



COMPARISON OF PREDICTED VO₂ MAX VALUES OBTAINED BY NON EXERCISE EQUATION AND EXERCISE EQUATION IN PHYSIOTHERAPY STUDENTS.

Physiotherapy

Dr. Rashmi Ronghe (P.T)M.P.Th Associate Professor Cardio vascular and Respiratory Physiotherapy dept. VSPM'S College of Physiotherapy Nagpur

Dr.Kirti Khandelwal

(P.T) M.P.T VSPM's College of Physiotherapy Nagpur

ABSTRACT

Background:- VO₂ max is measured by computerized maximal graded exercise stress test (GxT) performed on a treadmill or bicycle ergometer with gas analyser. When the use of such laboratory methods is not feasible, the following indirect methods such as non exercise and exercise (sub maximal field tests) is used to measure VO₂ max by using prediction equations. **Aim:-** To study the comparison of predicted VO₂ max values obtained by non exercise equation and exercise equation in physiotherapy students. **Objective:-** To estimate and compare VO₂ max using non exercise equation by NASA/Johnson and exercise equation by Queens College step test in physiotherapy student. **Methodology:-** Total 391 subject were included and participants PAR Score was obtained using PAR scale and used in non-exercise equation to obtained non exercise vo2 max. Then Carotid pulse rate was obtained by queen college step test and was used in exercise equation to obtained vo2 max. The data was documented, analysed and results were obtained. Results Comparison of two estimated VO₂ max using non exercise equation and exercise equation and it revealed that the estimated mean VO₂ max were similar. There was a difference of 0.30 between two means which is less than 1%. **Conclusion:-** The study concludes that non exercise equation can be used instead of exercise equation where it is not feasible by the subject or non availability of instruments to assess VO₂ max.

KEYWORDS

Cardio-respiratory fitness, VO₂ max, Queen college step test, PAR scale.

INTRODUCTION

The VO₂ max is a fitness indicator that shows cardiorespiratory endurance.¹ The largest amount of oxygen which can be used by the body during severe exercise, termed as VO₂ max and is a widely accepted factors that determines cardiorespiratory fitness (ACSM, 2010).² Cardiopulmonary fitness is an important component of health-related physical fitness because it improves the ability to perform high-intensity exercise for long periods of time (ACSM, 2006). The assessment of cardio respiratory fitness is valuable when educating individuals about their overall fitness status, developing exercise programs, and stratifying cardiovascular risk (ACSM).³ VO₂ max depends on the body composition, age, sex as well as ethnicity of an individual.³ VO₂ max is measured by direct as well as indirect methods using various exercise protocols.⁴ By direct method VO₂ max is commonly measured by computerized maximal graded exercise stress test (GxT) performed on a treadmill or bicycle ergometer with gas analysis. When the use of such laboratory methods is not feasible, the following indirect methods such as non exercise and exercise (submaximal field tests) is used to measure VO₂ max by using prediction equations.⁵

NON EXERCISE EQUATION:- The NASA/Johnson space centre physical activity rating scale is used for non exercise protocol.⁶ Non exercise equation developed from self-reported physical activity rating scale to estimate VO₂ max.⁷ This equation is also used to estimate VO₂ max without the need to perform the exercise test, as well as it is feasible to assess cardio respiratory fitness in epidemiological studies.^{6,7} VO₂ max will be calculated by Non exercise equation. It is simple to apply and cost effective especially in low infrastructure site using subjects PAR score, BMI and gender.⁴ Jackson and colleagues (1990) developed a Non exercise prediction model. The predictor variable included self-reported PAR, age, BMI and sex. The study confirmed that the non-exercise model including self-reported PAR, age, BMI, gender provided a valid estimate of VO₂ max.⁸

EXERCISE EQUATION:- Exercise equation is developed from Queen's college step test to estimate VO₂ max.⁹ Exercise test by Queen College step test is the submaximal test to measure maximum oxygen consumption (VO₂ max).⁹ Queen college step test consist of 3min of stepping up and down on a stepper at a pre decided rate.⁴ Carotid Pulse rate is used to estimate VO₂ max in exercise equation.⁴ Performing exercise test requires less equipments, small space and one metronome.¹⁰ The Queen college step test is a reliable method to evaluate and has good validity. (Chatterjee 2003)¹⁰ Based on the previous studies, estimated models are valid and can be used for a larger population. Accuracy and validation of these models are related to demographic and socio-environmental factors, including age,

gender, race, culture, geographical region, and living environment.⁸ The young physiotherapy students need long duration physical activities.^{11,12} The Physiotherapy field demands high physical activity and hence their endurance levels must be assessed.¹

