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Effects of Aerobic Exercise on Pulmonary Function among Healthy Adults

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Abstract

Sedentary lifestyle and physical inactivity lead to various health problems and burden worldwide. In order to maintain a healthy lifestyle, regular exercise or physical therapy is needed to promote better pulmonary function which later reduce the rate of morbidity in individuals. The objective of this study is to study the effects of aerobic exercise on pulmonary functions among healthy adults and aim to enhance people performing aerobic exercise as it will improve overall health and well-being. This quasi experimental study was conducted among adults by convenient sampling. Thirty healthy adults were recruited and they then further divided into intervention and control group. Aerobic exercise which is treadmill running was performed by subject in the intervention group with a specific intensity prescribe for four weeks with three times a week. While, in control group, there was no exercise prescribe and the subject were advice to continue their normal routine activities. Pulmonary function test was done before and after the prescription of exercise. Parameters that used were FEV_1, FVC and FEV_1/FVC. Paired t-test and RM Anova were used to analyze the data. The finding indicated that there was significant improvement in FVC, FEV_1 and FEV_1/FVC in individual in intervention group after their training period with $p<0.005$ which were <0.001, 0.001 and 0.024 respectively, as compared to their own values obtained before their training period (paired t-test). Besides, there was significant difference in term of the changes in FVC between intervention and control groups with p-value of <0.001 but not for FEV1 and FEV1/FVC value (RM ANOVA). Therefore, in terms of reducing or preventing pulmonary illnesses, aerobic exercise must be performed regularly to promote healthy lifestyle This study will potentially benefit the human because people that are having regular aerobic exercise will have better cardiorespiratory and pulmonary functions which further reduce the risk of chronic disease.

Keywords: aerobic exercise; pulmonary function; healthy adults

1. Introduction

An exercise or physical activity was universally acknowledged in maintaining and promoting overall health and well-being of people (Sharif et al., 2016). Besides, according to American College of Sports Medicine (ACSM) (2018), an exercise training program is the ideal design planned to meet individual best health and fitness level required. Exercise also has been used to test physical capabilities of an individual and also their physiological responses that form the 0fundamental aspect of best health and well-being (Fatima, Rahman, Saifullah & Khan, 2013).

How can exercise promote best health of an individual? According to Anderson and Durstine (2019), regular exercise training or physical fitness program is interrelated each other with healthier pulmonary functions and prevention most chronic disease. As someone is exercising regularly, occasionally they will have better pulmonary functions, thus reduce any chronic disease as well as maintaining good health (Janssen & LeBlanc, 2010). Moreover, good pulmonary functions are sign of better health. In medical practice, pulmonary function is one of the main predictive or diagnostic tools for morbidity, mortality and general assessment for both genders (Fatima, Rahman, Saifullah & Khan, 2013; Schünemann, Winkelstein, Grant & Trevisan, 2000).

According to US Census Bureau (2018), world population estimate in 2016 approximately 7.3 billion people as of 23 August 2016 with 57% of adult population. Unfortunately, according to WHO (2018), there are one out of four adults worldwide which is 28% or 1.4 billion people are physically inactive or having sedentary lifestyle.

In Malaysia, it is stated that one out of four adults were being categorized as having sedentary lifestyle (Jamil, Rosli, Ismail, Idris & Omar, 2016). These statistics give significant warning to the community because sedentary lifestyles leading top ten causes of death worldwide and increase high risk of all mortality (WHO, 2017). According to the latest update from Department of Statistics Malaysia (2017), pneumonia was in the ranking number two for the principle cause of death in 2016 after ischemic heart attack in Malaysia. This is an alarming issue because an individual with any lung disease whether obstructive or restrictive lung disease is a significant predictor of earlier death (Mannino, Buist, Petty, Enright & Redd, 2003).

In short, the prevalence of sedentary population was increasing which further lead to more morbidity and mortality. Thus, prescription of exercise is crucial to maintain and promote best health which later reduce rate of morbidity in individuals (WHO, 2017).

2. Methodology

IIUM Kuantan Campus was the target study setting of this research. IIUM Kuantan is located at Bandar Indera Mahkota and it is about five kilometers from the Kuantan town centre. A quasi experimental study design was used for this study. This study design is the most relevant to assess the effect of aerobic exercise on pulmonary function among IIUM Kuantan students when compared to true experimental design. It is because, random assignment is difficult to be conducted in this field settings as students were busy with classes and examination, plus it is hard to find the students who will commit in this study. The study began from February 2018 until June 2018. The population of this study was students. There were about 400 students with six different programs which were Audiology and Speech-Language Pathology, Biomedical Sciences, Diagnostic Imaging and Radiography, Nutrition Sciences, Optometry and Visual Sciences, and Physical Rehabilitation Sciences. Convenience sampling was used in this study. According to Gravetter and Forzano (2009),

convenience sampling is the easiest method to get participants as they are selected on their availability and willingness to respond.

