Cardiorespiratory Fitness Assessment and Treatment for Health Span and Lifespan

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Abstract:

Poor cardiorespiratory fitness (CRF) is an important risk factor for age-related diseases including cardiovascular disease, cancer, dementia and osteoporosis. When evaluated through an active metabolism test and reported as VO2Max, or the maximal oxygen uptake during intense exercise, CRF is a highly valued functional marker to assess overall wellness and disease risk in the elderly. For every 3.5ml/kg/min increase in VO2Max there is an associated 13% decrease in all-cause mortality. CRF is trainable in the elderly through endurance and high intensity interval training. A Naturopathic Doctor's holistic approach to optimal wellness includes exercise as a lifestyle intervention and CRF analysis enables their exercise protocols to be individualized for the purpose of improving VO2Max. VO2Max can be improved by up to 11% in 8 weeks with exercise consistency. CRF evaluation and treatment in the elderly population is a high priority of an evidence-informed optimal wellness program and one that Naturopathic Doctors are well trained to lead.

An aging population leads to a rise in age related conditions and the potential for an overwhelmed medical system. The four conditions of note for a lifespan/health span focused physician include cardiovascular disease, cancer, Alzheimer's disease and osteoporosis leading to fracture. A quadruple threat to those who live long enough.

As integrative clinicians, our role is to present evidence-based treatment options for those already afflicted and an equal quality of care to those working in prevention. As we organize our efforts for patients we strive to create protocols that will have the most impact for the least cost and difficulty. Fortunately, in both the treatment and prevention of the diseases of aging, lifestyle modification is impactful. The treatment of cardiorespiratory fitness (CRF) through exercise during active therapy[1] and in the prevention of cardiovascular disease,[1] cancer,[2] osteoporosis,[3] and Alzheimer's disease[4] has proven valuable clinically as a lifestyle intervention. CRF, as a diagnostic tool, is one of the most widely accepted functional markers evaluating overall wellness in the elderly and helps to predict both healthspan and lifespan.[5] Compared with hypertension, lipid abnormalities, smoking, physical inactivity, obesity, diabetes status and other traditional measures of wellness, CRF is a more powerful predictor of risk for poor health and longevity.[9]

In Naturopathic Medicine, we are well trained in lifestyle interventions for the purpose of extending healthspan and lifespan. Fitness programs are an integral part of our holistic protocols. We strive to use our individual experience, education and research to build effective protocols. By evaluating CRF through VO2Max testing and building precision, patient-centred exercise protocols to improve VO2Max we can make positive contributions toward recovery from chronic conditions,[1] actively extend lifespan[5] and reduce age-related decline thus supporting healthspan.[6]

What is the VO2Max Assessment?

VO2Max is the measurement of maximal aerobic capacity,[5] or the maximal oxygen uptake during intense exercise. It describes CRF for patients and can be tested in-office with proper equipment. The test is measured during either a treadmill or stationary bike active metabolism "ramp test" and is documented in the units mL/kg/min. Inhaled oxygen and exhaled CO2 are captured via a metabolic testing device during progressive intensity increases. Total test time is approximately 30 minutes including prep, warm up and cool down. Testing is to exhaustion, when the respiratory exchange ratio crosses 1.0, and often takes patients to 95% of maximum heart rate (220-age x 95%) or HR_{max}. This test is available in most major cities, including at some Naturopathic offices.

Through encouraging the completion of this assessment Naturopathic Doctors are able to quantify CRF for patients, properly set goals for CRF, design appropriate exercise and nutrition routines and estimate and subsequently describe the health benefits achieved through exercise.

What are the risks of the VO2Max Assessment?

Properly preparing a patient for CRF testing is extremely important. The process begins with reviewing the benefits of the test as outlined above, objective measurements obtained and their inherent value and risks associated. CRF testing can be a stress inducing experience as patients often feel a desire to perform well. The following are a list of possible contraindications to CRF testing (general contraindications to high intensity exercise)[8] to share with patients prior to their exam:

a) Physical inability to perform high intensity exercise and include disability, pain or injury
b) Fixed-rate pacemaker or ICD devices
c) Major cardiovascular event within the last three months
d) Chronic atrial fibrillation, Congestive Heart Failure secondary to valvular disease, congenital heart disease or obstructive cardiomyopathy
e) Severe arrhythmia
f) Recent bypass surgery
g) Percutaneous coronary intervention within last six months
h) Left ventricular ejection fraction <45%
i) Severe COPD
j) Unstable angina, uncontrolled hypertension

The following are a list of risks associated with CRF testing to share with patients prior to their exam:

a) The mask can cause claustrophobia during exercise and induce panic
b) There is a risk of falling on the treadmill during this exam
c) All risks and precautions taken with exercise should be reviewed such as chest pain, shortness of breath, lightheadedness, vision changes, nausea and dizziness

What can we expect clinically from VO2Max improvements?

