

Comparison of VO_2 Max in Untrained Healthy Adults-Bicycle Ergometer and Harvard Step Test

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ABSTRACT

The purpose of the study was to compare the VO_2 max from bicycle ergometer and Harvard step test in untrained adults. A total of fifty students between age group of 18-25 yrs were enrolled for the study (25 were males and 25 were females) all the participants were randomly selected and divided into two groups group A and group B. After analysing by student t- test significant differences in physiological responses between the two tests were seen between bicycle ergometer test and Harvard step test. So, it can be explained by the fact that except different levels of load and intensity of work and types of movements or movement characteristic for certain ergometer, there can be different cardio respiratory and metabolic reactions

Keywords: VO_2 , VO_2 max, Harvard step test, Bicycle ergometer.

INTRODUCTION

In recent years, physical exercise has gained prime importance in public life for its enormous health benefits. Cardiovascular and metabolic diseases have become common in individuals leading a sedentary life. Practice of regular physical exercise not only prevents the occurrence of such diseases but decrease their intensity also cure from the diseases. Exercise improves the physical fitness⁽¹⁾. VO_2 max is the maximum amount of oxygen our body can use during exercise, expressed in millilitres per kilogram per minute (ml/kg/min)⁽⁵⁾ Maximal oxygen uptake (VO_2 max) considered to be the best indicator of the aerobic power expressing the ability of the cardio respiratory system to transport oxygen to active tissues.⁽⁶⁾ As we begin exercise, our muscles start working above our rest VO_2 max rate. As a result they naturally need more fuel because increased demand requires more oxygen so our breathing gets progressively faster and deeper as our exercise pace increases. The introduction of continuous exercise testing led to the development and validation of numerous protocols for testing VO_2 max⁽⁸⁾ Bicycle ergometer exercise and Harvard step test exercise will save the time. Apart from regular exercise these methods are also used in the performance of multistage sub-maximal or maximal stress testing⁽⁴⁾. Furthermore, at that time, the researchers were focused on the suitability of a given protocol to match a subjects fitness and health status, the

incidence of a VO_2 plateau at VO_2 max, and the use of sub maximal VO_2 data to predict VO_2 max. This study is designed to compare two direct methods Harvard step test and bicycle ergometer for the estimation of maximal oxygen uptake in apparently healthy young adults. The Harvard step test is a test of aerobic fitness, developed by Brouha et al.(1943) in the Harvard Fatigue Laboratories. The features of this test are that it is simple to conduct and requires minimal equipment⁽⁹⁾. Before the subject start the ergometer test, they typically perform a low-resistance warm-up for at least two minutes to help minimize the risk of injury⁽¹⁰⁾.

MATERIALS AND METHOD

In the present study, all the students 18-25yrs age were included as study participants. The study was approved by Institute's Research council and Ethics committee. After determining the eligibility as per selection criteria, the volunteers were invited to participate and briefed about the nature of the study and written informed consent was obtained from them. A pre-designed questionnaire was used to record the information about descriptive data of the patients age, detailed family history and personal history, including history of smoking, alcohol consumption and history of long term drug intake which would affect the health and detailed history consisting of family history of hypertension and cardiovascular illness by interviewing

the participant.

Subjects were divided into two groups randomly by Group A and Group B. There were 25 subjects in group-A(Males) and 25 subjects in group-B(females). Tests were performed for each subject in two days. One subject from Group A performed Harvard step test exercise and One subject from Group B performed bicycle ergometer exercise on the first day, On next day subject of the exercising group were interchange i.e.- Group A subject performed bicycle ergometer exercise and Group B subject, performed Harvard step test. These protocol were followed for all subjects.

Cardiovascular parameter like blood pressure was recorded by using mercury sphygmomanometer and pulse rate will be counted. BP and PR were recorded at resting state and immediately after the exercise ⁽¹⁾ for both tests.

Harvard step test- Equipment required: Step or platform of 40cm high

The subject performed step up and down on the platform at a rate of 30 steps per minute (every two seconds) for 5 minutes or until exhaustion. The subject was immediately sit down on completion of the test, and the pulse rate was determined (no. of pulse was noted for 15 sec and count was multiplied by 4).

Bicycle Ergometer- The bicycle ergometer was properly checked, clearly told and calibrated before the procedure. Upon completion of the warm-up the subject had rest for one minute. The subject was get a five second countdown to begin the test, subject was continue to pedal quickly for 5 minutes or until exhaustion. We need to count and record the number of revolutions pedaled for every five second interval during the test, through which study data can be determined. Upon completion of the test immediately, number of pulse rate was counted (no. of pulse was noted for 15sec count was multiplied by4).

The final Recording of systolic and diastolic blood pressure was made just after recording of pulse rate for both tests.

CALCULATION OF VO₂ MAX-

In Males:

VO₂max (ml/kg/min) = 111.23-(0.42 x pulse rate in

beats/min)

In Females:

VO₂max (ml/kg/min) = 65.81-(0.184 x pulse rate in beats/min)

DATA ANALYSIS-

The data for all the parameters analyses was expressed as Mean ± S.D.