For recruitment of the subjects**,** advertisement regarding this study has been informed and spread to all of the students via social media which was society's Facebook page and also through Whatsapp group. For any interested subjects, they contacted the researcher to set the date for data collection. Those who met the inclusion and exclusion criteria as listed in **Table 1.1** were eligible to participate.

Table 1.1: List of Inclusion and Exclusion Criteria

Inclusion Criteria	Exclusion Criteria
1. KAHS students. 2. Age 18-25 years old. 3. Willing to participate in this study.	1. Pulmonary disease such as bronchial asthma, COPD, tuberculosis and known cardiac and respiratory diseases. 2. Smoking, alcohol, severe chest trauma, obvious chest and spinal deformity. 3. On medications for long duration. 4. Any major surgery (cardiac, pulmonary, abdominal) related to study. 5. Active sports training. 6. Hypertension, diabetes mellitus. 7. Arthritic disorders, skeletal deformities, or neuromuscular abnormalities.

For the data collection**,** a specific date had been given to all volunteers for the data collection procedure. Among thirty subjects, they already volunteered whether they were in control or intervention group respectively. So, there were fifteen participants for intervention group and fifteen participants in control group respectively. Initial explanation about the aim and purpose of the study, test procedure and method of testing had been given to the participants. They were requested to fulfill the consent form before completing the spirometry test and aerobic exercise plan for intervention group only. The study protocol was explained verbally to the participants before they gave their written consent. As for subject in intervention group, the data collection consists of three phases as: filling in a demographic data; spirometry recording and aerobic exercise plan. For control group, subjects just need to fill in demographic data and spirometry recording.

On the day of spirometry recording, subjects were asked to refrain from any caffeinated drinks (Chaitra, Narhare, Puranik & Maitri, 2012). Besides, subjects were advised not to eat large meal two hours before testing and not to wear tight fitting clothing as it might affects the spirometry reading (Miller et al., 2005). In order to achieve good results, all the procedure had been explained and demonstrated carefully to the subjects. In standing position, the force expiratory maneuver had been demonstrated to all the subjects (Johns & Pierce, 2008). Subjects then was instructed to take maximum inspiration and blew into the mouthpiece of spirometer as rapidly, forcefully and completely as possible for a minimum of six seconds, followed by full and rapid inspiration (Chaitra, Narhare, Puranik & Maitri, 2012). The best of the three trials were considered for data analysis. All

the testing protocols and the calibration of spirometer had been performed as outlined in the instruction for standardization of spirometer by Miller et al. (2005).

As for subjects in intervention group, aerobic exercise was done for the rest of four weeks with three times in a week. Subjects were instructed to set the treadmill running intensity to 60-70% of total heart rate which was moderate to high intensity. They then, performed treadmill running for 20 minutes with five minutes warmed up before running and five minutes cooled down after running. All the subjects were given a schedule sheet to make sure they finished their four weeks aerobic exercise. All the subjects could perform their treadmill running at the gymnasium of IIUM Sport Complex and also at the IIUM Physiotherapy Clinic. Spirometer reading then was repeated at the end of the training session.

Results then was keyed in Microsoft Office Excel to tabulate data and analyzed using the Statistical Package for Social Sciences (SPSS) version 20.0 for windows. If the value of mean, 5% trimmed mean and median were almost the same, all the assumption was considered met and could continue with the test. P value of <0.05 was considered as significant. The objectives were analyzed using statistical analysis of paired t-test and RM Anova. Paired t-test is to compare the pre and post-training values while RM Anova is to compare changes between groups.

Ethical approval was obtained from IIUM Research Ethics Committee (IREC). Participation in this study was on voluntary basis and subjects was asked to sign the consent form, if they agreed to participate in this study. Subjects has been explained about the procedures that are involved in this study. Then, the consent forms were obtained prior to the data collection. Any question from the subjects were answered accordingly. Subjects may also withdraw from this study at any time.

Since the study was conducted among KAHS students, the permission from the dean of the respective kulliyyah also was obtained. Any information of the participants in this study was remained confidential. The participants were treated as autonomous authority to the fullest extent possible except as required by law. Data was analyzed and stored in the computer. By signing the consent form, the participants had agreed for the data information to be analyzed, discussed and presented.

