Effect Of Different Modes Of Aerobic Exercise On Cardiorespiratory Efficiency And Exercise Performance In Sedentary Males

J M Harsoda*, Geetanjali Purohit**

* Professor& Head, **PhD Student, Department of Physiology, SBKS MI & RC,
Sumandeep Vidyapeeth, Vadodara, 391760

Abstract: Background: Physical activity is a complex behaviour that is nurtured by environmental and biological factors. In day-to-day life, moderate level of physical activity has a number of positive influences on all systems, especially cardiovascular and respiratory systems. Few studies reported how the different modes of aerobic exercise influence the cardiovascular efficiency and physical fitness in sedentary subjects. This study was aimed to study the effect of whole body exercise, walking exercise, upper and lower limb exercise and combined exercise on sedentary males. Method: Seventy five healthy non-smoking males aged between 15-25 years were recruited for 12 week exercise training. Participants were divided into five groups, 15 in each. Each group performed different exercise for 12 weeks under the supervision of physical trainer. Interventions included respiratory rate, resting pulse rate, blood pressure, forced expiratory volume in one second (FEV1), peak expiratory flow rate (PEFR), 6 minute walk distance (6 MWD), 12 minute walk distance (12 MWD), 6 minute bicycle ergometer (6 MBE) test and 6 minute arm ergometer (6MAE) test. Parameters were studied twice before and after exercise training. Data was represented as mean±SD. Students paired t test was applied for pre and post data analysis. Result: The increase in cardiorespiratory efficiency was found significantly higher in response to whole body, combined and walking exercise. The other mode like only upper limb or lower limb exercises are not as beneficial. Conclusion: In conclusion cardio-respiratory efficiency and exercise performance both are improved by regular exercise training and whole body exercise is the best among all. Lower limb exercise is least beneficial.

Key Words: Key words: 6MWD, 12 MWD, 6MBE, 6MAE, FEV1

Author for correspondence: Geetanjali Purohit, PhD student Department of Physiology, SBKS MI & RC, SV, Vadodara, 391760, Gujarat Mail ID: purohit85geet@gmail.com

Introduction: Development of brain occurred as men is destined to move locomotive apparatus constitute the majority of body mass. Basic instrument of mobility and locomotive apparatus is skeletal muscle[1].

Exercise has been a means of testing the physical capabilities and physiological responses of an individual that form the basis of good health and well-being. It develops the ability to tolerate, withstand stress, and carry on in circumstances where an unfit person cannot continue. The American College of Sports Medicine (ACSM) defines aerobic exercise as "any activity that uses large muscle groups, can be maintained continuously, and is rhythmic in nature." It is a type of exercise that overloads the heart and lungs and causes them to work harder than at rest[2] and the example are walking, jogging, running, skipping, dancing, swimming, bicycling etc.

In the many advance laboratories of exercises physiology specific exercise programme have been develop for specific training and conditions. There are many evidences confirming that the changes, which occur due to the regular physical work, not only increase the functional capacity of organism, but also decrease the risk of various diseases[3-4]. Exercise training is important for the improvement of cardio-respiratory efficiency, work performance and the functioning of other systems. Physical activity is known to improve physical fitness and to reduce morbidity and mortality from numerous chronic ailments[5].

Exercise training influence a number of factors which affect exercise performance. It may cause increase muscle strength, maximal oxygen uptake, structural and functional changes in a number of organ systems and there are psychological changes as well. The aerobics exercise is a system of acyclic exercises, which improves the capacity of cardiovascular functions, develops the toughness of muscles and the coordination of movement. A regular participation in aerobics exercise program, as in other endurance exercises, increases the capacity of cardiovascular system [6–7.]

