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Research Article

A REGRESSION EQUATION FOR THE ESTIMATION OF VO_{2MAX} IN NEPALESE MALE ADULTS

Pinaki Chatterjee[1,2] , Alok K. Banerjee[2], Paulomi Das[3,4], Parimal Debnath[4]

[1]Department of Physiology, Sudha Rustagi College of Dental Sciences and Research, Faridabad, India. [2]Department of Physical Education, University of Kalyani, Kalyani, West Bengal, India. [3]Department of Physiology, Nepalgunj Medical College, Chisapani, Banke, Nepal. [4]Department of Physical Education, Jadavpur University, Kolkata, India

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ABSTRACT

The purpose of the study was to validate the applicability of 20-meter multi stage shuttle run test in Nepalese male College students. 40 Nepalese students were recruited for the study. Direct estimation of cardiorespiratory endurance (VO_{2max}) comprised treadmill exercise followed by expired gas analysis by scholander micro-gas analyzer whereas VO_{2max} was indirectly predicted by the 20-meter multistage shuttle run test. The difference between the mean (SD) VO_{2max} values of direct measurement (VO_{2max} = 39.29+/-1.98 ml/kg/min) and 20-meter multi stage shuttle run test ($SPVO_{2max}$ = 39.20+/-2.27 ml/kg/min) was statistically insignificant ($p > 0.10$). Limits of agreement analysis also suggest that the 20-m multistage shuttle run test can be applied for use with the studied population. The results suggest that the application of the present form of 20-meter multistage shuttle run test be justified in the studied population. For better prediction of VO_{2max} a new equation has been developed based on present data.

***Key words*:** Beep Test, Aerobic Capacity, Maximum oxygen uptake capacity, Cardiovascular Fitness, Nepalese male.

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Corresponding author. Pinaki Chatterjee. Reader and HOD, Department of Physiology, Sudha Rustagi College of Dental Sciences and Research, Faridabad, India.
Phone: 9339958102/ Fax: 0129-2202958
E-mail: drpinakichattopadhyay@gmail.com
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INTRODUCTION

Direct measurement of maximum oxygen uptake (VO_{2max}) is recognized as the best single index of aerobic fitness (Astrand & Rodahl, 1986). But the test of the direct measurement of cardiorespiratory endurance (VO_{2max}) itself is difficult, exhausting and often hazardous to perform regardless the type of ergometer used (Fox, 1973). Since the direct testing procedure is rather complicated on larger populations, several indirect running and walking field tests have been developed. Scientists often calculate VO_{2max} with indirect protocols (Das & Bhattacharya, 1995). It has been stated that equations for predicting VO_{2max} indirectly using field tests are very sensitive to populations tested on. Therefore, before applying any indirect protocol for prediction of VO_{2max}, the validity of the test should be established in a particular population. The 20-m multi stage shuttle run (Leger et al., 1988; Leger & Gadoury., 1989) is often used for measurement of aerobic capacity (Wong et al., 2001; Mota et al., 2002; Guerra et al., 2002; Vicente-Rodriguez et al., 2003; Vicente-Rodriguez et al., 2004). Cooper et al. (2004) studied the repeatability and criterion related validity of the 20-m multistage fitness test as a predictor of maximal oxygen uptake in active young men. Suminski et al. (2004) established the validity of the 20-m MST for measuring aerobic fitness of Hispanic youth of 10 to 12 years of age. Chatterjee et al. (2006) and Chatterjee et al. (2008) studied the validity of 20-m MST in junior Taekwondo players and female university students of India. However, studies on the validity and suitability of this test are not done in any of the Nepalese population until now.

Recent study suggests that genders distinct equations provide more accurate prediction of VO_{2max} from 20-m multistage shuttle run test (Stickland et al., 2003). For this reason only male adults were recruited as subjects and not a male and female-pooled population. The present study was undertaken with an objective to assess the applicability of the 20-m MST to predict VO_{2max} in male College students of Nepal and also to develop a regression equation for use with the particular population.

METHODS

Subjects

40 male College students from different colleges of Nepal were volunteered for the study. They were selected on the basis of random sampling. The subjects are delimited to all over Nepal, as students from every part of the country come to these colleges for study.

