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Applicability of 20-M MST as A Predictor of Maximal Oxygen Uptake for Use with Trainee Taekwondo Players of Nepal

KEYWORDS: Maximal oxygen uptake, Aerobic capacity, 20-m MST, Shuttle run test

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ABSTRACT *Purpose of the study was to validate the applicability of 20-m multi stage shuttle run test (20-m MST) in trainee Taekwondo players of Nepal. 35 Junior Taekwondo players (age range 15 ~ 17 yr.) were recruited for the study. Direct measurement of VO_2 max comprised treadmill exercise with continuous gas analysis by Oxycon Champion whereas VO_2 max was indirectly predicted by 20-m MST. Difference between mean VO_2 max (±SD) values of direct measurement (VO_2 max = 45.17± 7.49 ml/kg/min) and 20-m multi stage shuttle run test ($SPVO_2$ max = 44.00 ± 7.30 ml/kg/min) was statistically significant ($p<0.05$). Although limits of agreement analysis reveal that 20-m MST may be used confidently in place of direct measurement. Intra-class correlation coefficients also suggested good reliability of the 20-m MST data. To produce a better estimation of maximum oxygen uptake a new equation has been developed based on present data.*

INTRODUCTION

Before applying any indirect protocol for prediction of Maximal aerobic capacity (VO_2 max), validity of the test should be established in particular population. The 20-m multistage shuttle run (20-m MST), (Leger et al., 1988; Leger and Gadoury, 1989) is often used world wide (Wong, et al., 2001; Mota et al., 2002; Vicente-Rodriguez et al., 2004) for measurement of aerobic capacity. Cooper et al. (2005) 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.

The 20-m MST is an excellent performance indicator of aerobic fitness, which requires many changes of direction. Furthermore, it has been reported that there are sport-specific differences when predicting VO_2 max from multistage shuttle run test (Gibson et al., 1998). Effort has been made to validate its applicability in Nepalese adult females and males by Chatterjee et al. (2010, 2010a). However, studies on the validity and suitability of this test in the sports population of Nepal are scanty (Chatterjee et al., 2009) until now. Taekwondo is becoming a popular sport in Nepal day by day and a huge number of youngsters undergo Taekwondo training in different sports academies of Nepal. It is therefore desirable to find a simpler procedure like 20-m MST for such a population to regular monitor their aerobic fitness. Keeping in view, all these aspects, we wanted to examine the applicability of the 20-m MST to predict VO_2 max in trainee Taekwondo players of Nepal.

METHODS

Subjects: 35 junior Taekwondo players were volunteered for the study. Subjects had mean age of 15.9 yr. (± 0.7), body height of 154.66(± 9.39) cm, and body mass of 50.90 (± 8.35) kg. They all have a training background of 2-3 years. All institutional policies concerning human subjects in research were followed.

Experimental Design: Maximum oxygen consumption of each subject was determined by both indirect and direct methods, respectively, at an interval of 4 days by random sequencing or crossover design. Indirect one in the half of the subjects followed direct method whereas indirect one was followed by direct in other half of the subjects to avoid any possibility of bias. They had a light breakfast 2 - 3 hours before the test and refrained from any energetic physical activity for that period.

Prediction of maximum Oxygen uptake capacity by 20-m MST: Subjects start running back and forth a 20-m course and must touch the 20-m line at an initial speed of 8.5 km/hr which gets 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 make up each stage; each stage is of one-minute duration. As the test proceeds the number of shuttle run (laps) increases in each stage and subjects are instructed to keep pace with the signal for as long as possible. When subject can no longer follow the pace, the last stage announced is used to predict maximal oxygen uptake using the equation of Leger et al. (1988) which is

$$Y = 31.025 + 3.238 X - 3.248A + 0.1536AX$$

Where,

Y= VO_2max (ml/kg/min)
X= Maximal shuttle run speed (km/hr.)
A= Age (yr.).

Direct measurement of maximum oxygen uptake capacity: Oxygen consumption and heart rate (HR) were measured through graded treadmill exercise (Jaeger & Co., Germany). Initial speed of the treadmill was 8 km/hr with an inclination of 2% and thereafter speed was increased by 2 km/hr after every 2 minutes until a plateau of VO_2 was attained or the respiratory quotient value (RQ) exceeded 1.15. Whole experiment was performed at room temperature varying from 23-25^{0}C with relative humidity varying between 50-60% (Shephard, 1984).