There are few studies reported on aerobic exercise and pulmonary function in general population. As far as the recent developments concern exercise physiology have shown significantly positive improvements, however non-significant associations have also been reported.[8-10] There are different parameters used for the measurement of lung functions but FEV1 has been proven to be most crucial in detecting pulmonary changes easily and effectively in clinical settings the patient turnover is high and in settings where obesity is prevalent.[11]

With this idea sedentary human were trained in different forms of exercise for 12 weeks. Their cardio-respiratory efficiency and exercise performance were measured and compared before and after exercise training. Authors were keen to know the role of physical activity in the modification of cardiovascular functions, lung functions; positive results if derived could then be communicated to the students for their fitness and well-being.

Material and Method: Participants: This study was conducted in Department of Physiology, PSMC, Karamsad after ethical clearance. Longitudinal experimental study was conducted in total 75 male subjects. After taking informed consent detailed history was noted. This was followed by a physical examination of each participant and those with a past medical history suggestive of asthma or exercise-induced asthma, smoking, chronic cough, recurrent respiratory tract infection, history of chest or spinal deformity, obesity, and chronic obstructive lung diseases were excluded from the study. Only healthy, non-smoker and non addict subjects were selected for the study. The aim of the study and procedure of the tests were explained to all subjects and only those who volunteered, included in the study. Now subjects were divided in to 5 different groups, 15 in each. Each group was trained for different exercise. Anthropometric measurements were taken.

Exercise training: Five different modes of exercise were used. All participants underwent the 12 week exercise training for half an hour daily, five times in a week. Table 1 showed the training protocol

Material and Interventions: All the subjects were studied for cardiorespiratory efficiency and exercise performance. Interventions were performed twice, before and after the 12 week of physical training. The following interventions were taken.

(A) Cardiorespiratory efficiency tests:

1. Measurement of resting pulse rate and blood pressure.

2. Respiratory rate: Resting respiratory rate was taken before the study and after the exercise training.

3. Forced expiratory volume in one second (FEV1): For the measurement of FEV1 digital spirometer SP-1A was used. Subjects were asked to breathe in deeply in upright position, then to take mouthpiece firmly between their lips and breathe out as strongly as possible for more than two seconds.

4. Peak expiratory flow rate (PEFR): To measure the PEFR the mini Wright’s peak flow meter was used. The subjects were asked to take a full and deep inspiration and then to blow out fast and forcefully in to the mouth piece of peak flow meter.

(B) Exercise performance test: (1) Walking tests: 6 minute (6MWT) and 12 minute walk tests (12MWT) were performed. Both the teats were carried out on a level enclosed passage. Subjects were asked to walk as much as distance as they could in 6 and 12 minutes and instructed to walk continuously as fast as possible without any stoppage or slowing down in speed. Subjects should put their maximum efforts to cover maximum distance. A physical instructor accompanied the subject, acting as time keeper and giving the necessary encouragement. Distance was measured in meters.

2. Bicycle Ergometer test: Six minute ergometer distance (6MED) was performed on Hero allegro Exer bike. The subjects were instructed to pedal (at moderate tension of 30 kg.m/sec) as fast as possible for a period of six minutes. During the test they were continuously encouraged to reach a maximal pedalling. The result was expressed as distance covered in kilometres. Six min maximum arm ergometer test (6MAE) was also performed by setting a moderate tension (30 kg.m/sec) on handle bars of hero allegro Exer bike. The subjects were instructed to row the pedals as maximally as possible for a period of six minutes. During the test they were continuously encouraged to reach a maximally rowing speed.

Statistical analysis: Students paired t-test (2 tail) was applied to compare the pre and post training values. Statistics were tested at the $p<0.05$ level of significance and data were reported as mean±SD.