3. Results and discussion

Table 1.2 shows demographic data of the subjects.

Table 1.2: Demographic data of the subjects (n=15)

Variables	Intervention (n=15) n(%)	Control (n=15) n(%)
Age		
20 years old	1 (6.7)	1 (6.7)
21 years old	2 (13.3)	1 (6.7)
22 years old	6 (40.0)	1 (6.7)
23 years old	2 (13.3)	0
24 years old	2 (13.3)	11 (73.3)
25 years old	2 (13.3)	1 (6.7)
Gender		
Male	5 (33.3)	3 (20.0)
Female	10 (66.4)	12 (80.0)
Race		
Malay	15 (100.0)	15 (100.0)
Department		
Department of Physical Rehabilitation	4 (26.7)	14 (93.3)
Sciences	5 (33.3)	0
Department of Biomedical Sciences	3 (20.0)	1 (6.7)
Department of Diagnostic Imaging and Radiography	1 (6.7)	0
Department of Audiology and Speech Language Pathology	1 (6.7)	0
Department of Dietetics and Nutritional Sciences	1 (6.7)	0
Department of Visual Sciences		

Comparison of pulmonary function of pre and post aerobic exercise in intervention group

There was significant difference in term of FVC, FEV1 and FEV1/FVC between pre and post aerobic exercise in intervention group ($p<0.05$) (**Table 1.3**). **Figure 1.1** shows bar chart comparing mean FVC and FEV1 for pre and post exercise in intervention group and **figure 1.2** shows bar chart comparing mean FEV1/FVC for pre and post exercise in intervention group.

Table 1.3: Comparing FVC, FEV1 and FEV1/FVC between pre and post intervention in intervention group (paired sample t-test), n=15

Variable	Pre Mean (sd)	Post Mean (sd)	Mean Difference (95% CI)	t-statistics (df)	p-value
FVC (L)	3.2040 (0.8655)	3.5627 (0.7772)	0.3587 (-0.4921,-0.2252)	5.765 (14)	<0.001
FEV1 (L)	2.9993 (0.7317)	3.2193 (0.6262)	-0.2200 (-0.3297,-0.1103)	4.301 (14)	0.001
FEV1/FVC (%)	94.4533 (7.0209)	90.98 (5.8307)	3.4733 (0.5261, 6.4206)	2.528 (14)	0.024

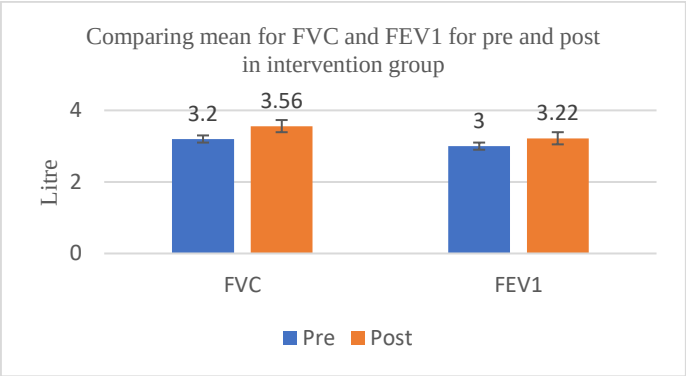

Figure 1.1: Bar chart comparing mean FVC and FEV1 for pre and post exercise in intervention group.

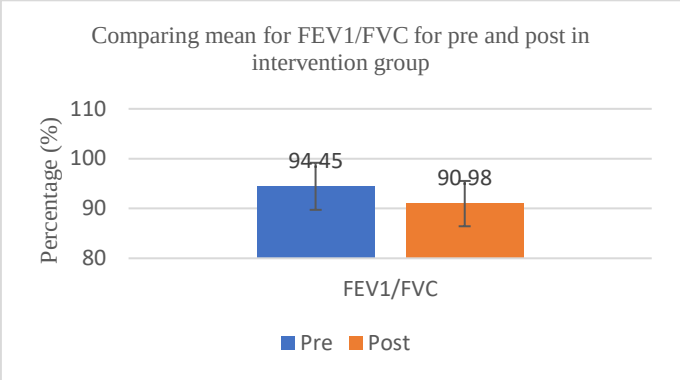

Figure 1.2: Bar chart comparing mean FEV1/FVC for pre and post exercise in intervention group.

Comparison of the changes in pulmonary function between intervention and control groups

First, there was significant difference in term of the changes in FVC between groups with ($p<0.05$). But there was no difference in term of the changes in FEV1 and FEV1/FVC between groups with ($p>0.05$) (**Table 1.4**). **Figure 1.3, 1.4 and 1.5** shows the plot comparing FVC, FEV1 and FEV1/FVC between control group and intervention groups respectively.

