Validity of Queen’s College step test for use with young Indian men

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Determination of cardiorespiratory fitness in terms of maximum oxygen uptake (VO₂max) is restricted to within the laboratory because of its exhausting and difficult experimental protocol. It is therefore desirable to find a simple procedure for evaluation of VO₂max in population studies, especially in the field and in the absence of a well-equipped laboratory. Among various indirect protocols the Queen’s College step test or QCT is the simplest one, but its applicability has not yet been explored in an Indian population.

The aim of this study was therefore to assess the suitability of the Queen’s College step test (QCT) to predict maximum oxygen uptake in Indian men.

OBJECTIVES

To assess the suitability of the Queen’s College step test (QCT) to predict maximum oxygen uptake in Indian men.

METHODS

Thirty sedentary male university students from West Bengal, India, with the same socioeconomic background and mean (SD) age, height, and weight of 22.6 (0.2) years, 166.4 (0.5) cm, and 53.8 (0.2) kg, respectively, were randomly sampled from University of Calcutta. VO₂max of each participant was determined by direct procedure involving incremental bicycle exercise and also by applying indirect QCT method with a gap of 4 days between the tests.

RESULTS

The difference between the mean (SD) VO₂max values directly measured (VO₂max = 39.8 (1.03) ml/min/kg body mass) and indirectly predicted (PVO₂max = 39.3 (1.07) ml/min/kg body mass) was statistically insignificant (p > 0.10). PVO₂max and VO₂max values expressed as ml/min/kg body mass corroborated with previous studies in the same laboratory involving the same population, and also exhibited significant statistical correlation (r = 0.95, p < 0.001) between them.

CONCLUSION

The results suggest that QCT can be applied in the studied population to produce a good estimation of maximum oxygen uptake, especially in the field where large numbers of participants are to be evaluated without a well-equipped laboratory.

PREDICTION OF MAXIMUM OXYGEN UPTAKE CAPACITY (PVO₂max) BY QCT

The step test was performed on a stool of 16.25 inches (41.3 cm) height for a total duration of 3 minutes at the rate of 24 cycles per minute, which was set by a metronome. After completion of the exercise, the subject was asked to remain standing and the carotid pulse rate was measured from 5–20 seconds of the recovery period. This 15 second pulse rate was converted into beats per minute and the following equation was used to predict the maximum oxygen uptake capacity:

\[
PVO_2max (ml/kg/min) = 111.33 - (0.42 \times \text{pulse rate in beats/min})
\]

DIRECT MEASUREMENT OF MAXIMUM OXYGEN UPTAKE CAPACITY (VO₂max)

Muller’s magnetic brake bicycle ergometer (model of Max Plank Institute of Work Physiology) was used for the study. All the subjects first performed a submaximal exercise at 73.35 watt (450 kg/min) intensity for duration of 5 minutes. Immediately after performing the submaximal exercise the intensity was increased to the first incremental intensity of 155.28 watt (950 kg/min), and thereafter the intensity was increased by 24.52 watt (150 kg/min) every 3 minutes until the subject stopped due to exhaustion. In the present study VO₂max was considered to be maximum peak heart rate of greater than 180 beats/min and levelling off—that is, when no further increase in oxygen uptake took place despite further increase in intensity, or the increase in oxygen uptake was less than 100 ml/min in response to the next higher intensity for repeated tests followed at an interval of 4 days. Subjects did not endure more than 8 minutes of continuously increasing intensity of exercise.

Abbreviations: BM, body mass; QCT, Queen’s College step test

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Means and standard errors of physical characteristics, predicted VO$_{2\max}$ (PVO$_{2\max}$), directly measured VO$_{2\max}$, and peak heart rate parameters of the participants are presented in table 1.

<table>
<thead>
<tr>
<th>Subjects (n)</th>
<th>Age (years)</th>
<th>Body mass (kg)</th>
<th>Body height (cm)</th>
<th>Maximum oxygen uptake (VO$_{2\max}$)</th>
<th>Peak heart rate (beats/min)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Direct method (STPD)</td>
<td>Indirect method</td>
</tr>
<tr>
<td>30</td>
<td>22.6 (0.2)</td>
<td>53.8 (0.2)</td>
<td>166.4 (0.5)</td>
<td>39.8 (1.0)</td>
<td>39.3 (1.0)*</td>
</tr>
</tbody>
</table>

Results presented as mean (standard error).

*NS, not significant (p>0.10).
STPD, standard temperature pressure dry.

DISCUSSION
Because the VO$_{2\max}$ and PVO$_{2\max}$ values (ml/kg body mass) obtained by direct and indirect procedures, respectively, show no significant variation between the means, and also using Bland and Altman’s method of limit of agreement approach (fig 1), we have shown that QCT can be applied to predict the maximum oxygen uptake in a young population from West Bengal. This method is especially useful in field work where the survey and screening of large numbers of participants are essential.

The mean difference between VO$_{2\max}$ and PVO$_{2\max}$ is 0.46 ml/min/kg body mass with 95% confidence interval -0.092 to 1.012 ml/min/kg body mass, indicating that QCT predicts the maximum oxygen uptake capacity by between -0.092 to 1.012 ml/min/kg body mass. Despite this, the limits of agreement (-2.50 and 3.42) are a small enough parameter for QCT to be used confidently in place of the complicated and exhaustive direct procedure for prediction of VO$_{2\max}$.

The complicated and exhaustive procedure for determination of cardiorespiratory fitness in terms of VO$_{2\max}$ can be replaced with simpler protocols. The Queen’s College step test is recommended as a valid method for evaluation of cardiorespiratory fitness in a young sedentary population of West Bengal, India, especially in field work where the survey and screening of large numbers of participants are essential.

Take home message
The complicated and exhaustive procedure for determination of cardiorespiratory fitness in terms of VO$_{2\max}$ can be replaced with simpler protocols. The Queen’s College step test is recommended as a valid method for evaluation of cardiorespiratory fitness in a young sedentary population of West Bengal, India, especially in field work where the survey and screening of large numbers of participants are essential.

REFERENCES


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ELECTRONIC PAGES

BJSM Online case reports: http://bjsm.bmjjournals.com/

The following electronic only articles are published in conjunction with this issue of BJSM.

A punch drunk jockey

P McCrory, M Turner, J Murray

The case is reported of a retired professional jockey with progressive memory loss. The concern is that he may be suffering from chronic traumatic encephalopathy or the “punch drunk syndrome”.

(Url: http://bjsm.bmjjournals.com/cgi/content/full/38/3/e3)

Isolated first rib fracture in athletes

T Sakellaridis, A Stamatelopoulos, E Andrianopoulos, P Kormas

Isolated fracture of the first rib is an uncommon and unusual entity not been previously reported in a kick boxer. It may be the result of trauma, violent muscular avulsion, or fatigue. There has been debate over the cause of isolated first rib fractures sustained without direct violent trauma. Many are located in an area of anatomical weakness (shallow depression for the subclavian artery). Powerful contraction of the scalenus anterior muscle (which inserts on the scalene tubercle adjacent to the subclavian artery), caused by coughing, sneezing, playing tennis, or baseball pitching, may result in acute fracture, with repeated insults resulting in stress fracture. We present a case of a first rib stress fracture in a kick boxer and review the pertinent literature.

(Url: http://bjsm.bmjjournals.com/cgi/content/full/38/3/e5)