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Cardiorespiratory, Hemodynamic, and Perceived Exertion Responses to Seated Chair Exercise

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Introduction

Exercise programs have progressively evolved from the implementation and monitoring of exercise to a more comprehensive patient-based approach that emphasizes counseling, education, individually tailored exercise training, modification of risk factors, and enhanced psychosocial well-being. Within the population of potential exercisers, individuals who may be unable to negotiate treadmill-based exercise programs, such as chronically disabled patients and those with orthopedic, neuromuscular, balance or stability problems, are among the most understudied. Special attention and personalization are required to accommodate these patients when developing physical conditioning programs that will achieve the desired cardioprotective effects. Recently, emphasis has been placed on the importance of regular exercise to increase functional capacity, expressed as METs,[1] to improve survival. Mild- to moderate-intensity aerobic exercise, if repeated over time, may provide a sufficient stimulus to promote beneficial cardiovascular adaptation and improvement in inactive or deconditioned individuals.[2,3] Moderate exercise corresponds to 40% to 59% of functional capacity or, in some studies, the ability to achieve 3.0-5.9 METs during physical activity.[1]

Aims and Objectives

Primary and secondary prevention programs have been promoted to reduce the incidence of initial and recurrent cardiovascular events and, potentially, the need for coronary revascularization. These programs employ a multifaceted approach which aims to adopt and maintain healthy lifestyle behaviors, lower rates of disability, and encourage a physically active lifestyle, healthy dietary practices, and smoking cessation (if appropriate) for patients. Exercise-based physical activity interventions have been demonstrated to increase cardiorespiratory fitness, decrease anginal symptoms, improve survival, enhance patients' quality of life, and favorably modify the cardiovascular risk factor profile. In this study, we aim to evaluate the cardiorespiratory, hemodynamic, and perceived exertion responses to seated chair exercise in deconditioned, otherwise healthy middle-aged and older patients to determine whether these responses can approach their prescribed aerobic requirements for exercise training.

Aim I – Develop a physical conditioning program that can be utilized by selected middle-aged and older patients who, due to balance or stability problems, may be unable to use treadmill-based exercise programs to potentially reduce the risk of initial or recurrent cardiovascular events.

Aim II – Determine the percentage of cardiorespiratory fitness, expressed as peak METs, that can be attained using chair-based exercise therapy.

Aim III – Determine whether chair-based exercise therapy is capable of increasing cardiorespiratory and hemodynamic responses to those corresponding to mild-to-moderate intensities (i.e. 2-4 METs).

Study Design

Recruitment & Enrollment of Subjects
Participants will be recruited from individuals who were recently evaluated in the Beaumont Cardiovascular Performance Clinic. Subjects will be recruited based on fulfilling the requirements for participation. As per protocol, subjects are evaluated for structural cardiac abnormalities with a limited 2D echocardiogram. Additionally, subjects are evaluated by a cardiologist. The sample size of the study population will be approximately 12-15 adults. The requirements for participation will include a recent cardiopulmonary exercise stress test to volitional fatigue, no exercise-induced abnormal signs/symptoms, and an average to below average level of cardiorespiratory fitness, based on age and gender norms.

Inclusion: The study population will include middle-aged and older men and women between the ages of 40 and 75 who have been previously screened for impaired left ventricular function via echocardiography and for significant dysrhythmias, angina, and signs and/or symptoms of myocardial ischemia during peak or symptom-limited cardiopulmonary exercise testing.

Exclusion: Individuals younger than 40 years of age and those with previous myocardial infarction, bundle branch block, digoxin therapy, left ventricular hypertrophy, pacemaker and/or implantable cardioverter defibrillator, unstable coronary artery disease and/or heart failure, severe pulmonary disease, activity-limiting arthritis, or other musculoskeletal problems will be excluded from participation.

