Research Article

Cardiorespiratory responses to moderate exercise and determination of aerobic power in first year medical students

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ABSTRACT

Background: Cardiovascular and metabolic disorder has become common in individuals leading a sedentary life. Exercise stress tests are carried out as part of the investigations for determining the individual fitness level. Aerobic power or VO₂max which involves a full functional support from cardio respiratory and metabolic pathways is an appropriate test to study cardio pulmonary fitness. The main objective of the study is to find out the normal cardiopulmonary responses to exercise and their aerobic power among untrained 1st year medical students by Astrand 6 minute cycle test.

Methods: All participants who were not undergone any physical training was taken for the study. Students with history of any respiratory or cardiovascular disorders, any lower limb surgery, smoking and drinking alcohol were excluded. Cardiorespiratory changes associated with exercise were studied using bicycle ergometer. VO₂max was determined from the heart rate noted at the end of 6 minutes cycling by using Astrand-Rhyming nomogram.

Results: Heart rate, systolic blood pressure and respiratory rate increased with exercise, while diastolic pressure recorded a fall. VO₂max in male students mean 2.973±0.245, in female students mean 2.665±0.305. The VO₂max is the best physiological indicator of a person’s capacity to continue the severe physical work. From this we can set a norm in assessing physical fitness and the test can be used as screening measures before joining in a job or sports training.

Conclusions: Aerobic power or VO₂max or physical work capacity which involves a full functional support from cardiorespiratory and metabolic pathways is an appropriate test to study cardiopulmonary fitness. Implication: Astrand 6 minutes cycle test can be used for screening measures before joining in a job or sports training where physical fitness is needed.

Key words: Bicycle ergometer, Astrand-Rhyming nomogram, VO₂max

INTRODUCTION

Physical exercise has gained prime importance in public life for its enormous health benefits. Cardio vascular and metabolic disease has become common in individuals leading a sedentary life. Practice of regular exercise not only prevents the occurrence of diseases in the community but also halts their progress and decreases their intensity, and sometimes also brings total cure from the disease. Exercise stress tests are carried out as part of the investigations for determining the individual fitness level. Aerobic power or VO₂max or physical work capacity which involves a full functional support from cardio respiratory and metabolic pathways is an appropriate test to study cardio pulmonary fitness. The Bicycle ergometer and treadmill are the most commonly used dynamic exercise devices. The advantage of the Bicycle ergometer are it is cheaper, takes up less space and makes...
less noise. Upper body motion is lessened that making blood pressure and E.C.G. recordings easier. By doing this study we can set a norm in assessing the physical fitness.

**Aim**

The aim of the study was to find out the normal cardiopulmonary responses to exercise and their aerobic power among untrained 1st year medical students by Astrand 6 minute cycle test.

**METHODS**

The present study was designed to be an experimental study conducted in the department of physiology, Rajah Muthiah Medical College, Annamalai University, Annamalai Nagar, Chidambaram, Tamilnadu, India. Students volunteers from Rajah Muthiah Medical College belong to the age group of 17 to 18 years, who were not undergone any physical training were taken for the study. 11 males and 19 females students were selected after detailed history and physical examination. The students were asked to report at the department of physiology by 9:00 a.m. Subjects were explained the whole procedure in detail and were motivated prior to the start of exercise. They were told to report immediately if they felt any discomfort, fatigue or dizziness.

**Inclusion criteria**

Healthy students

**Exclusion criteria**

Alcoholics, smokers, students with any respiratory, cardiovascular disorders and lower limb surgery were excluded from the study.

**Bicycle ergometer as instrument**

Cardiorespiratory changes associated with exercise were studied using bicycle ergometer (Model-V_max 7380 magnetic recumbent bike) available in the physiology department of Rajah Muthiah Medical College, Annamalai University, Chidambaram, India. The instrument is equipped with a programmable computer to help to track the progress and motivate the subject to reach the fitness goal. The computer provides different programmes to match the subject’s fitness goals

**Anthropometric measurements**

Height was measured in centimeters while standing erect. Reading was taken nearest to 1cm by using inch tape. Weight was recorded in kilograms by using a locally made calibrated electronic weighing scale, accuracy+0.01kg and weighing machine was approximately calibrated from time to time. Subjects rested in supine position for 15 minutes before the start of exercise. The parameters namely pulse rate was examined by palpatory method, blood pressure, with a mercury sphygmomanometer and respiratory rate visually during rest. Cycle ergometer was arranged with correct handlebar and seat adjustments. The loading wattage 125 was selected for male and 100 for female. Subjects were asked to pedal at 60 rpm for 6 minutes. During cycling, pulse rate should be steady state between 130-160 beats per minute. If the subjects pulse rate is not in the target range after 2 minutes, then the loading wattage was adjusted accordingly by 25 watts for the remainder of the test. At the end of 6 minutes, pulse rate and loading wattage were noted down from monitor. After 6 minutes of exercise, the subjects were asked to lie down. Cardiorespiratory parameters like pulse rate, respiratory rate, blood pressure were immediately recorded. Subjects were allowed to take rest for 15 minutes. Cardio respiratory parameters were recorded 15 minutes after exercises. Aerobic power was determined from the heart rate noted at the end of 6 minutes cycling by using Astrand –Rhyming nomogram.