Table 1.4: The comparison of change in FVC, FEV1 and FEV1/FVC score between control and intervention groups (RM ANOVA)

Variables	Pre and post	Mean (SD)	F-statistic (df)	p-value
FVC (L)				
Intervention	Pre	3.2040 (0.8655)	27.529 (1,28)	<0.001
	Post	3.5627 (0.7772)		
Control	Pre	3.1980 (0.4156)		
	Post	2.8473 (0.3795)		
FEV1 (L)				
Intervention	Pre	7.7960 (18.4393)	0.796 (1,28)	0.380
	Post	3.2193 (0.6262)		
Control	Pre	2.9573 (0.4193)		
	Post	2.6633 (0.4792)		
FEV1/FVC (%)				
Intervention	Pre	94.4533 (7.0209)	1.097(1,28)	0.304
	Post	90.98 (5.8307)		
Control	Pre	92.48 (6.7050)		
	Post	91.2667 (7.0291)		

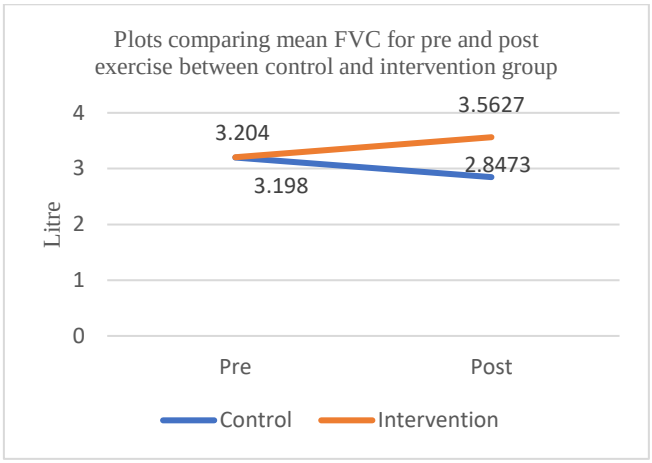

Figure 1.3: Plots comparing mean FVC for pre and post exercise between control and intervention group.

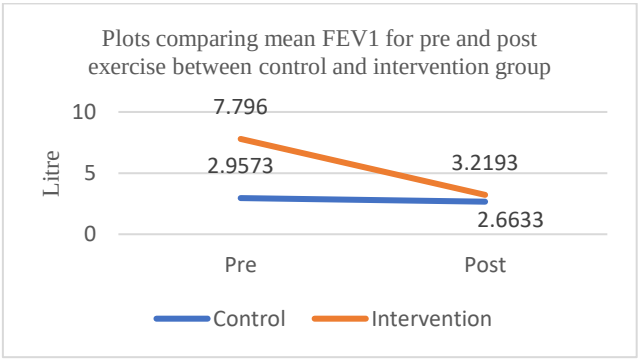

Figure 1.4: Plots comparing mean FEV1 for pre and post exercise between control and intervention group.

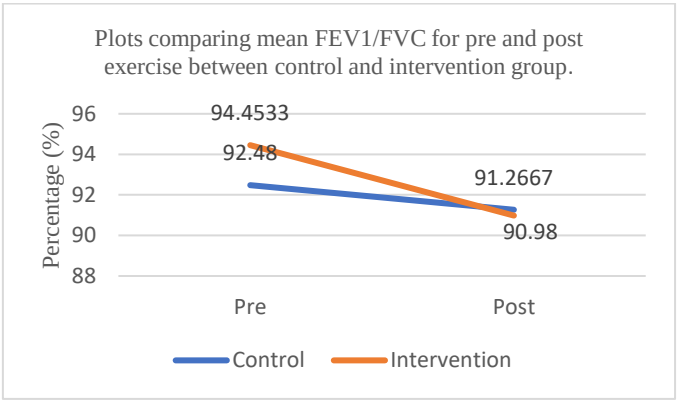

Figure 1.5: Plots comparing mean FEV1/FVC for pre and post exercise between control and intervention group.

The effects of aerobic exercise on pulmonary function

In this study, pulmonary function (FVC and FEV1) of an individual after performing aerobic exercise training were better and improved as compared to before undergoing aerobic exercise. It is because, the mean values for FVC and FEV1 are more and statistically significant after performing aerobic exercise training when compared to before exercise training. Thus, it shows that, one-month aerobic exercise training is enough to improve pulmonary function in an individual.

