

Comparative Study of Effect of Resistance Exercises versus Aerobic Exercises on Exercise Performance and Pulmonary Function in Adult Chronic Smokers

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ABSTRACT

Background: Cigarette smoking is the major cause of premature death. It accounts for 28% of all cardio vascular diseases and 40% of respiratory diseases as it is associated with impaired pulmonary function. Exercise is an effective and low cost of treatment which can promote good health of a smoker. Research indicates that individuals who maintain an exercise program are more likely to give up smoking than those who quit exercising.

Methodology: 150 subjects were included in the study and divided into two groups Group A (resistance exercises) and Group B (Walking). The exercises protocol was given for six weeks. Pre post PEFR and VO₂ max was calculated.

Results: both the groups showed improvement post intervention ($p < 0.05$) whereas resistance group showed better improvement than the walking group ($p < 0.05$).

Conclusion: Aerobic and Resistance exercises both showed significant improvement in PEFR and VO₂ max in smokers, however the resistance exercises showed better improvement in the cardiovascular and pulmonary function.

Keywords: Smoking, Aerobic exercises, Resistance exercises, Theraband

INTRODUCTION

Cigarette smoking is the major cause of premature death.^[1] It is a risk factor for cardiovascular and respiratory diseases^[2] Nicotine which is one of major constituent of cigarettes is a cause of arteriosclerosis, coronary artery disease, chronic obstructive pulmonary disease and results in low cardiopulmonary function.^[3] It accounts for 28% of all cardio vascular diseases and 40% of respiratory diseases as it is associated with impaired pulmonary function.^[4] India is the 2nd largest consumer of tobacco products and 3rd largest producer of tobacco in the world.^[2]

Each year tobacco use kills nearly 6 million people (W.H.O 2013)^[1] According

to the predictions of W.H.O the number of smokers who will die from cigarette related diseases will surpass the number of people dying from AIDS, traffic accidents and suicide.^[8] As there are many complications on health related to smoking because of which every year approximately 2/3rd of smoker report their willingness to quit.^[7] Many approaches to quit smoking and to alleviate post withdrawal symptoms has been reported following which in a study O'Connell et al recommends "taking controlled deep breaths" as a strategy for reducing smoking symptoms of smoking withdrawal.^[21]

Lichtenstein and Brown has suggested an approach called lifestyle

balancing in which they replace a negative addicting behavior with an alternative positive addicting behavior such as yoga, meditation, walking or running. Other approaches used in this field include interventions such as nicotine patch, behavioral therapy etc. [6] Many negative experiences are seen following quitting which might restrain a smoker from quitting such as cigarette withdrawal symptoms like craving to smoke stress, anxiety, mood changes, depression, weight gain, and sleep abnormalities which can be prevented by physical exercise. [19] Kochupillai and colleagues investigated yogic breathing exercises slow and fast inhalation and exhalation for quitting smoking. [9]

Exercise is an effective and low cost of treatment which can promote good health of a smoker. [6] Research indicates that individuals who maintain an exercise program are more likely to give up smoking than those who quit exercising. [4] Hunt and Matarazzo has proposed an approach by making more use of supportive measures such as regulated exercises and recreational and social activity as an aid to smoking cessation. [20]

As smoking majorly affects cardiovascular and pulmonary function aerobic training can affect these systems in which it will improve pulmonary function and cardio respiratory fitness. [10]

Aerobic exercise is a simple form of exercise which is defined as physical activity which increases the endurance of pulmonary and cardio vascular system and thus helps smokers [6] Resistance exercise reverses muscle weakness and atrophy. [11] It increases oxygen consumption rate and depth of respiration which leads to improvement in FVC. [10]

Studies have reported lower PEFR, forced expiratory volume in 1 second, loss of ventilatory function and increased respiratory symptoms among smokers than in non-smokers [12] and therefore in this

study emphasis on aerobic and resistance training has been done.

