

PREDICTION OF FUNCTIONAL CAPACITY DURING SIX - MINUTE WALK AMONG PATIENTS WITH CHRONIC HEART FAILURE

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ABSTRACT

Background: Formulae for predicting functional capacity during 6-minute walk are lacking and the accuracy of the existing formulae has been challenged in deferent populations.

Aims: The purpose of this study was to develop an equation that would be useful in predicting functional capacity in form of maximum oxygen consumption (VO_2) in Chronic Heart Failure Patients (CHF) during exercise.

Methods: Sixty-five subjects were recruited for the study. The procedure required the subjects to walk on a self paced speed on a 20 meter marked level ground for 6 minutes. The distance covered in 6 minutes was measured and the speed calculated.

Results: The result showed that the distance covered was highly correlated with the VO_2 (0.65, $p < 0.01$). The regression analysis revealed that a linear equation model developed was a good predictor of VO_2 for the group.

Conclusion: The study concluded that in situation where sophisticated equipments are lacking, this equation might be useful during exercise supervision for patients with CHF.

$[VO_2 \text{ (ml kg}^{-1} \text{ min}^{-1}) = 0.0105 \times \text{distance (m)} + 0.0238 \text{ age (yr)} - 0.03085 \text{ weight (kg)} + 5.598]$.

Key Words: Six-minute walk, Functional capacity, Chronic heart failure

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INTRODUCTION

The use of 6-minute walk test for assessing the functional status capacity of patients with cardiopulmonary disorders is gaining popularity among the experts. This is because the test is simple and convenient to administer without the need of sophisticated equipment and the exercise level is similar to daily physical activities^{1,2}. Six-minute walk test has been reported to be significantly correlated with peak VO_2 in patients with advanced chronic heart failure (CHF)³. Peak oxygen consumption (peak VO_2) provides an objective and reproducible assessment of functional capacity in CHF patients, and it has been shown to be a strong survival predictor^{4,5}.

The accurate method known for the assessment of VO_2 during aerobic exercises involved the collection of expired gas using a Douglas bag or max plank respirometer and a mouth piece and nose clip. This method has been found to be costly and impractical during exercise testing as the instrument inhibits oral communication between the patient and the clinicians⁶.

Equations have therefore been suggested for predicting VO_2 during level walking^{7,8}. ACSM equation ($VO_2 = \text{Speed} \times 0.1 \text{ ml O}_2/\text{kg}/\text{min}$)⁷ is probably the most widely used today. This study was designed to develop equation that will be suitable to quantify peak VO_2 in patients with CHF during 6-

minute walk test. The American College of Sport Medicine equation was developed among subjects population that are of different cultural and racial background from this present study. And for the fact that cardiovascular diseases are now becoming prevalent in Nigeria, information of this nature is essential to guide the clinicians during exercise prescription.

METHODOLOGY

Subjects

Sixty-five patients (35men and 30women) with Chronic Heart Failure who were receiving treatment in the Cardiac Care Unit of Obafemi Awolowo University Teaching Hospitals Complex, Ile-Ife, Nigeria (OAUTHC) were recruited for the study. Patients were examined and referred by cardiologists before being included in the study. All patients signed informed consent form and the study protocol was approved by the OAUTHC Ethics Committee.

The inclusion criteria require that patients attend the cardiac clinic with a clinical diagnosis of Chronic Heart Failure. A patient was recruited if he or she fitted into the, chronic stable New York Heart Association Classes II or III, was able to perform exercise testing and was in sinus rhythm. A patient was excluded if he or she had any of the following conditions: history or sign of significant respiratory disease, severe mitral regurgitation and other severe valvular diseases, angina pectoris, inability to walk without physical assistance.

Procedure

Each subject's age, height and weight were recorded. The procedure of the exercise was explained to the subjects. They were told that they are not under any obligation to complete the study and if they have shortness of breath, fatigue or discomfort, they should so indicate so that exercise could be terminated. Subsequently, all the subjects were introduced to the modified Borg scale for rating perceived physical exertion¹³. In the scale '0' represents no discomfort; '5' represents moderate; '10' extremely discomfort.

Prior to the commencement of the testing, patients were assessed during a 2-week period in which echocardiography and electrocardiogram were performed.

Subjects were given oral instructions with respect to exercise testing. They were requested to avoid non-essential physical work and strenuous exercise on the day before the testing. Furthermore, they were requested not to smoke, or drink alcohol or coffee on the day of the exercise test⁹. Cardiopulmonary equipments, including defibrillator and cardiac emergency drugs were in place in case of emergency. A 20-metre corridor within the cardiac unit of the hospital was marked out for the exercise. Subjects were allowed to rest for a period of 10 minutes in sitting position before the commencement of exercise test. The initial blood pressure and heart rate readings were taken in sitting position. They were subsequently instructed to walk from the starting point to the end at their own selected pace while attempting to cover as much ground as possible in six minutes and were encouraged every 30 seconds in a standardized manner¹⁰. After six minutes, the distance covered was measured to the nearest meter.

Analysis

Pearson product moment correlation coefficient was used to relate the distance walked in 6 min and peak VO₂. Regression analysis was used to predict VO₂ using age, physical characteristics and distance as predictor variables.

RESULTS

Two subjects were unable to complete the study due to excessive fatigue. Their data were therefore excluded from the analysis. The physical characteristics of the subjects are presented in table 1. The age of the patients ranged between 22 and 87 years with mean of 57 SD 15.2 years.

Forty-one patients were in NYHA III and 24 were in NYHA classification of II. The causes as recorded in this study include: hypertensive heart disease, dilated cardiomyopathy, and pulmonary disease. No major complications were found during the six minute walk. A significant correlation was found between distance walked and VO₂ (r=0.65 * P<0.01). Age and weight have no significant relationship with VO₂ (r=-0.227; r = -0.211, p > 0.05 respectively) Table 2.

