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ARTICLE

Using two steps for health: Testing fitness and prescribing exercise with STEP™

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Abstract

Background: The Step Test and Exercise Prescription (STEP™) tool was designed as an office-based instrument for measuring cardiorespiratory fitness (VO₂max) and prescribing tailored exercise in the primary care setting. The fitness assessment portion of the STEP™ tool involves a standardized step unit. **Purpose:** To test validity of the prediction equation for VO₂max from the fitness assessment portion of the tool among a range of step heights, which would allow for more widespread use of the STEP™ tool. **Method:** Participants completed two versions of the fitness assessment stepping protocol during a single testing session: one using the standardized step unit, and the other using variable step heights (e.g. step stool, commercial and residential stairs). Tests were completed in random order, and participants rested between tests until blood pressure returned to baseline. **Results:** 64 adults aged 18-64 years (Mean age 41.2 ±15y) participated. Predicted VO₂max was strongly correlated between stepping conditions ($r = 0.93$, $p < 0.01$), and acceptable agreement was further demonstrated through Bland-Altman analysis. **Conclusion:** The prediction equation for VO₂max from STEP™ is valid across a range of readily available step heights, which may facilitate more widespread use of the tool for clinical or community based, individualized exercise prescription. **Health & Fitness Journal of Canada 2013;6(3):132-137.**

Keywords: Cardiorespiratory fitness assessment; Exercise prescription; Self-paced VO₂max test; Validation study; Clinical tool; Community-based health promotion

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Introduction

Physical activity is associated with reduced rates of all-cause mortality, coronary heart disease, hypertension, stroke, metabolic syndrome, type 2 diabetes, breast and colon cancers, depression and falling (Lee et al 2012). Despite this, nearly one third of the world's population over the age of fifteen years are not meeting recommended guidelines for physical activity (Hallal et al 2012). Physical inactivity attributes to 9% of premature deaths annually around the world (Lee et al 2012). The growing body of exercise prescription interventions and programs around the world, such as Exercise is Medicine®, underscore the importance of prescribing physical activity for the management and prevention of chronic diseases.

The Step Test and Exercise Prescription (STEP™) tool was developed to provide health professionals with an evidence-based intervention to determine functional aerobic fitness and then prescribe an individualized training heart rate and exercise program. Central to the exercise prescription is the prediction of VO₂max using a self-paced stepping test. The STEP™ protocol is described in full elsewhere (Stuckey et al 2012). Briefly, the fitness assessment portion involves stepping up and down a standardized set of two steps (20 cm each) twenty times at

a self-selected pace, and functional cardiorespiratory fitness (referred to throughout as $VO_2\text{max}$) is estimated using a validated prediction equation. We have previously shown no difference between the correlation of $VO_2\text{max}$ with self-paced stepping at a normal versus fast pace for both men and women (male $r = 0.91$ normal, $r = 0.90$ fast, female $r = 0.93$ normal, $r = 0.95$ fast) (Petrella et al 2001). STEP™ has been validated across a range of primary care practices and used in exercise efficacy trials to change fitness and improve cardiovascular risk factors in patients (Aizawa et al 2009a 2009b, Petrella et al 2003, Stuckey et al 2011). Research interventions employing STEP™ have demonstrated beneficial effects on aerobic fitness, exercise compliance, exercise self-efficacy, and risk factors associated with cardiovascular disease (Stuckey et al 2012). Moreover, a recent systematic review of exercise prescription interventions in the primary care setting noted that a randomized control trial using the STEP™ tool realized the largest treatment effect for improving cardiorespiratory fitness (Orrow et al 2012). These findings support the use of STEP™ for chronic disease management and prevention.

Compared with traditional laboratory assessments of $VO_2\text{max}$, the functional fitness assessment stepping protocol from STEP™ is relatively simple to conduct: it requires little time, equipment or money to administer. The intervention is valid when delivered by both trained exercise specialists as well as other health care practitioners (Petrella et al 2001). Building on the intervention's simple design and effective implementation to-date, there has been interest in more widespread use of this tool across practice settings. The purpose of this

study was to test validity of the prediction equation for $VO_2\text{max}$ used in the STEP™ tool among variable (i.e., unstandardized) stepping heights. We hypothesized that predicted $VO_2\text{max}$ in the two stepping conditions (i.e., unstandardized versus standardized) would be highly correlated, thus allowing for acceptable use of the STEP™ tool with any set of readily available stairs.

