RESEARCH ARTICLE

COMPARISON OF NON-EXERCISE TEST AND STEP TEST IN ESTIMATION OF AEROBIC CAPACITY (VO_2max) IN YOUNG ADULTS

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Background: Cardiorespiratory fitness (CRF) is a health-related fitness parameter. The assessment of CRF is valuable while educating individuals about their overall fitness status and quantifying cardiovascular risk. Aerobic capacity or VO_2max is accurate parameter of cardiorespiratory fitness, measured by direct as well as indirect methods. Estimation of VO_2max by exercise test in large population becomes difficult. To overcome these difficulties calculating VO_2max by non-exercise test is suggested. These tests are very useful in low-infrastructure setup, less costly and easy to apply. They are better to use in children & geriatric populations.

Aims & Objective: To compare estimation VO_2max by non-exercise test with exercise test so that validity of non-exercise test can be explored.

Materials and Methods: VO_2max was estimated by exercise protocol using Queens College step test & non-exercise protocol using the NASA/Johnson Space Centre Physical Activity Rating (PA-R) scale. In 60 healthy I MBBS students (30 Boys, 30 Girls). VO_2max values obtained by both methods were compared using appropriate statistical test (unpaired t test). P value of <0.05 was considered as significant.

Results: In malesVO_2max values obtained by exercise protocol is 46.04 ± 9.65 ml/kg/min & by non-exercise protocol is 50.42 ± 8.37 ml/kg/min while in females VO_2max values obtained by exercise protocol is 37.68 ± 6.80 ml/kg/min & by non-exercise protocol is 36.80 ± 5 ml/kg/min.

Conclusion: In our study, we have found that estimation of VO_2max by non-exercise protocol to be as accurate as its estimation by exercise protocol. So, one can conclude that non-exercise protocols can be used for estimation of VO_2max in populations who may not be able to undergo exercise protocols.

Key Words: Aerobic Capacity (VO_2max); Queen's College Step Test; Non-Exercise Test (Nasa/Johnson Space Centre Physical Activity Rating (PA-R) Scale)

INTRODUCTION

Cardiorespiratory fitness (CRF) is a health-related fitness parameter that indicates the capacity of cardiovascular and respiratory systems to perform any physical activity or work.[1] Low cardiorespiratory fitness is associated with coronary artery diseases, high blood pressure and diabetes mellitus and some types of cancer.[2] The assessment of CRF is valuable while educating individuals about their overall fitness status, developing exercise programs and quantifying cardiovascular risk.[3] Aerobic capacity or VO_2max is most accurate parameter of cardiorespiratory fitness.[4] It is the maximum amount of oxygen used by the person during maximal or sub-maximal exercise.[5] VO_2max depends on the body composition, age, sex as well as ethnicity of an individual.[6] VO_2max is measured by direct as well as indirect methods using various exercise protocols. Estimation of VO_2max by exercise test in large number of individuals becomes difficult as it requires costly equipment, space to house the equipment and trained staff to administer the tests. To overcome these difficulties, calculating VO_2max by non-exercise test is suggested. These tests are very useful, particularly in low-infrastructure sites as these tests are simple, less costly and easy to apply. They are also better to use in children & geriatric populations. Therefore this study was aimed to compare estimation VO_2max by non-exercise test with exercise test so that validity of non-exercise test can be explored.

MATERIALS AND METHODS

Present study was a cross-sectional observational study. Study sample included 60 healthy M.B.B.S. Students between the age group of 17-22 years (30 Boys and 30 girls). Students having history of smoking, tobacco chewing and alcohol consumption, having any acute or chronic illness or any physical disability and those who are unwilling to take part in the study were excluded from the study. After receiving approval of institutional ethical committee; a written consent was taken from all the subjects after explaining the nature of study to them. Detailed medical history was obtained and a thorough clinical examination was performed to rule out presence of any major illness and physical disability as per attached proforma in all subjects. Body weight was measured when the subject was minimally clothed and without shoes,

standing motionless on a weighing scale and it was recorded to the nearest of 0.1 kg. Height was measured to the nearest of 0.1 cm while subject standing in erect position with bare feet on flat floor with heels touching the wall and head straight against a vertical scale. BMI was calculated as weight in kilograms divided by square of height in meters (kg/m^2).[16] Subjects having BMI in the range of 18.50 to 25.00 were included in the study.

Estimation of VO_2max by Non-Exercise Protocol: The NASA/Johnson Space Centre Physical Activity Rating (PA-R) scale[17] was used for non-exercise protocol. This scale is developed to provide an assessment score of 0-7 depending upon the person's level of routine physical activity. There are a series of eight statements about routine physical activity. Subject is required to select that best describes their physical activity level. Each statement is given a numerical value which is described as his PAR Score. VO_2max was calculated taking into account subjects PAR Score, his BMI and his gender: *(i) Equation for Male Subjects:* VO_2max (ml/kg/min) = 67.350 – [0.381 x age (years)] – (0.754 x BMI) + (1.951 x PAR); *(ii) Equation for Female Subjects:* VO_2max (ml/kg/min) = 56.363 – (0.381 x age (yrs)) – (0.754 x BMI) + (1.951 x PAR)