The experimental protocol was fully explained to the 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 program, except from some recreational sports. Their recreational sports include table tennis, badminton and volleyball. They play either of these games on an average twice a week, and for the duration of half an hour to one hour. Apart from this, most of the students have a practice of cycling for 20 minutes to half an hour daily, as their mode of transport from colleges to residence is bicycle. By analyzing their dietary pattern it reveals that – daily energy intake 2,875-3,000 kcal, of which 15-17% from protein and 10-20% from fat, and the rest from carbohydrate. Considering their life style and habitual activity they may be accepted as true representative of the majority of the Nepalese male College students. The tests were demonstrated to the subjects

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before actual administration and they agreed to sign a statement of informed consent. All institutional policies concerning the human subjects in research were followed. The ethical approval was taken from the competent authority.

Experimental Design

Maximum oxygen consumption of each subject was determined by both indirect and direct methods at an interval of 4 days by random sequencing. Indirect one in the half of the subjects followed the direct method whereas indirect one was followed by direct in other half of the subjects to avoid any possibility of bias. Subjects were asked to take complete rest at least for half an hour prior to the exercise, so that pulmonary ventilation and pulse rate might come down to steady state (Chatterjee & Chakravarti, 1986).

Indirect measurement of VO_{2max} using the 20 m MST

Subjects started running back and forth a 20-metre course and touched the 20 meter (m) line at an initial speed of 8.5 kilometer/hour (km/hr). The speed of the shuttle runs got progressively faster (0.5 km/hr every minute), in accordance with a pace dictated by a sound signal on an audio tape. Several shuttle runs made up each stage, and subjects were instructed to keep pace with the signal for as long as possible. When the subjects could no longer follow the pace, the last stage announced was used to predict VO_{2max} using the equation of Leger and Gadoury (1989).

Direct measurement of VO_{2max}

The subjects walked on a treadmill to warm up at a speed of 4 km/hr at a 4.5 inclination for duration of 5-min (Slonim et al., 1957). Running at a constant speed of 7 km/hr for a maximum duration of 5 min followed this. The inclination gradient was increased successively from 4.5 until the subject was unable to continue the task. In no case did it exceed 7.5 inclinations. The criteria for maximality was exhaustion and withdrawal from running within the scheduled 5 min period, when the heart rate was about their predicted maximum heart rate and when a further increase of inclination did not bring about any significant rise in oxygen uptake (Chatterjee & Chakravarti, 1986).

Gas Analysis

Low resistance high velocity Collin's Triple "J type" plastic valve was used for the collection of gas by open circuit method (Chatterjee & Chakravarti, 1986). The valve was connected with the Douglas Bag (150-liter) and the expired gas was collected in the second minute of the exhausting final workload, if signs of severe exhaustion supervened. No gas collection was made in the first minute of the workload. The expired gas measured in a wet gasometer (Toshniwal, Germany, CAT No. C G 05.10) and the aliquots of gas samples were analyzed in a Scholander micro gas analysis apparatus following the standard procedure (Consolazio et al., 1963).

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Validity of the results

Repeatability was investigated where 22 subjects performed the test twice. The results showed non-significant bias between the two applications of the 20-m MST (mean of the difference +/- standard deviation of the difference = -0.1+/-0.9 ml /kg/min; t = -0.7 p = 0.60 with 95% limits of agreement).

For direct measurement of VO_{2max}, results were corroborated with the previous investigation (Das & Bhattacharya, 1995) in the same laboratory involving an identical population using the same protocol. No significant difference ($p>0.1$) was observed between the results of the two investigations.

Statistical Analysis

Paired t-test, Pearson's product moment correlation, linear regression statistics and Bland and Altman, (1986) approach for limits of agreement were adopted for statistical analysis of the data. Statistical Package for Social Sciences (SPSS) Microsoft windows Release 11.5 version was used for statistical analysis.

RESULTS

Means and standard deviations of physical characteristics, shuttle predicted VO_{2max} ($SPVO_{2max}$) by the 20-m multi stage shuttle run test and directly measured VO_{2max} of the participants are presented in the Table 1.

