Abstract

Background: Most aerobic exercise programs are based on a percentage of an individual's maximal heart rate or heart rate reserve, of which maximal heart rate is a component. Maximal heart rate is the highest heart rate achieved by an individual while working at their maximal intensity, usually to fatigue. Maximal heart rate is related to an individual's age but is not completely dependent upon it. But there are rules that come with exercising maximally and some people do not want to put forth the effort; hence, predictive equations were created. Numerous equations for the prediction of maximal heart rate have been created, some for general population and some for specific special populations.

Purpose: The aim of this study was to test the accuracy of the traditional maximal heart rate equation and other predictive equations when compared to the actual measurement of maximal heart rate during an exercise test.

Methods: Subjects ran a graded exercise test in an attempt to achieve maximal heart rate. The Bruce protocol, which increases in speed and elevation every three minutes, was the chosen assessment. Heart rate was recorded with an electrocardiography machine, Quinton Q-Stress, by use of topical skin electrodes. The subjects were also connected to a metabolic cart, Sensor-Medics, with a mouthpiece which will analyze respiration rate and gas composition of each breath. Prior to testing, height, weight, and body fat percentage estimations were taken by the researcher using a skinfold technique. The equations tested in this study were Traditional (220-age), Tanaka (208-age*0.73), Londeree (206.3-age*0.771), ACSM (206.9-age*0.67),漫长 trained (205-age*0.61), Londeree untrained (198-age*0.41). SPSS was used to analyze the data.

Results

• 21 subjects were tested but 3 subjects' data had to be excluded due to failure to meet acceptance criteria. 18 subjects' data (BMI=22.3±2.2, height=170.2±5.2 cm, weight=77.1±10.0 kg, BMI=23.7±2.5, BF=24.6±4.5%) was used in the analysis. SPSS was used to analyze correlations between measured maximal heart rate and each of the other predictive heart rates. Analysis produced the following values: Traditional r=0.371, Tanaka r=0.422, Londeree r=0.41, ACSM r=0.371, Londeree trained r=0.458, Londeree untrained r=0.38. A paired samples t-test was also used. Traditional (p=0.371), Tanaka (p=0.018), Londeree (p=0.199), ACSM (p=0.005), Londeree trained (p=0.048), Londeree untrained (p=0.235).

Discussion: The results of the correlations found that none of the equations accurately predicted an individual's maximal heart rate; whether male, female, trained, or untrained. However, t-test analyses found significant difference (p<0.05) between Londeree and Measured Max values. Further statistical analysis found that all predictive equations used were highly correlated (r=0.99) with one another. In this equation, it is suggested that although maximal heart rate prediction equations cannot accurately estimate maximal heart rate, any of the tested equations would suffice, with the exception of Londeree, the traditional equation being the simplest. With a small sample size, limited age band, and short timeframe this research was severely restricted. ACSM values approached statistical significance; a larger and broader sample size could produce a more conclusive p-value.

Purpose

The aim of this study was to test the accuracy of the traditional maximal heart rate equation and other predictive equations when compared to the actual measurement of maximal heart rate during an exercise test.

Introduction

• Maximal heart rate is used when creating aerobic exercise programs
• Maximal heart rate is related to age, but not dependent upon it
• Achieving maximal heart rate is hard work and carries inherent risk
• Due to the difficulty of achieving maximal heart rate, prediction equations were created to estimate this value
• Numerous equations for the prediction of maximal heart rate have been created, some for the general population and some for specific special populations

Method

University of Texas at Arlington IRB# 2013-0108

Participants

• 21 subjects (15 male, 6 female)
• Subjects were instructed to avoid caffeine intake
• 3-site skinfold was taken from each subject

Experiment

• Subjects were connected with a 12-lead electrocardiography (ECG) machine
• Subjects were instructed to avoid caffeine intake
• Subjects were outfitted with a mouthpiece and headgear, which was connected to the SensorMedics metabolic cart to measure VO2 (>1.5)
• The Bruce treadmill protocol was used for the maximal exercise test

Results

Measured Max values.

<table>
<thead>
<tr>
<th>Predictive Equation</th>
<th>Correlation (r²)</th>
<th>t-test (p)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Traditional (220-age)</td>
<td>0.037</td>
<td>0.337</td>
</tr>
<tr>
<td>Tanaka (208-age*0.7)</td>
<td>0.042</td>
<td>0.088</td>
</tr>
<tr>
<td>Londeree (206.3-age*0.771)</td>
<td>0.042</td>
<td>0.010*</td>
</tr>
<tr>
<td>ACSM (206.9-age*0.67)</td>
<td>0.041</td>
<td>0.060</td>
</tr>
<tr>
<td>Lester trained (205-age*0.41)</td>
<td>0.043</td>
<td>0.199</td>
</tr>
<tr>
<td>Lester untrained (198-age*0.41)</td>
<td>0.043</td>
<td>0.235</td>
</tr>
</tbody>
</table>

* = Significance (p<0.05)

Conclusions

• Correlations found that none of the equations accurately predicted an individual’s maximal heart rate; whether male, female, trained, or untrained.
• t-test analysis found significant difference (p<0.05) between Londeree and Measured Max values.
• Further statistical analysis found that all predictive equations used were highly correlated (r=±0.99) with one another.
• Maximal heart rate prediction equations cannot accurately estimate maximal heart rate, but any equation, with the exception of Londeree, will work.
• With a small sample size, limited age band, and short timeframe this research was severely restricted.
• ACSM values approached statistical significance; a larger and broader sample size could produce a more conclusive p-value.