Estimation of VO_2max by Exercise Test: Queens College Step test[18] was performed using a 16.25 inches (41.30cms) height stool. Stepping was done for a total duration of 3 minutes at the rate of 24 cycles per minute. Metronome was used to guide the subjects for required rate of step cycles. After completion of the exercise the subjects were asked to remain standing comfortably and the carotid pulse rate was measured from the 5th to 20th second of recovery period. This 15 second pulse rate was converted into beats per minute and the following equation was used to predict VO_2 max: *(i) Equation for Male Subjects:* VO_2max (ml/kg/min) = 111.33 - (0.42 x pulse rate in beats per min); *(ii) Equation for Female Subjects:* VO_2max (ml/kg/min) =65.81 - (0.1847 pulse rate in beats per min)

Statistical Analysis: VO_2max values obtained by both methods were compared using appropriate statistical test (unpaired t test). P value of <0.05 was considered as significant.

RESULTS

Table 1 shows mean age, height, weight & body mass index of our subjects. Table 2 shows VO_2max levels obtained by exercise protocol & non-exercise protocol. There is no statistically significant difference between VO_2max values obtained by exercise protocol & non-exercise protocol using the NASA/Johnson Space Centre Physical Activity Rating (PA-R) scale. So, it can be said that non-exercise protocols are also good to estimate VO_2max levels.

Table-1: Demographic profile of our subjects

Gender	Age (years)	Height (m)	Weight (Kg)	BMI (Kg/m^2)
Males (n=30)	18.55 ± 0.77	1.7 ± 0.07	70.29 ± 12.98	24.24 ± 3.70
Females (n=30)	18.42 ± 3.45	1.58 ± 0.08	59.98 ± 13.09	24.02 ± 4.02

Values are expressed in Mean ± SD.

Table 2 - Comparison of VO_2max values obtained by exercise test and non-exercise test

Gender	VO_2max by Exercise Test	VO_2max by Non-Exercise Test	P Value
Males (n=30)	46.04 ± 9.65	50.42 ± 8.37	0.56
Females (n=30)	37.68 ± 6.80	36.80 ± 5.59	0.44

Values are expressed in Mean ± SD.

DISCUSSION

In our study, we have found that there is no statistically significant difference between VO_2max values obtained by exercise protocol & non-exercise protocol using the NASA/Johnson Space Centre Physical Activity Rating (PA-R) scale. So, VO_2max values obtained by non-exercise protocol using the NASA/Johnson Space Centre Physical Activity Rating (PA-R) scale are as reliable as estimation of VO_2max by exercise protocol. Other studies have also validated the accuracy of N-EX equations, and suggest that they provide a quick and useful prediction of VO_2max.[10-12] Siconolfi et al.[19] (1985) compared VO_2max values obtained by cycle ergo meter and Paffenbarger's Physical Activity Index Questionnaire.[20] Regression coefficients and equations were derived relating the maximal oxygen uptake, the physical activity level, and the frequency of sweating. Results showed correlations between maximal oxygen uptake and physical activity index.

In 1987, Kohl, Blair, Paffenbarger, Macera & Kronenfeld[21] established the association between self-reported responses to physical activity and an objective measure of physical fitness. The study included 375 men of an average age of 47 years. All participants responded to a numeric physical activity questionnaire and completed a maximal treadmill protocol. Participants' reported exercise values were converted to estimates of energy expenditure and combined into overall indices of physical activity participation. The variables that proved to be significant predictors of physical fitness were age (β = -0.34), an index of running, walking, and jogging participation (β = 0.31) and the frequency of sweating response (β = 0.35).

Jackson and colleagues (1990)[11] developed an N-EX prediction model based on 2,009 individuals between 18 and 70 years old. The predictor variables included self-reported PAR, age, body composition and gender. Participants' VO_2 peak was measured during the first three walking stages of the Bruce treadmill protocol. Self-reported PAR was the most highly correlated variable with measured VO_2 peak. The study confirmed that the N-EX model including self-reported PA-R, age, BMI, and gender provided a valid estimate (R = 0.783, SEE = 5.70 ml· kg-^{1}·min-^{1}) of VO_2 peak. Results also illustrated that the N-EX model was more accurate than estimated VO_2 peak from Astrand bicycle tests and established submaximal treadmill prediction models.

Heil, Freedson, Ahlquist, Price, & Rippe (1995)[22] developed a non-exercise model & conducted a study to compare it with the model presented by Jackson et al. (1990). The study included 439 participants between the ages of 20 and 79 years. Each participant performed a maximal walking treadmill test to determine VO_2 peak. Independent variables included both age and age-squared, percent body fat, gender, and the same self-reported activity rating used by Jackson et al. (1990). They concluded that their N-EX model was at least accurate, stable, and generalizable.

Thus, it can be said that non-exercise protocols are accurate in estimation of VO_2max. They are time-efficient, resource-efficient and can be applied to any age population that is healthy or otherwise. They could be especially useful to assess fitness in children & geriatric population as they may not be able to comply by exercise protocols.

CONCLUSION

In our study, we have found that estimation of VO_2max by non-exercise protocol to be as accurate as its estimation by exercise protocol. So, one can conclude that non-exercise protocols can be used for estimation of VO2max in populations who may not be able to undergo exercise protocols.

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