**RESULTS**

Statistical analysis was done by using ANOVA repeated measures and Boneferoni multiple comparison test. Table 1, shows the comparison of cardiorespiratory parameters. It showed a statistically significance with p value less than 0.001. Table 2 shows the mean aerobic power or VO_{2max} (L/min) of male & female students.

<table>
<thead>
<tr>
<th>Variables</th>
<th>Rest Mean</th>
<th>Rest SD</th>
<th>Immediately after exercise Mean</th>
<th>Immediately after exercise SD</th>
<th>15 minutes after exercises Mean</th>
<th>15 minutes after exercises SD</th>
<th>ANOVA repeated measures F value</th>
<th>p value</th>
<th>Boneferoni multiple comparison test result</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pulse Rate</td>
<td>76.000</td>
<td>6.187</td>
<td>142.600</td>
<td>8.418</td>
<td>88.867</td>
<td>6.897</td>
<td>922.72</td>
<td>&lt;0.001</td>
<td>1 Vs 2 Vs 3</td>
</tr>
<tr>
<td>Respiratory Rate</td>
<td>13.467</td>
<td>1.525</td>
<td>27.100</td>
<td>4.421</td>
<td>15.200</td>
<td>2.605</td>
<td>255.45</td>
<td>&lt;0.001</td>
<td>1 Vs 2 Vs 3</td>
</tr>
<tr>
<td>Systolic Blood Pressure</td>
<td>123.667</td>
<td>8.899</td>
<td>176.667</td>
<td>10.203</td>
<td>136.867</td>
<td>4.629</td>
<td>469.19</td>
<td>&lt;0.001</td>
<td>1 Vs 2 Vs 3</td>
</tr>
<tr>
<td>Diastolic Blood Pressure</td>
<td>74.000</td>
<td>5.632</td>
<td>61.667</td>
<td>7.466</td>
<td>63.333</td>
<td>7.112</td>
<td>109.22</td>
<td>&lt;0.001</td>
<td>1 Vs 2, 3</td>
</tr>
</tbody>
</table>
Table 2: Aerobic power.

<table>
<thead>
<tr>
<th>Variables</th>
<th>Mean</th>
<th>SD</th>
</tr>
</thead>
<tbody>
<tr>
<td>VO2max (L/min)</td>
<td>Male</td>
<td>2.973</td>
</tr>
<tr>
<td></td>
<td>Female</td>
<td>2.665</td>
</tr>
</tbody>
</table>

DISCUSSION

There was statistically significant increase in heart rate immediately after the exercise over the pre exercise value (p<0.001). Also there was persistent tachycardia 15 minutes after exercises. Tachycardia in exercise occurs due to following mechanisms: Increased sympathetic discharge, muscle heart reflex, increased release of catecholamines and thermogenic stimulation.2 4 There was statistically significant increase in systolic blood pressure immediately after the exercise over the pre exercise value (p<0.001).

Chapman CB et al conducted a study regarding stroke volume and cardiac output have shown that the stroke volume continue to increase at higher levels of exercise.5 Other investigators found that the stroke volume after increasing promptly with low level of exertion reaches a plateau and does not increase progressively as exertion becomes more intense for untrained subjects.6 7 Other researchers found that plateau in stroke volume may not occur for trained subjects.8-10 The result discussed earlier regarding blood pressure states that the systolic blood pressure always increases in exercise proportionate to increase in cardiac output.11 This occurs due to sympathetic induced cardio-acceleration.

There was statistically significant decrease in diastolic blood pressure immediately after exercise over the pre exercise value (p<0.001). The diastolic blood pressure decreases with moderate exercise, which could be due to sympathetic cholinergic vasodilatation of skeletal blood vessels, metabolic vasodilatation and thermogenic vasodilatation leads to decreased peripheral resistance.11

There was statistically significant increases in respiratory rate immediately after the exercise over the pre-exercise value (p<0.001). The respiratory rate increases with exercise, which could be due to neural mechanism, chemical mechanism and thermogenic mechanism.12-16 VO2max can be a limiting factor for individual capacity to do prolonged muscular work.17 So the determination of aerobic power or VO2 max gives an idea of the capacity and regulation of O2 transporting system.

Jackson AS et al suggests that VO2max or aerobic power increases during childhood and reaches a peak during early adulthood, after that a gradual and steady decline take place with the increasing age.18 19

VO2max varies greatly between individual, genetics play a major role.20 21 Training in aerobic exercise may improve VO2max. Resistance training alone does not increases VO2max.

CONCLUSION

Aerobic power or VO2max or physical work capacity which involves a full functional support from cardiorespiratory and metabolic pathways is an appropriate test to study cardiopulmonary fitness. Implication: Astrand 6 minutes cycle test can be used for screening measures before joining in a job or sports training where physical fitness is needed.

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