Reliability of the Results: Repeatability was investigated where 21 subjects performed 20-m MST twice. Results showed non-significant bias between the two applications of 20-m MST (mean of the difference ± standard deviation of the difference = 0.05±1.09 ml /kg/min; t = 0.20 p = 0.84 with 95% limits of agreement).

Statistical Analysis: Paired t-test, Pearson's product moment correlation, linear regression statistics and Bland and Altman approach for limit of agreement were adopted for statistical analysis of data.

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RESULTS AND DISCUSSION

Means and standard deviations predicted VO_2 max ($SPVO_2$ max) by 20-m multi stage shuttle run test and directly measured VO_2 max of the participants are presented in table 1.

Table: 1 Predicted and measured VO_2 max of the subjects (n =35)

Parameters	Minimum	Maximum	Mean	Std. Deviation
VO_2max (ml/kg/min)	34.00	58.00	45.17	7.49
$SPVO_2$max (ml/kg/min)	34.00	57.00	44.00	7.30
Maximal shuttle run Speed (km/hr)	10.0	13.5	11.48	1.25
Maximum heart rate (beats/min)	187	201	193.17	4.56

Mean value of VO_2 max determined by direct method was 45.17± 7.49 ml/kg/min. Mean value of predicted VO_2 max by 20-m MST was 44.00 ± 7.30 ml/kg/min. These two values show significant variation ($P<0.05$). Mean difference between VO_2 max and predicted VO_2($SPVO_2$max) max was 1.17 ml/kg/min with 95% confidence interval 0.82 to 1.51 ml/kg/min indicating that 20-m MST predict the maximum oxygen uptake capacity within a range of 0.82 to 1.51 ml/kg/min.

Analysis of data by Bland and Altman (Bland and Altman, 1986) method of approach for limits of agreement between predicted VO_2 max ($SPVO_2$max) and VO_2 max reveals that limits of agreement are 3.19 and –0.85. These are small enough parameter for 20 m-MST to be used confidently in place of direct procedure. Intra-class correlation coefficients (ICC) between directly measured VO_2max and shuttle predicted VO_2max using the equation was 0.95. But as significant difference ($p<0.05$) is observed between VO_2 max values by two methods, it is suggested not to use the present form of 20-m MST for the studied population. However, highly significant correlation ($r =0.97$, $p < 0.01$) existed between maximal speed of 20-m MST and VO_2max. The following equation, derived on the basis of present data will better predict the aerobic fitness in trainee Taekwondo players of Nepal.

Y= 7.900 + 5.687X-1.756A +. 001AX
Y= VO_2max (ml/kg/min)
X= Maximal shuttle run speed (km/hr.)
A= Age (yr.)

Using the above new equation for estimation of VO_2max for the present data, no significant difference is observed ($p>0.05$) between the values of VO_2max measured and predicted by direct and 20 m-MST respectively. Using this newly derived equation, limits of agreements analysis also reveals better agreement (2.16 and –1.60) between the two methods. When using this newly developed equation, shuttle run predicted VO_2max for 97% of the participants fell within the limits of agreement. On the other hand, using the equation of Leger and Gadoury (Leger and Gadoury, 1989), shuttle run predicted VO_2max for 95% of the participants fell within the limits of agreement. ICC between directly measured VO_2max and shuttle predicted VO_2max using the new equation was 0.97. As a general guideline ICC values above 0.75 indicate good reliability and those below 0.75 indicates poor to moderate reliability. Obtained ICC value suggests that reliability of 20-m MST using the newly derived equation is sufficient for use with the studied population. ICC value also suggests good reliability of 20-m MST using the equation of Leger and Gadoury (Leger and Gadoury, 1989) for present population. However, using this newly derived equation, limits of agreements analysis indicated better agreement.

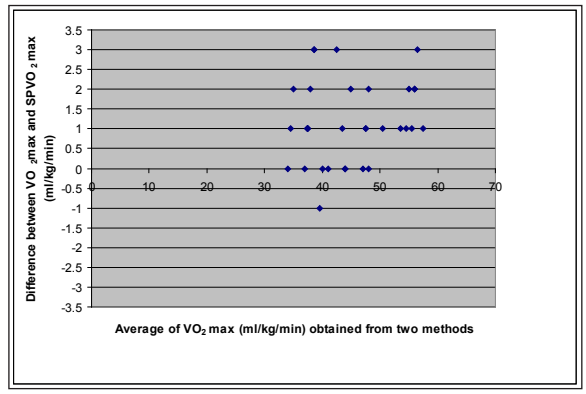

Figure 1: Plotting of difference between VO_2max values against their means (Bland and Altman method).