RATIONALE OF STUDY:

Study has been conducted to estimate VO₂ max using non exercise and exercise equation in medical students and result were significant.¹³ Physiotherapists are a health professional, who requires good physical fitness status.¹³ Hence it is necessary to understand their fitness levels. Studies indicate non exercise equation can be used as an effective tool to estimate VO₂ max.¹⁴ Studies have reported that VO₂ max by non exercise protocol to be as accurate as its estimation by exercise protocol.¹⁵ So non exercise protocol can be used for estimation in population who may not be able to undergo exercise protocol. Therefore, the need for study is comparison of estimated VO₂ max using non exercise equation and exercise equation in physiotherapy students.

RESEARCH QUESTION:

Is there any difference of estimated VO₂ max by non exercise equation and exercise equation in physiotherapy student?

AIM:

To study the comparison of predicted VO₂ max values obtained by non exercise equation and exercise equation in physiotherapy students.

Objective:

To estimate VO₂ max using non exercise equation by NASA/Johnson and exercise equation by Queens College step test in physiotherapy student.

To compare VO₂ max estimated using non exercise equation by NASA/Johnson and exercise equation by Queens's college step test in physiotherapy student.

METHODOLOGY:

Study design: An Analytical Cross Sectional Study. **Study setting:** College of Physiotherapy. **Duration of study:-** 18 months. **Study population:** Physiotherapy Students. **Type of sampling:** Universal sampling was used for the study. All the physiotherapy student aged 18-25 years (excluding male) enrolled in institution were selected. **Sample size estimation:** Sample size is determined considering mean difference in VO₂ max values as the main outcome measures. Total 391 subject were included in this study.

PROCEDURE:

Permission from the head of institution and approval from the ethical

committee was obtained. Physiotherapy student were selected for the study. Participants who met the inclusion criteria were briefed about the study in the language best understood by them and informed written consent was taken. Demographic data was documented. Participants PAR Score was obtained using PAR scale. And Carotid pulse rate was measured using Queen College Step Test. Participants PAR Score was used in non-exercise equation and Carotid pulse rate was used in exercise equation to obtain predicted VO_2max values. The data was documented, analysed and results was obtained.

METHODS OF MEASUREMENTS

Estimation of VO_2max by Non Exercise Protocol

Step 1:- The NASA/Johnson Space Centre Physical Activity Rating (PAR) scale was used for non-exercise protocol. An assessment score of 0-7 was used. It has eight statements related to physical activity. Participant was asked to select the best response which matches their physical activity level. Every statement has a numerical value which is his PAR Score. VO_2max was then calculated using PAR Score.

Step2 : Non Exercise Equation: VO_2max (ml/kg/min) = $56.363 - (0.381 \times \text{age (yrs.)}) - (0.754 \times \text{BMI}) + (1.951 \times \text{PAR})$

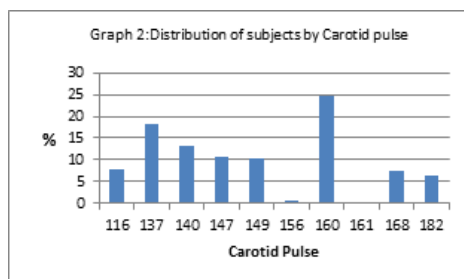
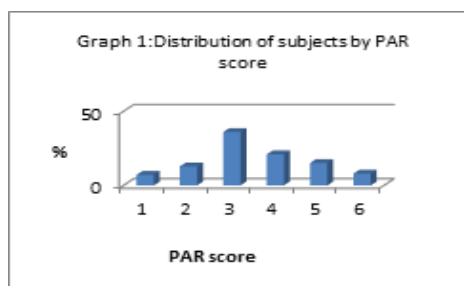
Estimation of VO_2max by Exercise Protocol:

Step1:- Queens College Step test was performed using a 16.25 inches (41.30cms) height stool. Its total duration was 3 minutes at the rate of 24 cycles per minute using metronome. After that the participant remains standing and then 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_2max .

