

INFLUENCE OF AEROBIC EXERCISE ON RESPONSE TO GRADED HEAD-UP TILT AND PULMONARY FUNCTION TESTS IN YOUNG MALE SUBJECTS

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Abstract

Introduction: Moderate levels of PA and physical fitness are well correlated with lower morbidity and mortality rates. The head-up tilt test has been established an important diagnostic tool in the unmasking of vasovagal syncope in patients with unexplained syncope. But the mechanisms in regulating Cardiovascular changes and organs perfusion upon orthostatic stress is unclear. The type of exercise and its effects on mechanisms regulating cardiopulmonary system needs to be evaluated further. Therefore the aim of this study was to evaluate the influence of Aerobic exercise on response to graded head-up tilt and Pulmonary function tests in young male subjects. **Methodology:** Exercising group was compared with Non Exercising Healthy male subjects. Exercising male subjects in 18-30 years age group who have been performing Aerobic exercise for the past 6 months for a minimum of 1 hour for 3 days a week were included in the study. Hemodynamic responses after 10° and 70° head-up tilt (HUT) using Tilt table were assessed Pulmonary Function tests (PFT) Force vital capacity (FVC), Forced expiratory volume 1 second (FEV₁), Forced expiratory volume 1% (FEV₁%) and Peak expiratory flow rate (PEFR) were compared in both the groups. **Results:** Present study found that Passive upright tilt at 70° led to a significant increase of Mean arterial pressure and Diastolic blood pressure in the exercising group compared to the Non exercising group. The decrease in Systolic blood pressure in response to 70° HUT was more in the Non exercising group compared to the Exercising group. Present study found that Aerobic exercise produced significant increase in Peak Expiratory Flow rate (PEFR). **Conclusion:** It is concluded that regular Aerobic exercise produces a Physiological system which is less challenged and less stressed at passive upright posture than supine. This was evident when passive upright tilt at 70° led to a significant increase of Mean arterial pressure and Diastolic blood pressure in the exercising group. Aerobic training can reduce airway resistance and thereby increase expiratory flow.

INTRODUCTION

Healthy living and physical fitness are closely related. Physical activity is known to improve physical fitness so as to reduce morbidity and mortality from numerous chronic ailments. Exercise is a reliable method for testing the physical abilities and physiological reactions that form the basis of good health and well-being. This can be used to measure the ability to endure stress and carry on in circumstances which unhealthy person cannot. ⁽¹⁾

Previous literature shows that moderate levels of PA and physical fitness are well correlated with lower morbidity and mortality rates. ⁽²⁾

The head-up tilt test has been established an important diagnostic tool in the unmasking of vasovagal syncope in patients with unexplained syncope ⁽³⁾.

Previous studies evaluated the effect of various exercise trainings on hemodynamic responses namely systolic arterial blood pressure and diastolic arterial blood pressure to head up tilt. The findings of such studies have been varied. Systolic arterial blood pressure during HUT was found to be unchanged with training, whereas diastolic arterial blood pressure was lower at the end of HUT after training⁽⁴⁾. Head-up tilt (HUT) in resistance-trained group found a significant increase in mean arterial pressure (MAP) but found no significant change in sedentary and the endurance-trained groups.^(4,5)

Though the hemodynamic responses response to posture changes have been widely studied, the cause and effect of various mechanisms, their interrelationships and mechanisms in regulating cardiovascular changes and organs perfusion upon orthostatic stress is a grey area and is not clear. The effects of regular exercise on hemodynamic responses to head up tilt is still not clear.

One of the most common Physiological challenge and stress to the body is exercise. Lung function parameters tend to have a relationship with lifestyle such as regular exercise and non-exercise. Previous studies have shown that exercising subjects had higher lung volumes, flow rates and increased Pulmonary capacity.⁽⁶⁾

The type of exercise and its effects on mechanisms regulating cardiopulmonary system needs to be evaluated further. It is known that Spirometry is pivotal for screening, diagnosis and monitoring of respiratory disease and is increasingly advocated in primary care practice⁽⁷⁾. The type of exercise and its specific effects on various lung parameters using Spirometry needs further exploration.

Therefore the aim of this study was to evaluate the influence of Aerobic exercise on response to graded head-up tilt and pulmonary function tests in young male subjects.

It is hypothesised that exercising subjects would show improved hemodynamic responses to head up tilt and pulmonary function tests.

MATERIALS AND METHODS

The study was a cross sectional observational study conducted in the research laboratory at Department of Physiology, School of Medical Sciences & Research Greater Noida. Permission was obtained from Institutional ethical committee with letter Ref.No.SU/SMS&R /76-A/2022/03.

Participants were healthy Male subjects in the age group of 18-30 years.

Sample size $(n) = \frac{z^2 \cdot p \cdot q}{l^2}$ with $z=1.96$ was calculated and accordingly 60 healthy males performing aerobic exercise and 60 healthy non-exercising males were included in the study. The total sample size was 120. The study population comprised of two groups- Exercising and Non-exercising group with 60 subjects included in each group.