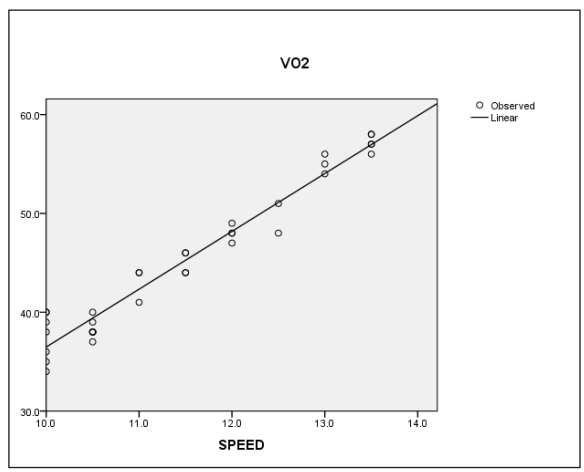

Figure 2: Relationship between Directly Measured VO_2 max (ml/kg/min) and Maximum Shuttle Run Speed (km/h) in 20-m MST

CONCLUSIONS

Therefore, from the present observations it is concluded that 20-m multistage shuttle in its original form should not be applied for studied population as significant difference exists between the results obtained from direct and indirect methods. However, we recommend the newly derived equation based on present data as a valid method to evaluate aerobic fitness in terms of VO_2max within the junior Taekwondo players of Nepal. This is particularly most useful method 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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REFERENCE

Bland, J. M., & Altman, D. G. (1986). Statistical method for assessing agreement between two methods of clinical measurements. Lancet, 1, 307-310. | Chatterjee, P., Banerjee, A.K., Das, P., & Debnath, P. (2010). A regression equation for the estimation of maximum oxygen uptake in Nepalese adult females. Asian Journal of Sports Medicine, 1(1), 41-45. | Chatterjee, P., Banerjee, A.K., Das, P., & Debnath, P. (2010a). A regression equation for the estimation of VO_2 max in Nepalese male adults. Journal of Human Sport and Exercise, 5(2), 127-133. | Chatterjee, P., Banerjee, A.K., Das, P., & Debnath, P. (2009). A regression equation to predict VO_2 max of young football players of Nepal. Int J Appl Sports Sci., 21(2), 113-121. | Cooper, S. M., Baker, J. S., Tong, R. J., Roberts, E., & Hanford, M. (2005). The repeatability and criterion related validity of the 20-m multistage fitness test as a predictor of maximal oxygen uptake in active young men. British Journal of Sports Medicine, 39(4), e19. | Gibson, A., Broomhead, S., Lambert, M.I., & Hawley, J.A. (1998). Prediction of maximal oxygen uptake from a 20-m shuttle run as measured directly in runners and squash players. Journal of sports sciences, 16(4), 331-5. | Leger, L. A, Mercier, D., Gadoury, C., & Lambert, J. (1988). The multi stage 20 m shuttle run test for aerobic fitness. Journal of Sports Sciences, 6(2), 93-101. | Leger, L. A., & Gadoury, C. (1989). Validity of the 20 m shuttle run test with 1 minute stages to predict VO_2 max in adults. Canadian Journal of Sports Sciences, 14(1), 21-6. | Mota, J., Guerra, S., Leandro, C., Pinto, A., Ribeiro, J.C., & Duarte, J.A. (2002). Association of maturation, sex, and body fat in cardiorespiratory fitness. American Journal of Human Biology, 14(6), 707-12. | Shephard, R. J. (1984). Tests of maximum oxygen intake - a critical review. Sports Medicine, 1(2), 99-124. | Vicente-Rodriguez, G., Dorado, C., Perez-Gomez, J., Gonzalez-Henriquez, J. J., & Calbet, J.A. (2004). Enhanced bone mass and physical fitness in young female handball players. Bone, 35(5), 1208-15. | Wong, T. W., Yu, T. S., Wang, X. R., & Robinson, P. (2001). Predicted maximal oxygen uptake in normal Hong Kong Chinese schoolchildren and those with respiratory diseases. Pediatr Pulmonol, 31(2), 126-32. |