Table 1: Exercise Training Protocol

Exercise training	Instrument used	Type of exercise	Speed	Tension
Whole body Group A (N=15)	Hero allegro Exer bike	Rowing+ pedalling+ walking	20 times/ min 20 kms/hr 10 kms/hr	Moderate 30 kg.m/sec
Combined limb Group B (N=15)	Hero allegro Exer bike	Rowing+ pedalling	20 times/min 20 kms/hr	Moderate 30 kg.m/sec
Walking Group C (N=15)	-	walking	10 kms/ hr	-
Upper limb Group D (N=15)	Hero allegro Exer bike	Rowing	20times/min	Moderate 30 kg.m/sec
Lower limb Group E(N=15)	Hero allegro Exer bike	Pedalling	20kms/hr	Moderate 30 kg.m/sec

Table 2: Anthopometric parameters

Data	Whole body	Combined limbs	Walking	Upper limbs	Lower limb
N	(N=15)	(N=15)	(N=15)	(N=15)	(N=15)
Age (Yrs)	17.9±0.9	17.9±0.9	17.53±0.64	18.93±0.40	17.73±.59
Weight (kg)	57.75±9.19	57.75±9.19	61.67±12.26	57.40±7.27	57.2±8.55
Height (cms)	168.55±5.52	168.55±5.52	168.33±4.91	172.07±5.70	167.4±5.47
BSA m^2	1.65±0.13	1.65±0.13	1.70±0.15	1.67±0.11	1.63±0.11

Result: There were 75 sedentary male subjects aged between 15-25 years were studied. Besides cardio-respiratory efficiency tests, exercise performance tests were also studied. Table 2 showed the anthropometric data of subjects for each group which include age, weight, height and body surface area. Table 3 showed the values of pre and post exercise changes in cardio-respiratory efficiency. Pulse rate and SBP decreased after all exercise modes, while DBP has shown variable values. Respiratory rate is not affected by exercise while FEV1 and PEFR improved after all modes of exercises except lower limb exercise. Table 4 showed the improvement in exercise performance as 6 MWD, 12 MWD both increased after exercise training. Results showing that whole body exercise showed significant changes in all parameters.

It consisted of rowing, pedalling on hero allegro exer bike and walking. Combined limbs exercise or walking exercise training is the next best and lower limb or upper limb exercise alone follows them.

Table 3: Comparison of effect different modes of exercise on cardio-respiratory parameters

Parameters	Whole body		Combined limbs		Walking		Upper limbs		Lower limb	
	Before	After	Before	After	Before	After	Before	After	Before	After
RR (/min)	15.7±2.37	16.0±2.14	14.9±2.25	15.2±1.82	15.7±2.37	16.0±2.14	14.5±1.96	15.6±1.88	15.1±2.6	15.5±1.60
PR (/min)	77.3±3.2	71.8±2.92***	77.3±3.18	72.3±3.1***	76.5±3.66	71.6±3.48***	78.1±3.34	70.9±2.71***	77.3±2.69	72.7±2.69***
SBP (mm/Hg)	116.7±7.2	109.9±5.88***	117.0±5.6	109.2±4.65***	120.2±7.55	112.2±6.88**	114.8±8.28	108.5±5.15*	115.3±8.34	109.6±6.47*
DBP (mm/Hg)	76.03±8.21	71.67±7.02**	75.3±6.40	73.5±8.21	78.4±8.01	75.6±6.73	73.87±6.44	66.53±4.75**	76.53±11.22	71.07±7.25
FEV1 (L)	3.4±.67	4.7±.61***	3.38±.71	4.36±.45***	3.26±.66	4.12±.33***	3.51±.03	4.07±.34**	3.31±.45	3.43±.47
PEFR (L/min)	556.6±61.15	594.7±64.39**	530.3±56.93	605.6±64.17**	577.3±47.88	615.6±55.45*	580.3±65.64	611.6±53.87*	538.6±61.4	546.0±62.7

RR= Respiratory rate, PR= pulse rate, SBP= systolic blood pressure, DBP= diastolic blood pressure, FEV1= forced expiratory volume in first one second, PEFR= peak expiratory flow rate, * P <0.05, ** P<0.005, *** p<0.001

Table 4: Comparison of effect different modes of exercise on exercise performance test