Inclusion Criteria

Exercising Group: Healthy males in 18-30 years age group who have been performing Aerobic exercise for the past 6 months for a minimum of 1 hour for 3 days a week. The exercise protocol included Aerobic exercise training for the last 6 months and 3 sessions per week. Every session lasted for 60 minutes and with intensity of 55-65 percent of maximum heart rate reserve⁽⁸⁾

Non-Exercising group: Healthy males in age 18-30 years who have not been exercising regularly. The procedure was explained to the participants and written informed consent for the study was taken after sharing the “participant information sheet”. Participants were asked to fill the short questionnaire form for assessing the exercising and non- exercising preference.

Exclusion Criteria was subjects with past history of syncope, Diabetes mellitus, cardiovascular disorder, any addictions, Lung disorders and any Autonomic dysfunctions.

Procedure: The procedure was explained to the participants and written informed consent for the study was taken after sharing the “participant information sheet”. Thereafter, at room temperature, all the anthropometric data were collected i.e., Height, weight, blood pressure and pulse were noted and the subject was assigned a code for data privacy. Pulmonary Function tests (PFT) Force vital capacity (FVC), Forced expiratory volume 1 second (FEV₁), Forced expiratory volume 1% (FEV1%) and Peak expiratory flow rate (PEFR) were recorded on RMS Helios 401 Pc Based machine.

Subjects rested in the supine position for 10 minutes. After the baseline haemodynamic measurements, subjects underwent passive head up tilt. It is known that haemodynamic steady state was reached within five minutes of the onset of tilt in healthy controls.⁽⁹⁾ hemodynamic responses namely Systolic and Diastolic blood pressure were measured in supine resting position and after 10 minutes of 10° and 70°head- up tilt (HUT) using Tilt table. The mean arterial pressure (MAP) was calculated by (MAP=DBP+1/3 PP).

RESULTS

The present study was conducted in the department of Physiology, School of Medical Sciences and research, Sharda University, Greater Noida, from March 2021 to November 2021.

Table 1: Number of Subjects

Exercising	60
Non- exercising	60
Total	120

Table 2: Mean age of Exercising and Non-Exercising Subjects

Parameter	Exercising Subjects n=60	Non-Exercising Subjects n=60
Age (years)	21.25±2.14	22.29±2.51

Values are expressed a mean± SD

Table 3: Height, Weight, BMI of Exercising and non- exercising Subjects

Parameter	Exercising	Non-Exercising	p-value
Height (cm)	173.33±5.90	172.60±5.95	0.50
Weight (kgs)	68.05±10.15	66.20±11.38	0.35
BMI (kg/m ²)	22.68±3.20	24.25±3.68	0.01*

Values are expressed as mean ± SD.

Table 4: Pulmonary Function Tests

	Exercising	Non- exercising	P value
FVC	3.00±0.74	3.03± 0.61	0.28 ^{NS}
FEV1	2.96±0.72	2.94±0.59	0.18 ^{NS}
FEV1%	97.90±3.58	96.78±5.51	0.44 ^{NS}
PEFR	6.84±1.25	6.15±1.52	<0.01 ^{**}

Values are expressed as mean± SD, NS-not significant , **- p<0.005

Statistically significant differences (p<0.05) were found in PEFR between the exercising and non- exercising subjects.

Table 5: Blood Pressure Responses to Graded Head up tilt

Parameters	Exercising	Non- Exercising	P value
Supine SBP	120.15±6.01	123.33±7.32	0.01*
Supine DBP	71.57±6.48	75.47±6.69	0.002 ^{**}
10° HUT SBP	119.60±6.84	121.43±7.73	0.17 ^{NS}
10° HUT DBP	71.08±6.38	75.05±7.57	0.002 ^{**}
70° HUT SBP	116.83±7.63	117.55±6.71	0.6 ^{NS}
70° HUT DBP	76.13±6.55	77.90±6.70	0.15 ^{NS}
Supine MAP	87.33±7.02	101.24±8.68	0.0001 ^{***}
10° HUT MAP	86.22±9.00	101.00±9.89	0.002 ^{**}
70° HUT MAP	94 ±8.94	105.19±7.84	0.04*
Change in SBP, Supine to 70°HUT	-3.32±4.79	-5.78±5.51	0.01*
Change in DBP, Supine to 70°HUT	5.02±5.66	2.43±5.87	0.02*
Change in MAP, Supine to 70°HUT	7.30±4.50	4.72±6.19	0.05*

Values are expressed as mean± SD, NS- not significant ,*-p<0.05 significance,**- p<0.005 significance

Passive upright tilt at 70° led to a significant increase of mean arterial pressure and diastolic blood pressure in the exercising group compared to the non exercising group. The decrease in Systolic blood pressure in response to 70° HUT was more in the Non exercising group compared to the Exercising group.

DISCUSSION

The purpose of this study was to evaluate the influence of Aerobic exercise on response

to graded head-up tilt and pulmonary function tests in young male subjects.