This prospective study will evaluate energy expenditure, expressed as METs, during standardized chair exercise. Participants will include previously sedentary, asymptomatic middle-aged and older individuals without known CVD with directly measured average to below average levels of cardiorespiratory fitness. Subjects will initially participate in a cardiopulmonary exercise stress test to volitional fatigue to evaluate VO_2 max or MET capacity. These will be used as a baseline for comparison to determine the percentage of maximum MET's that can be achieved during chair exercise. Participants will perform a 5- to 8-minute, seated exercise sequence (e.g. arm raises, knee extensions, heel raises) during which they will be electrocardiographically monitored and breathing through a computerized metabolic measurement system. The first 2 minutes will consist of range of motion/light callisthenic exercises that will gradually increase in intensity. The aerobic portion will last 5 minutes and consist of full body exercise. The remaining minute will consist of light callisthenic and range of motion exercises that gradually decrease in intensity. The exercises from warm-up through cool-down will be performed in a continuous fashion, unless the patient demonstrates adverse signs and/or symptoms during the submaximal chair exercise indicating the testing should be discontinued. Only those patients with recent (previous 6 months) normal responses to maximal exercise testing will be recruited as subjects.

Results

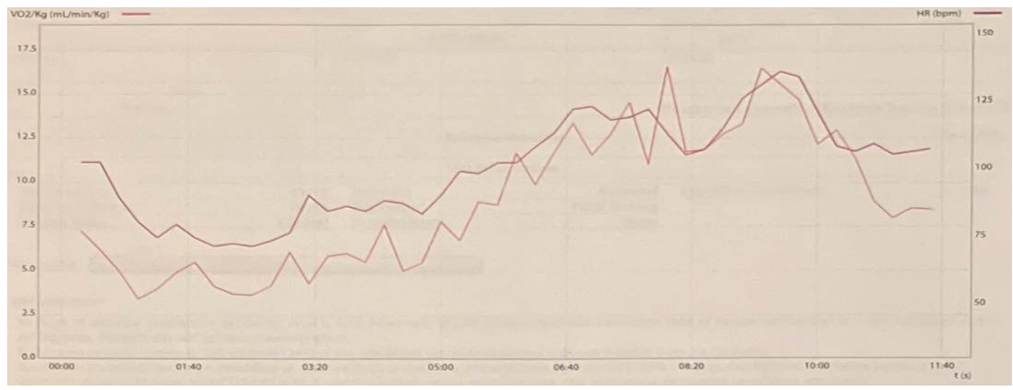
Subject 1: 24 year old male Weight : 155 lb BMI: 25.0

AVERAGE

Metabolic	Column1	Rest	AT	RC	Max	Pred	%Pred	Normal
VO2	mL/min	306	1028	424	783	3265	24	>2743
VO2/kg	mL/min/kg	4.4	14.6	6	11.1	46.4	24	>39.0
METS		1.2	4.2	1.7	3.2	13.3	24	>11.1
RQ		0.79	1.04	0.74	1.12			>1.10
Ventilatory		Meas.						
VE/VCO2 slope		29.6				24.2	122	>29.1
Cardiovascular								
HR	bpm	73	120	87	122	196	62	>176
VO2/HR	mL/beat	4.1	8.6	4.9	6.4	16.7	39	>13.3
Gas Exchange								
VE/VO2			33.5	30.3	41.3			
VE/VCO2			32.2	41.2	36.9	24.1	133	<28.1

PEAK

Metabolic	Column1	Rest	Max	Pred	%Pred	Normal
VO2	mL/min	306	1165	3265	36	>2743
VO2/kg	mL/min/kg	4.4	16.6	46.4	36	>39.0
METS		1.2	4.7	13.3	36	>11.1
RQ		0.79	1.12			>1.10
Ventilatory		Meas.				
VE/VCO2 slope		29.6		24.2	122	>29.1
Cardiovascular						
HR	bpm	73	122	196	62	>176
VO2/HR	mL/beat	4.1	9.5	16.7	57	>13.3
Gas Exchange						
VE/VO2			41.3			
VE/VCO2			36.9	24.1		<28.1