Table 1. Physical parameters, predicted and measured VO_{2max} of the subjects (N=40)

Parameter	Minimum	Maximum	Mean	Std. Deviation
Age (yr)	20.42	24.92	22.72	1.27
Height (cm)	163.00	167.90	165.90	1.28342
Weight (kg)	52.10	56.50	54.03	1.14
VO_{2max} (ml/kg/min)	36.00	44.20	39.29	1.98
$SPVO_{2max}$ (ml/kg/min)	35.60	44.60	39.20	2.27
Shuttle run speed (km/hr)	10.50	12.00	11.10	0.38

No significant variation was observed ($p>0.10$) between the values of directly measured and predicted VO_{2max}. The mean difference between VO_{2max} and $SPVO_{2max}$ was 0.09 ml/kg/min with 95% confidence interval -0.11 to 0.29 ml/kg/min indicating that 20-m MST predict the maximum oxygen uptake capacity by between -0.11 to 0.29 ml/kg/min.

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DISCUSSION

Analysis of data by Bland and Altman method of approach for limits of agreement (Bland & Altman, 1986) between $SPVO_{2max}$ and VO_{2max} reveals that limits of agreement are –1.13 to 1.31. These are small enough parameter for 20-m MST to be used confidently in place of direct method (Figure 1). Limits of agreement analysis suggest that application of the present form of 20-m MST should be justified for the studied population.

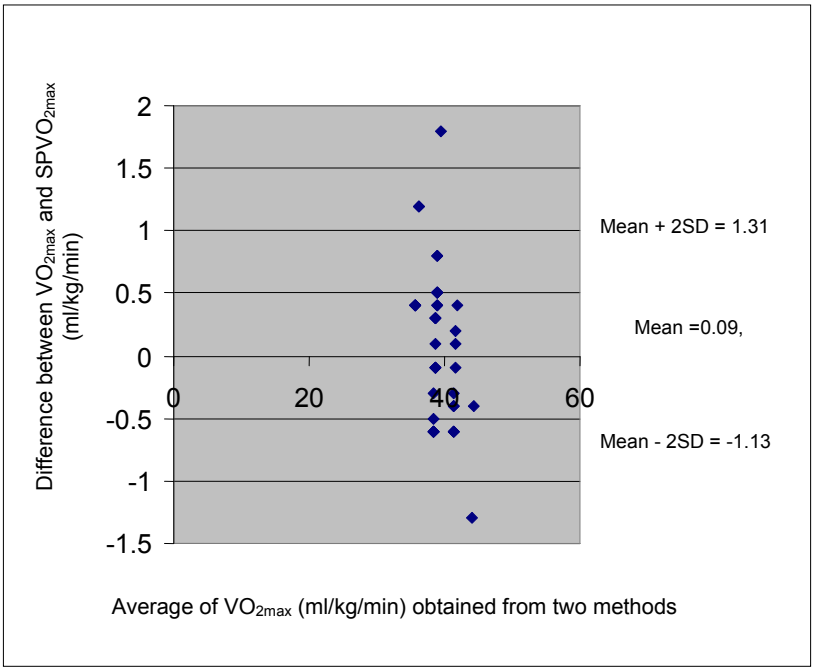

Figure 1. Plotting of difference between VO_{2max} values against their means (Bland and Altman method of approach).

Highly significant correlation ($r = 0.97$, $p \leq 0.01$) existed between the maximal speed of the 20-m MST and VO_{2max}. The following equation, derived on the basis of present data will better predict the aerobic fitness in male College students of Nepal.

$Y = -16.961 + 5.068X$,

Where,

Y= VO_{2max} (ml/kg/min)

X= Maximal shuttle run speed (km/hr)

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Using the above new equation the limits of agreement between directly measured VO_{2max} and $SPVO_{2max}$ from the 20-m MST are -1.00 to 0.99. The result suggests that better limits of agreement exist between the two methods when this newly developed equation is used for prediction of VO_{2max} from 20-m MST.

CONCLUSIONS

Therefore, from the present observations it is concluded that the 20-metre multistage shuttle run test is recommended as a valid method to evaluate aerobic fitness in terms of VO_{2max} within male (age 20.42-24.92 yr.) college students of Nepal. The equation developed on the basis of present data is recommended to be used. This is particularly most useful method for regular monitoring of aerobic fitness in the studied population when a large number of subjects are to be evaluated without the help of a well-equipped laboratory, in less expense and within a short period of time.

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