Critical considerations for the estimation of VO\(_2\)max by the regression equation of Jackson in trained females

Stadlmann Monika\(^1\) Ring-Dimitriou Susanne\(^1\) Gruber Josef\(^1\), Müller Erich\(^1\) Laukkanen Raija\(^2\)

\(^1\)Department of sport science and Kinesiology, University of Salzburg, Austria; \(^2\)Polar Electro Oy, Kempele, Finland

Introduction

One of the most used parameters for the determination of endurance capacity is the VO\(_2\)max. But the measurement of this parameter is connected with immense effort, costs and is also often dependent on the motivation of the subjects. Therefore the estimation of VO\(_2\)max, containing, age, gender, height, weight enjoys increasing popularity. The problem of these predictions is that most of them do not include the habitual physical activity. There is one attempt by Jackson et al. (1990) who tried to calculate VO\(_2\)max on the basis of the self-estimation of the physical activity level (PA-R, self-rating). He found an activity code which significantly correlates with the measured VO\(_2\)max which he included as a constant in an equation. This predicted VO\(_2\)max was most accurate for a range of 36-55 ml min\(^{-1}\)kg\(^{-1}\).

The aim of the present study was to find out if the predicted VO\(_2\)max is related to the measured one dependent on the maximum running velocity in trained females.

Methods

39 female sport science students at the age of 19 to 25 years (21.3 ±1.3 kg m\(^{-2}\) BMI, 44.9 ±4.6 ml min\(^{-1}\)kg\(^{-1}\) VO\(_2\)max) and of different kinds of sports (n=19 endurance, n=20 non-endurance) participated in this study. The subjects were divided into a “very good” (n=8), a “good” (n=21) and an “average” (n=10) trained group. The VO\(_2\)max was examined using a modified ramp protocol by Balke on a treadmill (warm-up 4min at 5km/h, starting speed 6km/h, speed increase 1.5km/h per minute, standard 1% incline) and was measured by a gas-analysis (K4b\(^2\), Cosmed, Italy). For estimating the VO\(_2\)max the subjects had to rate their physical activity level based on the scaling system of Jackson et al. (1990). Using the gender specific Jackson formula including age, B.M.I. and PA-R the VO\(_2\)max was calculated. A Bland-Altman plot was executed to compare measured and estimated VO\(_2\)max. The mean difference in VO\(_2\)max was analysed by a one-way ANOVA with group as predictor variable. To compare the mean differences in VO\(_2\)max of each performance level a t-test has been done (Table1).

Results

The Bland-Altman plot showed that the methods to determine VO\(_2\)max did not agree well (Figure 1). A significant difference between the performance level was seen in measured VO\(_2\)max only (Table1). As indicated in Figure 1 at higher performance level, expressed by maximum running speed, the estimated VO\(_2\)max was significantly lower (-4.5 ml min\(^{-1}\)kg\(^{-1}\), \(P=0.027\)) compared to the measured one.

![Bland-Altman Plot of VO2max](image)

**Table1. Mean data of estimated and measured VO2max**

<table>
<thead>
<tr>
<th>km/h</th>
<th>13.5</th>
<th>15</th>
<th>16.5</th>
</tr>
</thead>
<tbody>
<tr>
<td>estimated VO2max</td>
<td>41.8 ±2.5</td>
<td>43.1 ±2.2</td>
<td>43.2 ±3.2</td>
</tr>
<tr>
<td>Measured VO2max</td>
<td>40.4 ±5.7</td>
<td>44.1 ±3.9</td>
<td>47.7 ±4.0</td>
</tr>
<tr>
<td>(P) (F)</td>
<td>0.483</td>
<td>0.331</td>
<td>0.027</td>
</tr>
<tr>
<td>(P) (T)</td>
<td>(0.732)</td>
<td>(-1.040)</td>
<td>(-2.797)</td>
</tr>
</tbody>
</table>

Discussion

For well trained females with a maximum running velocity of 16.5 km h\(^{-1}\) the measured VO\(_2\)max was significantly higher and could not be determined accurately by the Jackson formula (Jackson et al. 1990), although they were characterized by 47.7 ml min\(^{-1}\)kg\(^{-1}\). It seems that the PA-R does not fit well for females with higher performance levels. On the other hand only 9.7% of the total sample of the study from Jackson et al. (1990) consisted of females. In our study the Jackson regression equation was not an accurate method to determine VO\(_2\)max in well trained females.

Reference