Methods

Participants

To test the relationship between stepping scenarios in the present study, a sample of 64 participants was recruited (2 constructs, 3 analyses, minimum of 10 participants per construct). A convenience sample of community-dwelling adults (27 female) aged 18-64 years volunteered to participate in the study. Exclusion criteria for the use of STEP™ in clinical practice were followed, which included: resting blood pressure $\geq 180/110$ mmHg; history of myocardial infarction, angioplasty, coronary artery bypass or cerebrovascular ischemia; symptomatic congestive heart failure; atrial flutter; unstable angina; implanted pacemaker; second or third degree heart block; unstable pulmonary disease; use of medications known to affect heart rate (e.g. β -blockers); and any orthopaedic condition restricting ability to ascend and descend two stairs. All participants provided informed written consent as approved by the Western University Health Sciences Research Ethics Board (Protocol# 102676).

Design

Participants attended a single testing session, during which they completed two versions of the functional aerobic capacity stepping test in random order.

Exercise Testing and Prescription with the STEP™

Participants rested between tests to minimize effects of fatigue. Seated blood pressure was measured with a BpTru® automatic cuff (Coquitlam, British Columbia, Canada) before each test to ensure that recovery to resting state was achieved before beginning the subsequent test.

The stepping protocol required participants to step up and down a set of two steps twenty times at a self-selected pace. Participants completed one or two practice stepping cycles to become familiar with the pattern. One testing scenario utilized the standardized step unit from the STEP™ tool, which includes a set of two steps, each 20 cm high (Figure 1a). The other testing scenario utilized various readily available steps, including commercial and residential stairs as well as common two-step household step stools (Figure 1b). Time to complete the test, post-test heart rate, body weight, age and sex were entered into Equation 1 to predict functional $VO_2\max$.

Equation 1: STEP™ Prediction Equation for $VO_2\max$:

$$VO_2\max = 3.9 + (1511/\text{time}) * ((\text{weight}/\text{HR}) * 0.124) - (\text{age} * 0.032) - (\text{sex} * 0.633),$$

where $VO_2\max$ is predicted maximal oxygen uptake (L/min), time is the time to complete the stepping test (s); weight is body mass (kg); HR is bpm) palpated immediately upon completion of the stepping test in a 6-second count; age is the patient's age (y); and sex is 1 for males and 2 for females. Relative $VO_2\max$ (mL/kg/min) is used for fitness classification during the exercise prescription portion of the STEP™ tool.

Statistical Analysis

Analyses were conducted in IBM® SPSS® Statistics Version 20 (Chicago, Illinois, USA). Unpaired t-tests were conducted to compare mean measures from the sample with average measures from a representative sample of Canadian adults from the Canadian Health Measures Survey (Shields et al 2010). The relationships between predicted $VO_2\max$ measures from each test scenario were

Figure 1: Example of Stepping Conditions for Step Test.



A: Standardized step unit from the STEP™ tool

B: Example of non-standardized stepping conditions (2 steps, 17-24 cm each)

B₁: Commercial stairwell

B₂: Common household 2-step stool

examined using Pearson's product-moment correlation coefficients. Paired t-tests were conducted to assess systematic

difference between stepping scenarios (i.e. standardized versus variable step heights). A Bland-Altman plot was generated to assess agreement between tests. Data are presented as mean ± standard deviation.

Results

No adverse events were observed. Table 1 describes the sample population. The sample was similar to a typical age- and sex-matched Canadian adult (Shields et al 2010) for weight, height, body mass index and cardiorespiratory fitness (p = 0.709 female; p = 0.931 male).

Table 1: Sample Characteristics. Data presented as Mean(±SD).

Variable	Sample (n=64)	Female (n=27)	Male (n=37)
Age (yr)	41 (14)	42 (15)	40 (14)
Weight (kg)	75.9 (15.2)	65.5 (9.7)	83.5 (13.9)
Height (cm)	171.8 (9.6)	164.0 (6.7)	177.5 (6.9)
BMI (kg/m ²)	25.6 (3.7)	24.5 (3.6)	26.4 (3.5)
Heart rate, rest (bpm)	68 (10)	70 (11)	67 (10)
Heart rate, post-test (bpm)	124 (19)	124 (16)	124 (21)
VO ₂ max (mL/kg/min)	45.9 (9.7)	43.4 (10.1)	47.7 (9.1)

Note: BMI, body mass index; VO₂max, predicted functional aerobic capacity from standardized stepping scenario; Heart rate post test, post test heart rate from standardized stepping scenario.

Readily available sets of two steps ranged between 17-24 cm each, with mean first step height 18.6 ± 1.3 cm, and mean second step height 19.0 ± 1.0 cm. Predicted VO₂max using the equation from the STEP™ tool was strongly correlated between stepping conditions,

and remained strong across sex and age (Table 2).