Previous study by Zaidi et al. in normal subjects show that with increasing tilt angle. Head up tilt produced progressive increase in systolic blood pressure and diastolic blood pressure. It was found that Cardiac output and stroke volume fell on head up tilt by 17–20% and by 28–34% respectively. ⁽⁹⁾

Oyake K et al.determined the blood pressure differences and various hemodynamic responses between the head-up tilt tests (HUT) and sit-up test. This study found significant increase in systolic blood pressure and reduction in stroke volume during both the sit-up test and head-up tilt test. Along with the increases in blood pressure variables there was also significant increase in total peripheral resistance. ⁽¹⁰⁾

Similar to the above mentioned studies our present study showed significant increases in Mean arterial pressure and diastolic pressure in response to 70°HUT from supine

position in both the exercising and non exercising subjects. (Table -5). The increase in diastolic blood pressure indicates an increase in peripheral resistance which is similar to the study by Oyake K et al.

In a recent study by Onizuka et al. Nurses who have a high degree of physical activity and 12 healthy controls underwent a 70° head-up tilt (HUT) test for 10 minutes. Blood pressure (BP), heart rate (HR) and pulse pressure were measured and compared between Nurses and healthy subjects. It was found that Nurses with high degree of physical activity were able to effectively maintain blood pressure during HUT, suggesting higher orthostatic tolerance in them. ⁽¹¹⁾

A recent study by Fois et al. a novel mathematical model of the human CVS was proposed to investigate the effects of passive head-up tilt devoid of any muscular intervention on posture changes. This study found that Passive upright tilt led to an increase of mean arterial pressure, heart rate, and a decrease of stroke volume and cardiac output. ⁽¹²⁾

Similar to the previous studies, the present study found that Passive upright tilt at 70° led to a significant increase of mean arterial pressure and diastolic blood pressure in the exercising group compared to the non exercising group. The decrease in Systolic blood pressure in response to 70° HUT was more in the Non exercising group compared to the Exercising group.

Pulmonary Function Tests

Present study evaluated the influence of Aerobic exercise on Pulmonary function tests in Exercising subjects in comparison with the non Exercising young male subjects. Significant differences ($p < 0.05$) between the exercising and non- exercising subjects were found for PEFR (Peak Expiratory Flow rate).

Study by Esha et al. evaluated the effects of aerobic exercise on pulmonary function tests in 65 healthy adult volunteers in age group of 20- 35 years. Study found that the Mean values of *Forced vital capacity* (FVC), maximal voluntary ventilation (MVV) and the forced expiratory volume in one second (FEV₁) were higher and statistically significant after subjects underwent Aerobic exercise training than before the Aerobic exercise training. ⁽¹³⁾

Recent study by Moazzami et al. compared the effects of six-month Aerobic training on pulmonary function tests in obese and non-obese women. The study found that after Aerobic training, FVC Index increased significantly in obese group. It was found that if Aerobic training was conducted in adequate timing and intensity leading to weight loss in obese people, there can be improvement in pulmonary functions. ⁽¹⁴⁾

Meta analysis by Wu X et al. found that continuous Aerobic exercise regularly done by Asthma patients showed no improvements in FEV₁%predicted and FEV₁/FVC% but had beneficial effects on FEV₁, PEF, FVC, FVC% predicted. The quality of life of Asthma patients also showed improvement. Among the Aerobic exercises, Treadmill training and Swimming were considered as better options. ⁽¹⁵⁾

Shadmehri S et al. compared the effects of Aerobic Training and High-Intensity Interval Training (HIIT) on Respiratory Volumes among the Female Students. It was reported that Aerobic training showed significant improvement in peak expiratory flow and the forced expiratory volume in one second. HIIT did not produce any significant change on the Respiratory volumes. ⁽¹⁶⁾

Similar to the previous studies, the present study found statistically significant differences in PEFr between the exercising and non-exercising subjects. Aerobic exercise produced significant increase in Peak Expiratory Flow rate (PEFR).

Previous studies have found that Pulmonary adaptation is improved with Aerobic training. This is due to the strength and endurance of the respiratory muscles. It has also been found that Aerobic training can reduce smooth muscle tone in the airways and thereby increase expiratory flow. ⁽¹⁶⁾ Another mechanism shown to reduce airway resistance is the frequent stretching of the lungs due to airway smooth muscle which has found to reduce airway resistance. ⁽¹⁷⁾ Decreased smooth muscle contraction and tone are suggested mechanisms to reduce air resistance. Air flow increases as smooth muscle tone and airway resistance decreases along with decrease in Pulmonary volume. These combined mechanisms have been implicated for the increased airflow.

CONCLUSION

It is concluded that regular Aerobic exercise produces a Physiological system which is less challenged and less stressed at passive upright posture than supine. This was evident when passive upright tilt at 70° led to a significant increase of mean arterial pressure and diastolic blood pressure in the exercising group compared to the non-exercising group. These cardiovascular changes in response to postural changes in Aerobic exercising subjects has promising implications for many Autonomic nervous system disorders.

Regular Aerobic training can reduce airway resistance and thereby increase expiratory flow.

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Conflict of Interest: None

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