ligament reconstruction [13-15]. Similarly, CKC posture might also have effect for the improvement of respiratory muscle function and oxygenation. For the rehabilitative aspect, we realized that CKC had the effect on the muscular force producing the expiratory lungs volume. Therefore, if we create the closed circuit chain around the chest, that will help to increase the expiratory lungs volume and consequently increase the inspiratory lungs volume.

Overall, non-asthmatic participants had greater lungs function volume compared to asthmatic samples. The respiratory muscle recruitment due to the airflow obstruction in the asthma patients can result in the adaptive hypertrophy of these muscles. Since these respiratory muscles are under repeated tension, they lose the flexibility and become shorter in length [16].

**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

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

	<b>Normal</b>	<b>Asthmatic</b>	<b>95% Confidence interval</b>	<b>P value</b>
	<b>Mean±SD</b>	<b>Mean±SD</b>	<b>of difference</b>	
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*

Our study has some limitations such as small sample size with 15 participants in each group. It was because of the time constraint and availability of asthma patients and control participants.

## 5. CONCLUSION AND RECOMMENDATION

Spirometry had been used to investigate the effect of body positions on lungs volume in both non-asthmatic and asthmatic participants. This research highlighted that the supine position was the best for pulmonary function in asthmatic patients. Although there might be discrepancy, this unique finding provided the insight for consideration of effect of "closed kinetic chain posture" in asthmatic patients to improve the lungs volume and oxygenation. In asthma patients, supportive positions such as supine or leaning to the wall are suggested to improve pulmonary function, especially during asthmatic attack.

Further studies about closed kinetic chain posture in asthmatic patients should be continued to evaluate the 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.

## CONSENT

All authors have declared that written informed consent was obtained from all the participants.

## ETHICAL APPROVAL

Approval to conduct the study was obtained from Research Committee, Universiti Malaysia Sarawak (UNIMAS). Hilly M, Adams ML, Nelson SC. A study of digit fusion in the mouse embryo. *Clin Exp Allergy*. 2002;32(4):489-98.

## COMPETING INTERESTS

Authors have declared that no competing interests exist.

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