Now that we have our baseline measurement we can help the patient to determine their specific CRF goals. VO2Max grouping categories are often divided into quintiles and progress is quantified by metabolic equivalents (MET) (with 1 MET equal to 3.5 ml/kg/min).[9] It is helpful to illustrate both what can be obtained clinically from accomplishing improvements in VO2Max and how many increases in metabolic equivalents are required to do so. Using the Reference Standards outlined by Mayo Clinic Proceedings based on the *Fitness Registry* and the *Importance of Exercise National Database* we can confidently quantify the fitness levels of patients.[9]

Showing patients which VO2Max quintile they fall within is incredibly powerful. As a marker of health VO2Max has been correlated with increased lifespan independent of age, sex, ethnicity and comorbidities[5] and goal setting should take into account that every 1 MET increase (VO2Max increase of 3.5ml/kg/min) is associated with a 13% decrease in mortality risk.[5] Improving CRF requires work and its benefits are independent of anything else occurring genetically, lifestyle, or condition related.

On average VO2Max declines 1.6% per year[6] and its reduction is associated with the development of obesity, hypertension, coronary vascular disease, stroke, loss of independence, and premature mortality.[6] Understanding where a patient is within that average decline pattern can highlight the influence a presence or lack of conditioning may be having on their wellbeing and disease risk.

Condition related tracking is important as well. The following statistics are powerful when discussing exercise benefit in chronic disease prevention:

- Those in the lowest quintile CRF measurement have a 1.92 fold increased risk of dementia compared to those in the highest quintile of CRF measurement.[4]
- High CRF is associated with decreased cancer mortality,[2] lower incidence of lung and colorectal cancer,[2] fewer toxic effects of radiotherapy, chemotherapy and endocrine therapy in cancer treatment.[7]
- In high CRF postmenopausal women there is a 70% reduction in risk of osteoporosis compared with those with low CRF.[3]
- Increases in CRF of only 1-2 METS are associated with 10-30% lower adverse cardiovascular event rates[10]
- Those in the lowest CRF quintile have a 2-5 fold increased risk in cardiovascular disease or all-cause mortality, independent of other CVD risk factors.[9]

Can we improve CRF in the elderly population?

A holistic approach to wellness includes exercise as a foundational pillar. When working with an elderly population or in a chronic disease setting, for good reason, exercise prescriptions can become more detailed, nuanced and cautious. As outlined above, CRF improvements through VO2Max increases provide significant value to health and likely have the most evidence for longevity benefit of all possible markers.

As we age the efficiency of the cardiovascular system suffers, our skeletal muscle fibre density declines and the oxidative capacity of our muscles reduces.[12] Without aerobic training VO2max will begin to decline 1% per year on average starting after the 3rd decade of life.[13] These impacts are compounded by the increasing risk of chronic disease with aging. From neuropathy and arthritis to polypharmacy and fracture risk, many factors can influence our ability to test overall fitness and implement an exercise prescription. For some cardiovascular performance can only be measured at a submaximal level by the 6 Min Walking Test.[12] This is mainly due to balance issues, frailty and severe chronic disease. During the initial

course of their condition-specific treatment it may be appropriate to implement a 12-24 week program focused on building an aerobic base, strength training, and balance work. This type of work is often facilitated by physical therapists with experience working with this population.

With consistent effort and appropriate exercise prescriptions, VO2Max is trainable, even over the age of 60.[13] After a maximal exercise test measuring VO2Max, deliberate goal setting of 1 MET per 12 week period can anchor an exercise plan and enable the clinician to easily quantify the potential benefit. Also, it is an attainable goal for most. In addition to benefits outlined above, aerobic training in the elderly improves ventilatory efficiency, a marker of lung function (ventilation exchange/volume CO2 slope or VE/VCO2 slope), the ventilatory threshold (the point at which ventilation increases in a non-linear fashion during exercise), and heart rate recovery (the decrease in heart rate at 1 minute after cessation of exercise).[12]

How can we best improve CRF in elderly?[12]

A 2017 study published in the journal *Medicine and Science in Sports and Exercise* subdivided subjects into six categories based on age, with the top age-bracket being those 70 years of age and older.[14] They then implemented an 8 week high intensity interval training program that asked participants to exercise 3 times per week, supervised, using heart rate monitoring for proper zone-specific training.[14] They followed the following routine:[14]

- 10 minute warm-up
- 4x4 minute intervals with an intensity of 90%-95% of HR_{max} with 3 minute active recovery periods at 70% of HR_{max}
- 5 minute cool down (70% of HR_{max})
- Specifics - The training could be done on a treadmill at an incline of 5% or greater or on a stationary bike with a cadence of 60-80rpm.