There was good agreement between the derived equation and the value calculated using ACSM equation (r = 0.875, **p < 0.001). There were no significant differences in systolic blood pressure and diastolic blood pressure before and after the 6 minutes walk (p>0.05). However, heart rate rose significantly after the 6 minutes walk.

The equation generated from the regression analysis is as follows:

$$VO_2 \text{ (ml kg}^{-1} \text{ min}^{-1}) = 0.0105 \times \text{distance (m)} + 0.0238 \text{ age (yr)} + 0.03085 \text{ weight (kg)} + 5.598.$$

Table 1: Physical Characteristics of the Study Population.

Variable	Mean ±SD Women(n=30)	Mean ±SD Men(n=35)	Mean ±SD Total n=65	P Value
Age(year)	52.3±16.2	61.6±13.9	56.95±15.05	0.134
Height(m)	1.6±0.57	1.65±0.06	1.63±0.34	0.664
Weight(kg)	57.56±12.1	61.06±11.26	59.31±11.68	0.356
BMI(kg/m ²)	22.4±5.1	23.08±5.2	22.74±5.15	0.345

Table 2: Relationship between VO₂, Age, Weight and Distance.

Dependent Variables	Pearson Product Correlation
Age (yr)	- 0.227
Weight (kg)	- 0.211
Distance (m)	0.647**

** P<0.01

Table 3: T-test analysis of Variance of Cardiovascular Responses during 6 Minutes Walk.

Variable	Resting	6Minutes Walk	T	Sig.
SBP(mmHg)	124.4±17.0	127.9±18.3	2.3	0.009
DBPmmHg	82.8±15.6	86.8±14.6	1.309	0.278
HR(Beat/min)	85.0±17.6	96.4±19.1	8.44	0.001*

*Significant at P<0.05

DISCUSSION

The purpose of this study was to derive a formula relating VO₂ to distance walked during six minute level walk among patients with CHF. Age and weight were included as predictors of VO₂ because they have been reported to be significant predictors of VO₂⁸.

The result of this study showed that the ACSM have good agreement with the new equation developed in this present study ($r=0.875$, $**p<0.001$).

Earlier reports revealed that ACSM overestimates VO₂ in patients' with coronary arteries disease but underestimates VO₂ in all age groups during horizontal walking¹¹. The present study might be more clinically relevant because of inclusion of age and weight in the formula. The study of Morales et al also included age and weight in their formula developed for shuttle walk⁸. Age and weight are known risk factors for development of cardiovascular disease¹².

The result of this study should be interpreted with caution due to small sample size. The equation of our study can only be applied to adults with similar diagnosis of CHF and similar physical characteristics to subjects recruited for this study. Six-minute walk is cost effective and it is very simple to administer. It could help in monitoring progress of patient response to treatment protocols and it can be useful in assessing the effectiveness of treatment modalities.

REFERENCES

1. **Solway S, Brooks D, Lacasse Y.** A qualitative systematic overview of the measurement properties of functional walk tests used in the cardiorespiratory domain. *Chest* 2001; 119: 256-270.
2. **Tsang RCC.** Reference values for 6-minute walk test and hand-grip strength in healthy Hong Kong Chinese Adults. *Hong Kong Physiotherapy Journal* 2005; 23:6-12.
3. **Cahalin LP, Mathier MA, Semigran MJ, Dec GW, Disalvo TG.** The six-minute walk test predicts peak oxygen consumption and survival in patients with advanced heart failure. *Chest* 1996; 110:325-332.
4. **Szlachic J, Masie BM, Framer BL, Topic N, Tubua J.** Correlates and prognostic implication of exercise capacity in chronic congestive heart failure. *Am J Cardiol* 1985; 83: 778-786.
5. **Stelken AM, Younis LT, Jennison SH, Miller DD, Miller LW, Shaw LJ.** Prognostic value of cardiopulmonary exercise testing using percent achieved to predicted peak oxygen uptake for patients with ischemic and dilated cardiomyopathy. *J Am Coll Cardiol* 1996; 27:345-352.
6. **Balogun JA, Martin DA, Clendenin MA.** Human energy expenditure during level walking on a treadmill at speed 54-130n min-1. *Int. Disabil. Studies* 1989; 11: 71-74.
7. American college of Sport Medicine. Guidelines for Graded Exercise Testing and Exercise Perception 1995;(Lea and Fabiyer, Philadelphia.
8. **Morales FJ Martinez A, Mandez M, Agarrado A, Montemayor T, Burgos J. A.** Shuttle Walk Test for Assessment of Functional Capacity in Chronic Heart Failure. *Am Heart J* 1999; 138(2):292-298.
9. **Balogun MO, Akintomide AO, Ogunnowo PO, Ladipo GOA.** The effect of regular alcohol consumption on circulatory responses to exercise in treated hypertensive males. *Trop Cardiol* 1990; 16:95-99.
10. **Lipkin DP, Scriven AJ, Crake T, Poole-Wilson PA.** Six minute walking test for assessing exercise capacity in chronic heart failure. *BMJ* 1986; 292: 653-655.
11. **Montoye HJ, Ayer T, Nagle F, Howley ET.** The oxygen requirement for horizontal and grade walking on a motor-driven treadmill. *Med Sci Sports Exercise* 1985; 17:640-645.
12. **Adedoyin RA, Mbada CE, Awofolu OO, Oyebami OM.** The influence of socio-economic status on casual blood pressures of the adult Nigerians. *Euro J Cardiovasc Prev Rehabil* 2005; 12(3):271-273.
13. **Borg G.** Psychosocial basis of perceived exertion. *MED Sci Sports Exercise.* 1982; 472: 377-381.