METHODOLOGY

Institutional ethics committee approval was obtained before commencement of the study. 150 subjects who were smokers in age group of 20-40 years both males and females were selected randomly out of which 100 subjects who smoked 5 cigarettes per day for more than one year and their scoring more than 5 on Fagerstrom scale for nicotine dependency were recruited in the study. Subjects with any cardiovascular and respiratory disorder and subjects with psychological disorder were excluded. Subjects were divided into two groups by chit method in Group A (Aerobic group) and group B (Resistance). Group A was given walking as aerobic exercise for 6 weeks. First 3 weeks subjects did brisk walking for 30 mins with intensity of 11-13 on Borg's scale (6-20) and next 3 weeks subjects walked for 30 mins with intensity of 13-15 on Borg's scale. Prior to walking subjects did 5 mins of warm up and cool down exercises. Group B was given resistance exercises with yellow theraband for shoulder internal and external rotators, latissimus dorsi, pectoralis muscle, hip abductors and adductors, knee flexors and extensors. First 3 weeks 10 repetition * 2 sets and in next 3 weeks progression with red colour theraband was done with 15 repetition * 3 sets. The exercise performance (VO₂max) was measured pre and post by Queens's college step test using the formula

Male = VO₂ max (ml/kg/min) = 111.33 - (0.42 * post exercise heart rate)

Female = 65.81 - (0.7388 * post exercise heart rate). [18]

Pulmonary function was measured pre and post intervention by using the PEFR

Statistical Analysis:

Table 1: Comparison of demographic data in both the groups

	Group	N	Mean	Std. Deviation	t value	P value
Age (Years)	Group A	50	23.94	4.354	2.370	0.020*
	Group B	50	25.92	3.994		
Height (m)	Group A	50	1.7048	0.0931	1.192	0.236
	Group B	50	1.6822	0.0964		

Interpretation: both group age and height were compared using unpaired t-test $p > 0.05$ suggestive that both the groups were comparable

Table 2 Group A (Resistance): Pre-Post comparison of VO₂max and PEFR values using paired “t”test

	N	Mean	Std. Deviation	t value	P value
PEFR (L/min) pre	50	342.32	42.969	17.910	<0.001**
PEFR (L/min) post	50	351.42	43.054		
VO ₂ MAX pre	50	36.3768	2.65479	13.507	<0.001**
VO ₂ MAX post	50	37.290	2.7882		

Interpretation: pre post comparison of resistance training using paired t- test show that there was significant improvement seen post intervention $p < 0.05$

Table 3 Group B (Walking) Pre-Post comparison of VO₂max and PEFR values using paired “t”test

	N	Mean	Std. Deviation	t value	P value
PEFR (L/min) pre	50	336.06	42.252	2.354	0.023*
PEFR (L/min) post	50	341.62	41.895		
VO ₂ MAX pre	50	33.789	2.5502	14.647	<0.001**
VO ₂ MAX post	50	34.386	2.5865		

Interpretation: pre post comparison done in walking group using paired t test show significant difference post intervention $p < 0.05$

Table 4: Intergroup comparison of Group A and B for parameters PEFR and VO₂ max

Mean difference	Group	N	Mean	Std. Deviation	Z value	P value
PEFR	Group A	50	9.100	3.592	3.978	<0.001**
	Group B	50	5.560	16.704		
VO ₂ MAX	Group A	50	0.913	0.4781	3.860	<0.001**
	Group B	50	0.596	0.2880		

Interpretation: Unpaired t test was used to compare the effects of resistance and aerobic training showing that resistance training was better statistically $p < 0.05$

DISCUSSION

The purpose of this study was to compare effects of resistance exercise and walking on PEFR and VO₂ max values in chronic smokers. Significant improvement was observed in PEFR following resistance exercise as seen in Table 1 and 3, post six weeks of intervention. Resistance training can reduce perception of fatigue and improve oxidative enzymes, respiratory muscle function, breathing pattern, respiratory muscle strength and endurance and exercise tolerance by increasing muscular efficiency.⁽¹³⁾

As stated resistance exercise, increases the rate and depth of respiration which stimulate the ventral group of respiratory neurons in respiratory Centre of medulla. This causes an increase in PaCO₂ which is strongest for regulation of breathing. Increased PaCO₂ level stimulates the inspiratory Centre to get rid of excess CO₂ by increasing expiration^[15]

A study conducted by Singh and Joseley also found significant improvement in pulmonary functions in smokers by resistance training according to their study resistance exercise promotes a more efficient breathing pattern, improve ventilation which attribute to improvements in depth of respiration, consumption of O₂ and rate of diffusion.⁽¹⁰⁾