Test	Whole body		Combined limbs		Walking		Upper limbs		Lower limb	
	Before	After	Before	After	Before	After	Before	After	Before	After
6 MWD (m)	705.5±47.21	743±56.7***	694.6±30.26	758.6±57.99**	705.5±55.65	761.2±58.23*	715.6±46.4	717.2±46.53	706.4±54.66	734.8±58.57
12 MWD (m)	1439.6±113.4	1534.3±119.2***	1441.4±65.41	1551.2±113.0***	1453.9±120.1	1553.0±104.3*	1462.7±126.4	1506.6±88.18	1427.3±113.8	1526.8±165.3
6MBE (Km)	3.26±0.53	3.90±0.60***	3.13±0.50	4.36±0.41***	3.39±0.40	4.17±0.44***	3.37±0.61	3.51±0.61	3.13±0.57	3.57±.0.46*
6MAE (m)	306.0±33.2	347.9±40.9***	296.8±35.36	373.5±29.7***	312.4±37.98	332.8±35.29	311.2±26.07	371.1±25.1***	303.7±33.22	314.1±39.07

6MWD= 6 minute walk distance, 12MWD= 12 minute walk distance, 6MBE= 6 minute bicycle ergometer test, 6MAE= 6 minute arm ergometer test, * P <0.05, ** P<0.005, *** p<0.00

Discussion: Our study state that regular moderate aerobic exercise training significantly improves cardiorespiratory efficiency in sedentary male subjects. Whole body exercise training causes maximum benefits in subjects.

Walking and combined limb exercise training are the next. Lower limb and upper limb exercise training has variable effects[12].

It is reported that aerobic exercise is particularly useful for evaluating the cardiopulmonary capacity of athletes and normal people, as well as for clinical practice, such as diagnosis and evaluation of cardiovascular disease, assessment of treatment effect, ascertainment of pathophysiology, and exercise prescription for rehabilitation[13-16].

Pulse decreases significantly in all kind of exercises. Resting pulse depends upon vagal and sympathetic tone, but the vagal tone predominates[17]. Aerobic exercise increases the vagal tone and also increases the concentration of circulatory catecholamine. Reflex activation of heart rate due to cardiovascular and pulmonary reflexes is reduced and the effect of stretch receptor of muscle and joints on heart rate also reduced.[18]

Blood pressure depends upon central and peripheral mechanism of regulation, peripheral vascular resistance, mechanical efficiency of heart and cardiac output. Exercise decreases the magnitude of central and peripheral mechanism, also reduced the peripheral vascular resistance may cause increase mechanical efficiency of heart.[19] Exercise is a stressful condition that produces marked change in body functions, improves endurance and reduces breathlessness. Skeletal muscle control many crucial elements of aerobic conditioning, including lung ventilation. The possible explanation could be that regular forceful inhalation and deflation of the lungs for prolonged period's leads to strengthening of respiratory muscles.[20] There might be an increase in the maximal shortening of the inspiratory muscles as an effect of training, which has been shown to improve lung function[21]. FEV1 depend upon airway resistance, lung compliance and contraction power of respiratory muscle. In present study FEV1 increase significantly in whole body and combined and walking exercise in males. This may be due to increased elasticity of joints concern with respiratory movements leading to greater expansion and recoil of thoracic cage. FEV1 is also improved after exercise in asthmatic persons but the rise was statistically insignificant maybe due to respiratory muscle weakness.[22] Our study improvement in FEV1 after an 12-week exercise course is comparable to a study in which significant augmentation in FEV1 and FVC were observed after physical training in healthy male welders. These results also agreed with a previous study which proved that ventilatory exercise programme improves all measured pulmonary parameters.[23-24]