The value for FEV1/FVC also statistically significant when compared to the value of pre exercise. Most of the studies done before shows that there was statistically not significant in terms of FEV1/FVC after performing exercise (Bharali, Chutia & Jahan, 2015; Thaman, Arora & Bachhel, 2010). It was probably due to the value of FVC and FEV1 were not rise equally after exercise.

Improvement of pulmonary function (FVC and FEV1) after aerobic exercise training holds a same view from a many study done previously. A study done by Angane and Navare (2016) shows effect on pulmonary function after performing aerobic exercise training on healthy adults. In their study, aerobic exercise training was done for sixteen weeks and five sessions per week with high intensity exercise. After sixteen weeks, the mean value of FVC and FEV1 are more and statistically significant compared to before exercise. Other than that, study from Chaitra, Narhare, Puranik and Maitri (2012) also proves that aerobic exercise training improves pulmonary function among healthy young Indian man after sixteen weeks aerobic exercise plan. From the study of Angane and Chaira (2016) also, it clearly shows that the longer the aerobic exercise training, the more it will affect the pulmonary functions of an individual.

Not even that, study from Shashi, Anterpreet and Pankaj (2013) also claimed that aerobic exercise training performs by male adult of Punjab significantly improved their pulmonary function after twelve weeks of aerobic exercise plan. Although the intensity used was not stated in this study, the subjects need to perform aerobic exercise training for five times a week, which was quite high repetition.

Other than that, eight-week aerobic exercise plans also improve pulmonary function in asthmatic patients (Farid et al, 2005). Farid et al. (2005) had prescribed three sessions of aerobic exercise in a week and again intensity of exercise used was not stated in the study. Furthermore, this study was also supported by Cheng, Macera, Addy, Sy, Wieland & Blair (2013) as they proved that pulmonary functions among healthy sedentary people was improved after physical activity prescribed to them.

Moreover, Azad, Gharakhanlou, Niknam and Ghanbari (2011) studied the effect of twenty-four weeks (three days per week) aerobic training on pulmonary function among overweight and obese students and found improved lung function and significantly lower BMI and weight after aerobic exercise training. Next, Moazami and Farahati (2013) studied the effect of aerobic training on pulmonary function among postmenopausal women. Eight weeks with three sessions per week of aerobic exercise training was prescribed and the results show improvement and significant increase in pulmonary function as well as anthropometric parameters and VO_{2max} of an intervention group.

Other studies from Thaman, Arora and Bachhel (2010) found that physical activity improved pulmonary functions in security force trainees of India. In this study, the duration of exercise training was very long which was nine months and the intensity and type of exercise was not specified. It is hard to know which exercise actually give effect to the lung function.

How aerobic exercise training can improve pulmonary function? It is believed that after performing aerobic exercise training, an individual improves in respiratory muscle strength and endurance (Moazami & Farahati, 2013), thus an individual can have more effective and powerful inhalation and exhalation when compared to before aerobic exercise training (Chaitra, Narhare, Puranik & Maitri, 2012). Besides, it is found that, aerobic exercise improves pulmonary function by reducing the excess truncal fat which further increase respiratory muscle strength (Daftari, Retharejar, Bedekar, Shyam & Sancheti, 2015).

Pulmonary function: control group vs intervention group

In this study, pulmonary function in terms of FVC for control and intervention groups were found to be statistically significant. Comparing the results, the mean for FVC in control group shows decrement whereas in intervention group, there is improvement in average mean. Reduction in average mean for control group may be due to reduce respiratory muscle strength, thus reduce effort of breathing but vice versa for intervention group.

Next, FEV1 value shows reduction in average mean for both groups and thus statistically not significant between the two groups. This result was different from the previous study done by Farid et al. (2005) which study the effect of aerobic exercise on pulmonary function among asthmatic patients. Based on the study, the mean of FEV1 changes between the two groups was statistically significant. As the subject from this study was different from the study done by Farid et al., so it may probably affect the result of this study. For FEV1/FVC, there was also statistically no significant difference in the changes between the groups. This hold same review from a study done by Farid et al. (2015) where they prescribed eight weeks aerobic exercise for asthmatic patients.

4. Conclusions

In this study, the effect of aerobic exercise on pulmonary function among healthy adults were investigated. The finding shows significant improvement in pulmonary function (FVC, FEV1 & FEV1/FVC) after performing aerobic exercise plan in intervention group. When compared between control and intervention groups, only FVC value shows significant difference. Therefore, in terms of reducing or preventing pulmonary illnesses, aerobic exercise must be performed regularly to promote healthy lifestyle and indirectly support Healthy Lifestyle Campaign by Malaysia's Ministry of Health.

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