ORIGINAL ARTICLE

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

S Chatterjee, P Chatterjee, P S Mukherjee, A Bandyopadhyay

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See end of article for authors' affiliations

Correspondence to: Amit Bandyopadhyay, Sports & Exercise Physiology Laboratory, Department of Physiology, University of Calcutta, University College of Science & Technology, 92, APC Road, Kolkata 700009, India; bamit74@yahoo.co.in

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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. VO_2max 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) VO_2max values directly measured (VO_2max = 39.8 (1.03) ml/min/kg body mass) and indirectly predicted (PVO_2max = 39.3 (1.07) ml/min/kg body mass) was statistically insignificant ($p>0.10$). PVO_2max and VO_2max 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.

Determination of cardiorespiratory fitness in terms of maximum oxygen uptake (VO_2max) is restricted to within the laboratory because of its exhausting and difficult experimental protocol.[1] It is therefore desirable to find a simple procedure for evaluation of VO_2max in population studies, especially in the field and in the absence of a well equipped laboratory.[2] Among various indirect protocols[1 3–8] the Queen's College step test or QCT is the simplest one,[8] but its applicability has not yet been explored in an Indian population.

The aim of this study was therefore to assess the suitability of QCT[8] to predict VO_2max in young individuals from West Bengal, India.

METHODS

Participants

Thirty apparently healthy, male, sedentary students from the same socioeconomic background, having mean age of 22.6 years, body height of 166.4 cm, and body mass of 53.80 kg, were recruited for the study on the basis of random sampling from the postgraduate section of the University of Calcutta, West Bengal, India. The experimental protocol was fully explained to participants. They had a light breakfast 2–3 hours before the test and refrained from any energetic physical activity for that period. The participants had no history of any major disease and did not follow any physical conditioning programme, apart from some recreational sports.

Experimental design

Maximum oxygen consumption of each subject was determined by both indirect and direct methods, respectively, at an interval of 4 days. Subjects were asked to take complete rest for at least half an hour before the exercise, so that pulmonary ventilation and pulse rate could come down to a steady state.[9]

Prediction of maximum oxygen uptake capacity (PVO_2max) 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:[8]

$$PVO_2\text{max (ml/kg/min)} = 111.33 - (0.42 \times \text{pulse rate in beats/min})$$

Direct measurement of maximum oxygen uptake capacity (VO_2max)

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 73.55 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 VO_2max 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.[9] Subjects did not endure more than 8 minutes of continuously increasing intensity of exercise.

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

Table 1 Physical parameters, predicted and measured VO_2max, and peak heart rate values of the subjects

Subjects (n)	Age (years)	Body mass (kg)	Body height (cm)	Maximum oxygen uptake (VO_2max) (ml/kg BM/min) Direct method (STPD)	Maximum oxygen uptake (VO_2max) (ml/kg BM/min) Indirect method	Maximum oxygen uptake (VO_2max) (l/min) Direct method (STPD)	Maximum oxygen uptake (VO_2max) (l/min) Indirect method	Peak heart rate (beats/min)
30	22.6 (0.2)	53.8 (0.2)	166.4 (0.5)	39.8 (1.0)*	39.3 (1.0)*	2.14 (0.05)*	2.12 (0.04)*	189.0 (0.7)

Results presented as mean (standard error).
*NS, not significant ($p>0.10$).
STPD, standard temperature pressure dry.

Low resistance high velocity Collin's triple ''J type'' plastic valve was used for the collection of gas by open circuit method.[9] The valve was connected with the Douglas Bag (150 l) by a standard corrugated rubber tube and the expired gas was collected in the last minute of final intensity of exercise. Gas was collected in the second minute of the final workload if the subject showed signs of severe exhaustion. No gas collection was made in the first minute of the workload. The expired gas was measured in a wet gasometer (Toshniwal, Cat No CG 05.10) and the aliquots of gas samples were analysed in a Scholander microgas analysis apparatus following the standard procedure.[10]

The peak heart rate was recorded manually from the time taken for 10 carotid pulsations immediately after cessation of exhaustive exercise.[9]

The whole experiment was performed at a room temperature varying from 27–29℃ and at a relative humidity ranging between 75% and 83%.

Statistical analysis

Paired *t* test, Pearson's product moment correlation, linear regression statistics, and Bland and Altman approach for limit of agreement were used for statistical treatment of the data.

RESULTS

Means and standard errors of physical characteristics, predicted VO_2max (PVO_2max), directly measured VO_2max, and peak heart rate parameters of the participants are presented in table 1.

The mean value of VO_2max is in agreement with previous studies[2 12] reported from the same laboratory involving an identical population.

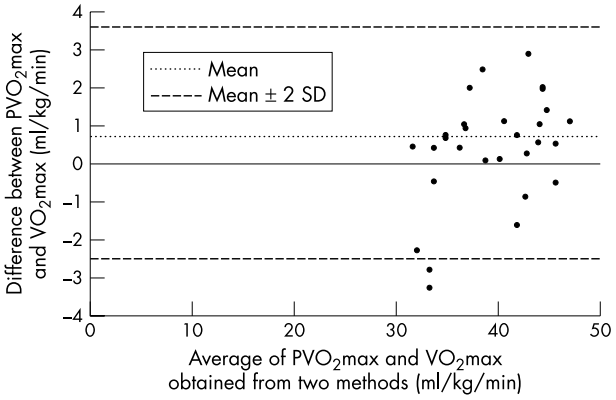

Figure 1 Plotting of difference between VO_2max values against their means.

Take home message

The complicated and exhaustive procedure for determination of cardiorespiratory fitness in terms of VO_2max 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.

The mean difference between VO_2max and PVO_2max 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_2max.

DISCUSSION

Because the VO_2max and PVO_2max values (ml/min/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.

Highly significant correlation ($r = -0.96$, $p<0.001$) existed between the recovery heart rate in QCT and VO_2max. The following equation, derived on the basis of the present data will better predict the cardiorespiratory fitness in terms of VO_2max in this particular population.

$$VO_2\text{max (ml/kg/min)} = 55.23 - (0.09 \times \text{pulse rate in beats/min})$$

Therefore, from the present observations, the Queen's College step test is recommended as a valid method to evaluate cardiorespiratory fitness in terms of VO_2max for large numbers within the young population of West Bengal, India.

Authors' affiliations
S Chatterjee, P Chatterjee, P S Mukherjee, A Bandyopadhyay, Sports & Exercise Physiology Laboratory, Department of Physiology, University of Calcutta, University College of Science & Technology, Kolkata, India

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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''.

(*Br J Sports Med* 2004;**38**:e3) http://bjsm.bmjjournals.com/cgi/content/full/38/3/e3

Recurrent macroscopic haematuria due to bladder blood vessels after exercise induced haematuria

P Lüthje, I Nurmi

The case is reported of exercise induced asymptomatic macroscopic haematuria, which became recurrent haematuria no longer induced by exercise. The cause, diagnosis, and management are discussed. An overview of the potential causes of sport related haematuria is presented.

(*Br J Sports Med* 2004;**38**:e4) http://bjsm.bmjjournals.com/cgi/content/full/38/3/e4

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.

(*Br J Sports Med* 2004;**38**:e5) http://bjsm.bmjjournals.com/cgi/content/full/38/3/e5