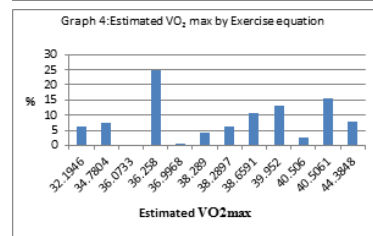
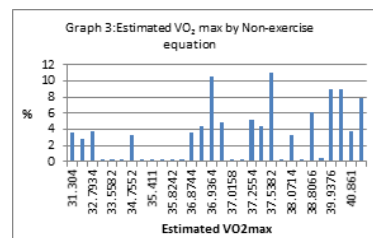
Step2: Exercise Equation : VO_2max (ml/kg/min) = $65.81 - (0.1847 \times \text{pulse rate in beats per min})$

RESULTS:

The aim of our research was to find out and calculate VO_2max by exercise and non exercise equation with sample size of 391 Physiotherapy students aged 20-25 years. The mean age of the population was 23.08 ± 0.74 . The mean BMI of the participants was 21.87 ± 2.93 . The mean PAR score of the subject was 3.48 ± 1.31 . The mean of carotid pulse of the subject was 149.1 ± 15.85 . VO_2max was obtained by non exercise equation using NASA/JOHNSON space centre Physical Activity Rating (PA-R) scale and the mean of this equation was 37.96 ± 3.22 . VO_2max obtained by exercise equation using Queens college step test and the mean of this equation was 38.27 ± 2.93 . Comparison of the two estimates of VO_2max by exercise equation using Queens college step test and non exercise equation using NASA/JOHNSON space centre Physical Activity Rating (PA-R) scale revealed that estimates of mean VO_2max are similar.



The graph 1 shows the distribution of subjects by PAR score with the mean 3.48 ± 1.31



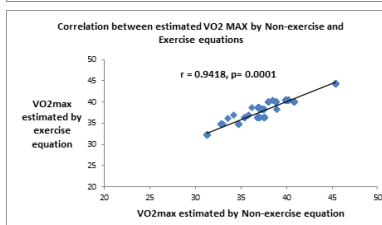
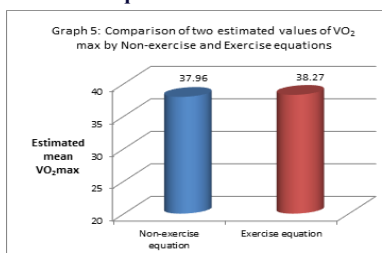
The graph 2 shows the distribution of subjects by carotid pulse with the mean of 149.1 ± 15.85 .

The above table and graph shows Comparison of two estimated VO_2max using non exercise equation and exercise equation and it revealed that the estimated mean VO_2max were similar. There was a difference of 0.30 between two means which is less than 1%.

Table 1: Comparison of two estimated values of VO_2max by Non-exercise and Exercise equations

Estimate	Non-exercise equation	Exercise equation
Mean VO_2max	37.96	38.27
SD	3.22	2.93
Mean difference	0.30 $\pm$ 3.22	
t value	5.54, df=390	
p value	p=0.0001	

Graph 5: Comparison of two estimated values of VO_2max by Non-exercise and Exercise equations



DISCUSSION

The mean VO_2max obtained by using the exercise equation using Queens college step test was 37.96 ± 3.22 , while the non exercise equation using NASA/JOHNSON Physical Activity Rating Scale was 38.27 ± 2.93 . The p value was $p=0.0001$, which indicates that the report was statistically significant. When both groups were compared, the mean vo_2max were similar. The difference between the two means was 0.30, which is less than 1%. In addition, the Pearson correlation

coefficient ($r=0.948$) indicates significant, positive and almost perfect linear link between the two VO_2 max estimates. Our data is compatible with that of James D.George, Samantha L.Paul, and collaborators. Their aim was to create regression model based on submaximal treadmill exercise and non-exercise data to predict optimum VO_2 max. They concluded that using both exercise and non exercise data, the submaximal treadmill test and associated regression model managed to give relatively accurate VO_2 max estimates in healthy people aged 18-65 years.¹⁵ An earlier study in 2014 Anita V Rao et.al. assessed VO_2 max by exercise protocol using Queens college step test and non exercise protocol using the NASA/Johnson space Centre PAR scale and found that estimation of VO_2 max by non exercise protocol was similar to estimated exercise protocol which was in agreement with previous reports.⁴ A Study conducted in 2011 by Juan Marcelo Simoes Caceres¹, Anderson Zamperli¹Ulbrich¹ et.al. "A Non- exercise prediction model for adult cardiorespiratory fitness estimation noted that the model developed for cardiorespiratory fitness prediction is feasible and practical for VO_2 peak prediction in epidemiological studies or when cardiopulmonary exercise testing (CPET) is impossible.¹⁶ A Non-Exs prediction model was developed by Jackson and Colleagues using Self reported PAR, age, body composition and gender. The most correlated variable with measured VO_2 peak was self-reported PAR, age, BMI and gender and it was found to offer a reliable estimate of VO_2 peak. The N-Ex model was also found to be more accurate than established submaximal treadmill prediction models and estimated VO_2 max from Astrand bicycle tests.⁴ Sunita Basavaraj Kalyanshetti, et.al., 2016 undertook a cross-sectional study of the relationship of BMI and VO_2 max to use a non exercise test in medical students. For the non-exercise regimen the NASA/Johnson space centre PA-R scale was used. They reached the conclusion that as a person's BMI increases their VO_2 max reduces and hence their cardiovascular fitness.⁶