VO2Max was tested before the study began and after 8 weeks of training. The results showed an improvement in VO2Max of 9%-13% corresponding to an average of 4.1ml/kg/min for males and 4.2ml/kg/min for females.[14] There was no difference between age groups. Those greater than 70 years of age had similar benefit to those between the ages of 20 and 29.[14] This confirms that we can suggest with confidence to patients over the age of 70 that with only 43 minutes of training 3 times per week for 8 weeks we can see a VO2Max improvement of 4.1-4.2ml/kg/min.

In another study published in *Circulation* sedentary subjects over the age of 65 were assessed against age-matched Masters athletes.[15] This study took an approach to the untrained subjects that included building aerobic conditioning before adding high-intensity interval training.[15] They followed a protocol with the following guidelines:[15]

- Month 1 and 2 - Walked or jogged 3 times per week for 25 minutes per session at 75%-85% of HR_{max}.
- Month 3 and 4 - Add one 30 minute session of maximal steady state exercise (85%-90% of HR_{max}) per month.
- Month 5 and 6 - Add two 30 minute sessions of maximal steady state exercise (85%-90% of HR_{max}) per month.
- Month 7 - Add three sessions per month of high intensity interval training. These included 8 repetitions of 30 second intervals with a target heart rate within 5 to 10 bpm of the maximal heart rate (the duration of each interval session was gradually prolonged from 30 to 45, 60 and 75 and were followed by 90 seconds of rest, subsequently adjusted as the sessions progressed to 75, 60 and 45 seconds).
- Month 8 - A 45 minutes/session of "long slow distance" was then added at the eighth month.
- Month 12 - The duration of the "long slow distance" was prolonged to 60 minutes/session by the end of the training program.

After one year of training, in this manner sedentary seniors experienced a 19% improvement in VO2Max, an average cardiac output increase of 11%, and stroke volume increase at peak exercise of 13%.[15] Not only is this type of exercise possible for our advanced-age population, but it is highly effective for improving CRF.

After screening for balance, frailty, and chronic illness preventing maximal exercise testing we can assess VO2Max to achieve a baseline CRF measurement. With the adoption of endurance and high-intensity interval training protocols using the principles outlined above, we can expect VO2Max improvements in as quick as 8 weeks. Commonly exercise protocols clinically are set on 12 week cycles with bi-weekly to monthly check-ins for compliance and safety.

When should we begin assessing VO2Max?

Improving VO2Max reduces mortality, but also improves markers of healthspan in the elderly.[16] Through proteomic pattern analysis, researchers have been able to assess functional markers of healthspan and the impact of aerobic exercise on their regulation.[16] Beyond VO2Max aerobic exercise benefited vascular endothelial function, wound healing, regulation of apoptosis, glucose-insulin and cellular stress signaling, and inflammation/immune responses.[16] This translates to improved immune responses as well as less hypertension and insulin resistance.[16]

In the longest study of VO2Max to date individuals began testing in their mid 40s and were followed for an average of 46 years.[11] They discovered that high CRF was associated with a lower prevalence of hypertension, lower body mass index, lower alcohol consumption, higher physical activity, and increased longevity.[11] The difference in life expectancy between the highest level of CRF and lowest was 5 years.[11] This result means that for every 1 ml/kg/min improvement in VO2Max there was an associated 45 day increase in longevity.[11]

It is never too late to test CRF and implement strategies to intervene. Achieving a baseline in the mid 40's is optimal, as the potential for yearly decline at that time is high and the value for supporting and increasing if necessary is immense. With precision, safety, and guidance we can enable our elderly patients to participate in the benefits of improved CRF through endurance and high-intensity interval training.

About the Author

David Duizer, ND is the co-owner of Nobile Naturopathic clinic in Vancouver, BC. His clinical focus is chronic disease management and integrative cancer care. He completed his Bachelor of Science in Chemistry and Psychology as part of the Regular Officer Training Program (ROTP) at the Royal Military College of Canada in 2008 and graduated from the Boucher Institute of Naturopathic Medicine (BINM) as a Doctor in Naturopathic Medicine in 2014. Dr. Duizer is on the Board of Directors of the Boucher Institute of Naturopathic Medicine (now CCNM).

Competing interests: Dr. Duizer ND offers VO2Max testing at his clinic using a clinical grade metabolic analyzer.

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