Student's t-test was used to compare the data between Bicycle ergometer and Harvard step test. Difference were considered significant at p<0.05 level.

Results: A cross sectional study was conducted to find out the effect on vo₂ max by comparison between Bicycle Ergometer exercise and Step Bench exercise in Healthy young adults. The Data was analyzed for 50 volunteer students.

Age ,body height ,body weight and BMI of both groups were presented in table -1and similarity is found in age and BMI but height and weight of males were high.

Group -1 Mean±SD of Vo₂max(ml/kg/min.) of with both tests were presented in table -2 out of with bicycle ergometer were shown high Vo₂max (58.64,±7.35) with maximum of 76.89 and minimum of 45.81 with Harvard step test (48.36,±7.61) max 68.49 and min of 35.73. Level of significance is P-value 0.001*.

Group -2 Mean±SD of Vo₂max(ml/kg/min.) of with both tests were presented in table -2 out of with bicycle ergometer were shown high Vo₂max (43.64, ±2.62) with maximum of 48.82and minimum of 39.95with Harvard step test (40.65, ±3.23) max 47.34and min of 34.04. Level of significance is P-value 0.000*.

TABLE1- Baseline characteristics-Age, Height, Weight, BMI of Group A(Males) and Group B(Females).

Basal Parameters	Group A (Males) Mean±SD	Group B (Females) Mean ±SD
Age(Years)	18.76 ±1.16	18.60 ±0.81
Height(cm)	1.69±0.79	1.56 ±0.058
Weight(kg)	60.80±8.73	52.64 ±6.44
BMI(kg/m ²)	21.19 ±1.92	21.49 ±2.53

TABLE -2. Comparison of VO₂max by after bicycle ergometer and Step Bench Exercise in Group B(Females)and Group A(Males)

Parameters	After Exercise (Bicycle ergometer)			After Exercise (Step Bench)			P-value
	Mean , ±SD	Max.	Min.	Mean , ±SD	Max.	Min.	
Vo ₂ max (ml/kg/min.) Females	43.64, ±2.62	48.82	39.95	40.65, ±3.23	47.34	34.04	0.000*
Vo ₂ max (ml/kg/min.) Males	58.64,±7.35	76.89	45.81	48.36,±7.61	68.49	35.73	0.001*

Discussion: Increase in VO₂ max with training results primarily from an increase in maximum cardiac output. VO₂ max is an important variable which sets the upper limit for endurance performance. It was seen that the body weight has a significant influence on the test reliability, while the influence of body height was at a minimal level ⁽¹⁾. The participants had a higher O₂ consumption rate and energy expenditure on the Bicycle ergometer test, when compared to step test. This is clearly depicted in table-2. The difference can be explained by the fact that the physiological reaction of the body in step test is different in comparison to work on a bicycle ergometer. Post exercise heart-rate is the primary parameter for estimating aerobic capacity^[3]. Relationship between the performance of tests and VO₂max were Recovery Test or Endurance Test⁽²⁾. From present study, the finding showed a significant positive relationship between the performance of the tests and the VO₂max during the Maximum Incremental Bicycle Running Test ($p < 0.05, n = 50$). The mean and standard deviation of the respiratory ratio of the participants in the Maximum Incremental Bicycle Running Test was (128.48,±4.97, 74.40, ±7.72, 125.44,±17.51 ,119.04, ±8.92, 72.48, ±8.41, 120.00, ±14.21). This ensured that all participants achieved a maximum effort in the Maximum Incremental Bicycle Running Test. Deviations in the predicted values of maximal oxygen consumption in this study can be explained physiological responses to work in the step test determine their characteristics in relation to work during riding on bicycle ergometer. VO₂ max will result in strengthening the muscle of heart and increasing blood inflow to tissues, strengthening blood circulation system, regulating blood pressure,

decrease of heart activity while resting and improving the condition of blood vessels ⁽⁷⁾ Work on the step bench in relation to the bicycle ergometer is different because of the engaged muscles and their mass, and the reaction of the cardiovascular system. From a physiological point of view it is not justifiable to expect that different types of work, even when they have the same values, will give the same physiological response of an organism. In the end it is necessary to indicate that for the precise evaluation of the objectivity of these two sub-maximal tests which were presented in this work it was necessary to compare them with the data about maximal oxygen consumption measured in the laboratory.

CONCLUSION

Significant differences in physiological responses between the two tests were seen. The present study clearly demonstrates that aerobic Bicycle ergometer is more suitable to improve cardio-respiratory fitness and in prescribing weight loss exercises. Step aerobics is practiced in health centers, fitness training gyms and academic institutions all over the world because of its simplicity. It means that by the application of these tests, we can get objective information about the aerobic abilities of the participants.

Ethical approval : Institute's Research council and Ethics committee

Conflict of Interest : NIL

Source of Funding : NIL

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