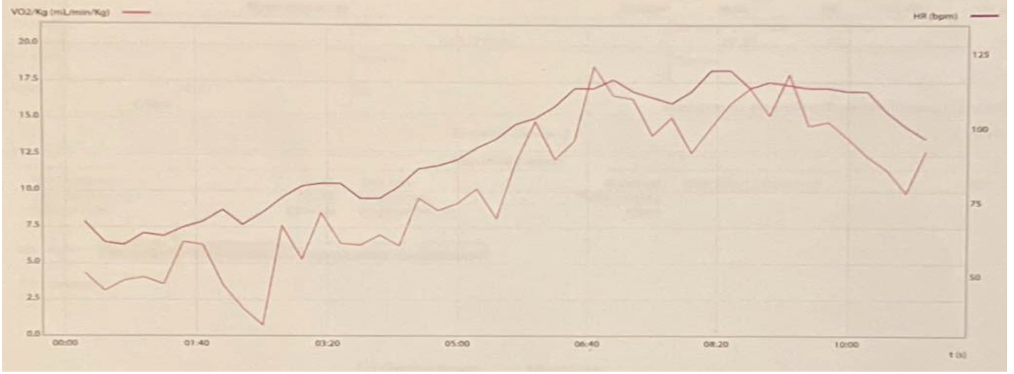
Subject 2: 26 year old male Weight : 195 lb BMI: 27.2

AVERAGE

Metabolic	Column1	Rest	Max	Pred	%Pred	Normal
VO2	mL/min	391	1187	3736	32	>3138
VO2/kg	mL/min/kg	4.4	13.4	42.2	32	>35.5
METS		1.3	3.8	12.1	32	>10.1
RQ		1.04	1.16			>1.10
Ventilatory		Meas.				
VE/VCO2 slope		27		23.5	115	<28.4
Cardiovascular						
HR	bpm	68	114	194	59	>175
VO2/HR	mL/beat	5.7	10.4	19.3	54	>15.4
Gas Exchange						
VE/VO2			35.1			
VE/VCO2			30.2	23.9		<27.9

PEAK

Metabolic	Column1	Rest	Max	Pred	%Pred	Normal
VO2	mL/min	391	1598	3736	43	>3138
VO2/kg	mL/min/kg	4.4	18.1	42.2	43	>35.5
METS		1.3	5.2	12.1	43	>10.1
RQ		1.04	1.16			>1.10
Ventilatory						
VE/VCO2 slope		27		23.5	115	<28.4
Cardiovascular						
HR	bpm	68	114	194	59	>175
VO2/HR	mL/beat	5.7	14	19.3	73	>15.4
Gas Exchange						
VE/VO2			35.1			
VE/VCO2			30.2	23.9		<27.9



Conclusions

The results of the pilot study are observational and promising for future studies. Subject 1 maintained an average value of 3.2 METs and a peak value of 4.7 METs. Subject 2 was able to achieve an average value of 3.8 METs and a peak value of 5.2 METs. These values correspond to a moderate level of exercise (3.0-5.9 METs). As previously stated, this level of regular exercise can provide significant cardioprotective benefit including an increase in cardiorespiratory fitness, decrease anginal symptoms, improve survival, enhance patients' quality of life, and favorably modify the cardiovascular risk factor profile.[4] Future studies with a more significant sample size are needed to confirm the validity of the pilot study. However, the favorable results of this pilot study may create new exercise approaches for preventive interventions and rehabilitation. Implementation of chair based exercise programs routinely in cardiac rehabilitation programs will increase the overall level of activity of participants in the target population. Moreover, this may lead to an overall incidence of cardiovascular events and associated health expenditure costs. In 2010, the direct medical costs of acute coronary events associated with CVD were approximately $273 billion and are estimated to increase to $818 billion by the year 2030[5]. The combination of rising costs and an expected increase in the prevalence of CVD within the coming decade (9.9%) highlights the importance of the development of effective preventative measures.[6]

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