REFERENCES:

1. Ortega FB, Ruiz JR, Castillo MJ, Sjöström M. Physical fitness in childhood and adolescence: a powerful marker of health. *International journal of obesity*. 2008 Jan;32(1):1-1.
2. Thompson WR, Gordon NF, Pescatello LS, editors. ACSM's guidelines for exercise testing and prescription. Lippincott Williams & Wilkins; 2010.
3. Ainsworth BE, Montoye HJ, Leon AS. Methods of assessing physical activity during leisure and work.
4. Rao AV, Phadke AV, Patil PB, Joshi AR. Comparison of non-exercise test and step test in estimation of aerobic capacity (VO_2max) in young adults. *National Journal of Physiology, Pharmacy and Pharmacology*. 2014;4(3):218-20.
5. McArdle WD, Katch FI, Katch VL. Exercise physiology: nutrition, energy, and human performance. Lippincott Williams & Wilkins; 2010.
6. Kalyanshetti SB, Veluru S. A cross-sectional study of association of body mass index and VO_2 max by nonexercise test in medical students. *National Journal of Physiology, Pharmacy and Pharmacology*. 2017;7(2):228-231.
7. Neto GD, Farinatti PD. Non-exercise models for prediction of aerobic fitness and applicability on epidemiological studies: Descriptive review and analysis of the studies. *Revista Brasileira de Medicina do Esporte*. 2003;9(5):304-24.
8. Jackson AS, Blair SN, Mahar MT, Wier LT, Ross RM, Stuteville JE. Prediction of functional aerobic capacity without exercise testing. *MedSci Sports Exerc*. 1990 Dec 1;22(6):863-70.
9. Newland A, Nguyen K. Queen's College Step Test and Its Validity of VO_2 (2max) Prediction on Young Healthy Females.
10. Chatterjee S, Chatterjee P, Mukherjee PS, Bandyopadhyay A. Validity of Queen's College step test for use with young Indian men. *British journal of sports medicine*. 2004 Jun 1;38(3):289-91.
11. Balogun JA. Assessment of physical fitness of female physical therapy students. *Journal of Orthopaedic & Sports Physical Therapy*. 1987 May;8(11):525-32.
12. Bello AI, Bonney E, Opoku B. Physical fitness of Ghanaian physiotherapists and its correlation with age and exercise engagement: a pilot study. *Archives of physiotherapy*. 2016 Dec 1;6(1):2.
13. Rayas RV, Shetye JV, Mehta AA. Agreement between Estimated VO_2 max by 6-Minute Walk Test and Non-Exercise Equation in Physiotherapy Students. *Journal of Exercise Science & Physiotherapy* Vol. 2019;15(1).
14. Shenoy S, Tyagi BS, Sandhu JS. Concurrent validity of the non-exercise based VO_2 max prediction equation using percentage body fat as a variable in Asian Indian adults. *Sports Medicine, Arthroscopy, Rehabilitation, Therapy & Technology*. 2012 Dec;4(1):34.
15. George JD, Paul SL, Hyde A, Bradshaw DI, Vehrs PR, Hager RL, Yanowitz FG. Prediction of maximum oxygen uptake using both exercise and non-exercise data. *Measurement in Physical Education and Exercise Science*. 2009 Jan 22;13(1):1-2.
16. Cáceres JM, Ulbrich AZ, Panigas TF, Benetti M. A non-exercise prediction model for estimation of cardiorespiratory fitness in adults. *Brazilian Journal of Kinesiology and Human Performance*. 2012 May 3;14(3):287-95.