Improved pulmonary function following exercise training could be due to decreased airway resistance, and strengthened respiratory muscles as well as lung and thorax elasticity.⁽¹¹⁾ Reduced lung retractibility and induced vasodilatation of pulmonary vessels take place due to increased activation of adrenaline system during exercise training in which vasodilatation of pulmonary vessels cause a decreased airway resistance and an enhanced vital capacity through increasing airflow.⁽¹¹⁾

Furthermore, there was significant improvement in values of VO₂ max post six weeks of intervention in Resistance group as seen in table 2. Similarly, table 3 shows significant improvement in VO₂ max values in resistance and walking group; however Resistance group shows more significant increase in VO₂ max values post six weeks of intervention. Resistance exercise increases muscle contractility which causes increase in capillarization of muscles undergoing training.⁽¹²⁾ Thus, causing effective blood redistribution and increased blood volume causes increase oxygenation to the working muscles and improves VO₂ max.⁽¹²⁾

Resistance training causes increase in cardiac output, stroke volume, maximum heart rate and a-vO₂ difference, which helps improving VO₂ max. Increase in muscle mass in exercising muscle and blood flow to the exercising muscle is other possible factors that improve VO₂ max.⁽¹⁴⁾

Increase in a-Vo₂ difference is induced by an increase in capillary density and myoglobin concentration of muscle as well as an increase in muscle mitochondria content and enzyme activity. Changes in peripheral vascular resistance which is involved in increasing muscular blood flow in working muscles may thus, contribute to the increase in VO₂ max following resistance training.⁽¹⁴⁾

Exercise gives remarkable changes in bodily conditions owing to its stressful nature, and lungs are not excluded. Multiple aspects may support improvement of

pulmonary function following aerobic exercises.⁽¹⁵⁾ In the present study there was improvement in PEFr in Walking group, post six weeks of Intervention as seen in table 2 and graph 2a.

Metabolic activities are on a rise during exercising therefore, both the pulmonary and cardiac systems exert greater efforts to make an elevated level of ventilation. During aerobic exercise, minute ventilation increases and increased load is placed on respiratory muscles thus leading to improvement in vital capacity resulting in improved PEFr.⁽¹⁵⁾

The improvement in aerobic exercise may have occurred because regular exercises strengthen the respiratory muscles. This may have further helped in improving chest expansion. Increased chest expansion results in more air inspiration thus increasing the vital capacity and enabling more capillaries to be formed around the alveoli to allow more gaseous exchange to take place.⁽¹⁵⁾

A study conducted by Roopam and Saurabh on the effects of walking on PEFr also found significant improvement in PEFr. They state that the cause of improvement in PEFr values could be because of capabilities of aerobic exercises which enhances breathing efficiency and decreases pulmonary resistance⁽¹⁵⁾

As seen in table 2 there was improvement in values of VO₂ max in walking group. According to Fick principle, the improvement in both cardiac output (stroke volume and heart rate) and arterial venous oxygen difference contribute to VO₂ max.⁽¹⁵⁾ According to the presentation theory VO₂ max following aerobic training results from increased blood volume, increased cardiac output(via stroke volume) and better perfusion of active muscles with blood.⁽¹⁶⁾

Increase in maximal stroke volume is due to volume overload induced left ventricular hypertrophy. Enhanced sensitivity to catecholamine's and increase in load volume may also increase Stroke Volume max.⁽¹⁴⁾ The increment in a-VO₂

difference following aerobic exercises is mainly induced by an increase in capillary density and myoglobin concentration of muscle with qualitative and quantitative alterations of mitochondria in muscles.⁽¹⁴⁾

In this study there was significant improvement observed in resistance and aerobic group, with resistance exercises showing highly significant results in PEFR and VO₂ max values and so to conclude that Resistance exercise shows improvement by a reduction of resistance to oxygen flux at the fiber capillary interface, which might be an important adaptation for improvement of cardio respiratory parameters.⁽¹⁴⁾

CONCLUSION

Aerobic and Resistance exercises for a period of six weeks shows significant improvement in PEFR and VO₂ max in smokers, however the resistance exercises showed better improvement in the cardiovascular and pulmonary function.

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