Our study found that PEFR improved after all exercises. It is reported that 16 weeks aerobic exercise plan (five 20 minute sessions of jogging in a week) can improve the PEFR up to 17% significantly[25]. As far as airways are concerned, activity-induced bronchodilation reduces airway resistance and improves pulmonary ventilation. It is known that normally the volume and pattern of ventilation are initiated by neural output from the respiratory centre in the brainstem. This output is influenced by input from chemoreceptors, proprioceptors in muscles, tendons and joints and impulses sent by nerves to the intercostal and diaphragmatic muscles.[26]Our result correlates with Y.J. Cheng et al. who showed in their study that physical activity improved pulmonary function in healthy sedentary people [27]

Our study found that exercise training not only improves the cardio-respiratory capacity but also increase the exercise efficiency. Exercise training improves the 6 MWD and 12 MWD. We found that the 6'WT is a reliable and reproducible test. It is reported that after exercise training, a significant improvement of walking distance (WD) was shown in T-CHD[28]. The 6MWT appears reproducible and valid relative to cycle ergometer assessments of cardio-respiratory responses, and offers a simple method of clinical assessment. An 8-week moderate walking program improves the cardiopulmonary fitness of children with CP, as measured by 6MWT.[29]

Conclusion: In conclusion the longitudinal purposeful physical exercises significantly improve the cardiorespiratory efficiency in sedentary persons. Amongst different modes of aerobic exercises the whole body exercise is best suited to the individuals. It is confirmed above mentioned aerobic exercise improves the physical health component of quality of life and endurance in persons. It should be included as a part of a comprehensive health promotion strategy.

Results of blood pressure enlightened the further way of hypertension management. Our study suggests that the moderate aerobic exercise can improve airway functions in healthy people and thus provides further support for the aerobic exercise as an important component of pulmonary rehabilitation. This will lead to better and improved treatments of COPD. Repeated periodic exercise helped in improving lung functions, especially FEV1. Periodic measurement of FEV1 with regular exercise can help in generating awareness regarding lifestyle modifications, and acquiring a healthy habit of being active.

Acknowledgement: I acknowledge all the participants involved in this study, without their cooperation and regularity this study was impossible. I am thankful to Ms. Geetanjali Purohit for drafting and revision of this manuscript.

References:

1. Astrand P, Rodahl K. “Our biological heritage” Text book of work Physiology: Physiological basis of exercise;3rd ed. McGrew Hill International. 1986:P 10.
2. Guidelines for Exercise Testing and Prescription. American College of Sports Medicine- Lea and Fabiger 1988:168-69.
3. Halm MA, Denker J. Primary prevention programs to reduce heart disease risk in women. Clin Nurse Spec 2003;17(2):101-09
4. Howes DG. Cardiovascular disease and women. Lippincotts Prim Care Pract 1998;2(5):514-24.
5. Garrick JG, Regua RK. Aerobic dance: a review. Sports Med 1998;6:169-79.
6. Poderys J. Asmenssveikatosugdymas (Personal health promotion) Kaunas: Kaunomedicinosuniversitetas; 2000.
7. Shephard RJ, Balady GJ. Exercise as cardiovascular therapy. Circulation 1999;99: 963-72.
8. Twisk JW, Staal BJ, Brinkman MN. Tracking of Lung Function Parameters and the Longitudinal Relationship with Lifestyle. European Respiratory Journal. 1998; 12:627-34.
9. Garber CE, Blissmer B, Deschenes MR, Franklin BA, Lamonte MJ, Lee IM, Nieman DC, Swain DP. American College of Sports medicine. Quantity and quality of exercise for developing and maintaining cardio respiratory and muscular fitness and flexibility in health adults. Med Sci Sports Exerc 1998;30:975-91.
10. Nourry C, Desuelle F, Guinhouya C, Baquet G, Babic C, Bait F. High intensity intermittent running training improves pulmonary function and alters exercise breathing pattern in children. Eur J Appl Physiol 2005;94:415-23.
11. Thaman R G, Arora A, Bachhel R. Effect of Physical Training on Pulmonary Function Tests in Border Security Force Trainees of India. J Life Sci 2010;2:11-5.
12. Lake F R, Henderson K, Briffa, Openshow J, Musk W. Upper limb and lower limb exercise training in patients with chronic air flow obstruction. CHEST 1997;5:1077-81
13. Garber CE, Blissmer B, Deschenes MR, Franklin BA, Lamonte MJ, Lee IM. American College of Sports Medicine. Quantity and quality of exercise for developing and maintaining cardiorespiratory, musculoskeletal, and neuromotor fitness in apparently healthy adults: guidance for prescribing exercise. Med Sci Sports Exerc. 2011;43:1334–59.
14. Fletcher GF, Balady GJ, Amsterdam EA, Chaitman B, Eckel R, Fleg J. Exercise standards for testing and training: An statement for healthcare professionals from the American Heart Association. Circulation. 2001;104:1694–740.
15. Mezzani A, Agostoni P, Cohen-Solal A, Corra U, Jegier A, Kouidi E. Standards for the use of cardiopulmonary exercise testing for the functional evaluation of cardiac patients: a report from the Exercise Physiology Section of the European Association for Cardiovascular Prevention and Rehabilitation. Eur J Cardiovasc Prev Rehabil. 2009;16:249–267.
16. Myers J, Prakash M, Froelicher V, Do D, Partington S, Atwood JE. Exercise capacity and mortality among men referred for exercise testing. N Engl J Med. 2002;346:793–801.
17. Johan BW. Cardiovascular control and integrated response in “physiological basis of medical practice”; Best and Taylor’s 11th international student edition 2012:263-82
18. De Meersman R E. Heart rate variability and aerobic exercise. Am Heart J. 1993;725:726.
19. Jone D R, Speier J, Canine K, Owen R, Stull A. Cardiorespiratory response to aerobic training by patients with poliomyelitis sequelae. JAMA 1989;261(22):3255-58.
20. Thaman R G, Arora A, Bachhel R .Effect of Physical Training on Pulmonary Function Tests in Border Security Force Trainees of India. J Life Sci 2010;2:11-5.
21. Hamilton P, Andrew GM. Influence of growth and athletic training on heart and lung functions. Eur J Appl Physiol Occup Physiol 1976;36:27-38.
22. Gimenez M, Predine E, Marchand M, Servera E, Ponz J L, Polu J M. Implication of upper and lower limbs training in patients

with chronic airway obstruction. CHEST 1992;101(5): 279-88.
23. El-Batanouny MM, Amin Abdou NM, Salem EY, El-Nahas HE. Effect of exercise on ventilatory function in welders. Egyp J Bronchol 2009;3:67-73.
24. Ali AT, Badr NM, Batanony MM, Seri ZMH. Ventilatory functions response to respiratory exercise program in workers of Tourah Cement Factory. A doctoral thesis, Faculty of physical therapy, Cairo University, 2002;168.
25. Chaitra B , Vijay Maitri. Effect of Aerobic Exercise Training on Peak Expiratory Flow Rate: A Pragmatic Randomized Controlled Trial. Int J Biol Med Res. 2011; 2(3): 789-92
26. Guyton A, Hall JE. Text book of medical physiology. 9th ed. Philadelphia: W.B. Saunders Company,1996;300-18.
27. Cheng YJ, Macera CA. Effects Of Physical Activity on exercise tests and respiratory function. Br. J. Sports Med. 2003;37:521-528
28. Moalla W, Gauthier R, Maingourd Y, AhmaidiS.Six-minute walking test to assess exercise tolerance and cardiorespiratory responses during training program in children with congenital heart disease. Int J Sports Med. 2005;26(9):756-62.
29. NsengaLeunkeu A, Shephard RJ, Ahmaidi S. Six-minute walk test in children with cerebral palsy gross motor function classification system levels I and II: reproducibility, validity, and training effects. Arch Phys Med Rehabil. 2012;93(12):2333-39.

Source Of Financial Support-Nil
Conflict Of Interest-None