The Bland-Altman plot is presented in Figure 2, and further demonstrates acceptable agreement between tests. Although not clinically meaningful, systematic bias was observed between stepping scenarios, indicating moderately greater values in the variable versus standardized stepping scenario (mean difference = 1.8 mL/kg/min; 95% CI = 0.9-2.7 mL/kg/min, p = 0.000).

Table 2: Relationship between Testing Scenarios.

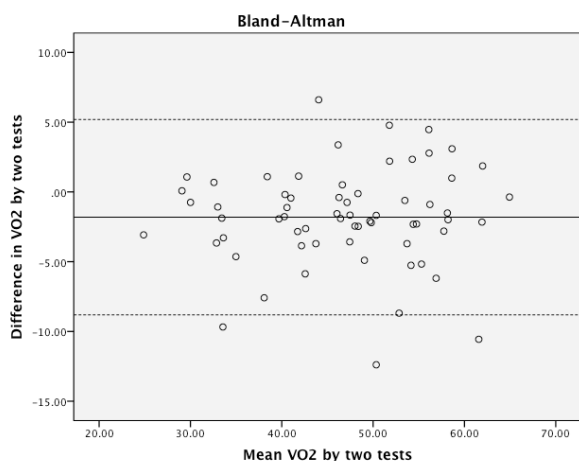
Group	Sample (n)	Pearson's Coefficient of Correlation (r)
Whole Sample		
18-64 yr	64	0.934**
Sex		
Male	37	0.920**
Female	27	0.934**
Age		
18-24 yr	8	0.805*
24-34 yr	15	0.860**
35-44 yr	13	0.842**
45-54 yr	12	0.830**
55-64 yr	16	0.922**

Note: *p<0.05; **p<0.01

Discussion

The current study established the validity of the prediction equation for VO₂max from the STEP™ tool using any set of available steps with a rise of 17-24 cm each. Utilizing existing stepping resources (e.g., stairwells) may extend access for clinicians and patients to determine predicted VO₂max and deliver the STEP™ intervention. This allows for widespread use of a consistent protocol for fitness assessment and exercise prescription in various settings including those with limited resources.

Figure 2: Bland-Altman Scatterplot.



Note: VO₂ is functional VO₂max predicted using STEP™ equation in each testing condition. Solid line represents mean, and broken lines represent the limits of agreement.

STEP™ was designed as a user-friendly tool, and is valid when delivered by both trained and untrained individuals (Petrella et al 2001). Therefore, patients could be educated for self-administration of STEP™ to augment self-management and ongoing care. Moreover, widespread access to stairs (instead of a standardized stepping unit unique to the STEP™ tool) could increase regular use of the STEP™ intervention tool for ongoing assessment of functional cardiorespiratory fitness. The validity of STEP™ across step heights may help to contribute to the translation of this evidence-based intervention from a primary care-based toward community-based or self-management paradigms. Moreover, removing the barrier of standardized stepping equipment may help to increase utilization of evidence-based fitness assessments and exercise prescription by various health care professionals.

Study participants were comparable to the average Canadian adult for multiple

health and fitness markers. The average age of participants in this study was 41.2 ± 15 yr. Sample measures were compared with average measures for a 45 yr-old Canadian adult (Shields et al 2010), and demonstrated that the study sample was, on average, similar to sex-matched typical Canadian adults for both anthropometric and cardiorespiratory fitness. This information could further support the use of STEP™ among typical populations (i.e. patients for whom exercise is not contraindicated, or who are not on medication affecting heart rate response to physical exertion). Therefore, clinicians seeking a user-friendly fitness assessment and tailored exercise prescription tool may wish to consider the STEP™ intervention for use in practice.

Conclusion

The evidence base demonstrates substantial interest in healthy living programs and exercise prescription interventions around the world. These programs are designed and implemented in an effort to positively impact physical activity behaviours and contribute to chronic disease management and prevention. It is anticipated that such interventions which leverage the health benefits of physical activity will become an integral component of prevention and treatment in health care systems globally (Exercise is Medicine 2013). Prescribing exercise for health management is of interest to a broad array of health practitioners. The use of STEP™ in primary care has been shown to elicit aerobic fitness treatment effects as well as improve exercise compliance, exercise self-efficacy, and cardiovascular disease risk factors (Orrow et al 2012, Stuckey et al 2012). Results from this study showed that the STEP™ prediction equation for

VO₂max is valid when the test is performed on non-standardized step heights (2 steps, 17-24 cm, each). This removes the barrier of access to a standardized step unit, thus allowing for more widespread use of the tool in health promotion and chronic disease management.

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Authors' Qualifications

The authors' qualifications are as follows: Emily Knight, PhD(c), CEP; Melanie I Stuckey, PhD, CEP; Robert J Petrella, MD, PhD

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