How to Measure Exercise Intensity of Gardening Tasks as a Physical Activity for Older Adults Using Metabolic Equivalents

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Abstract

Regular physical activity (PA) can provide many health benefits for older adults. Gardening is often recommended as a form of PA although there is lack of research data to support this recommendation. By determining the exercise intensity of various gardening tasks, physical activity programs using gardening can be developed for improvement and maintenance of physical health. Therefore, the purpose of this paper is to show a useful method for measuring exercise intensity of gardening tasks in older adults.

INTRODUCTION

Regular physical activity (PA) contributes to healthy aging (ACSM, 1998; Pate et al., 1995). Health benefits of PA include reduction in the risk of coronary heart disease, hypertension, type 2 diabetes, osteoporosis, ischemic stroke, selected cancers, anxiety and depression (ACSM, 1993, 2004; Helmrich et al., 1991; King et al., 1989; Lee et al., 1991; Leon et al., 1987; Powell et al., 1987; Taylor et al., 1985; Wendel-Vos et al., 2004). Physical activity also provides improvement in fitness level, muscle strength, aerobic capacity, balance and bone mineral density (ACSM, 1998; DiPietro, 2001; USDHHS, 1996). Thus, the American College of Sports Medicine (ACSM) and the Centers for Disease Control and Prevention (CDC) recommend PA for health, which is at least 30 minutes of moderate intensity PA on most days of the week (Pate et al., 1995).

Gardening is a prevalent type of PA among older adults (Armstrong, 2000; DiPietro, 2001; Walsh et al., 2001). In the US, 69% of men and 75% of women aged 65 years or older reported participation in gardening as a form of leisure-time PA (Yusuf et al., 1996). Gunn et al. (2005) and Withers et al. (2006) reported that lawn mowing is a moderate intensity PA in females and males aged 55-65 years old. However, we do not know the exercise intensity of various gardening tasks in older adults. For a well-designed exercise program through horticulture for older adults, the exercise intensities for each gardening task must be known. Therefore, the purpose of this paper is to explain a useful method for measuring exercise intensity of gardening tasks in older adults.

MATERIALS AND METHODS

Concept of METs

Metabolic equivalent is a term commonly used to measure metabolic rate. MET is a unit of metabolic equivalent and is the ratio of a person's metabolic rate at rest to that while performing a task. One MET is the amount of O_2 consumed when a body is at rest (about 250 ml·min^{-1} for an average man and 200 ml·min.$^{-1}$ for an average woman). Two METs equals two times the O_2 consumed at rest. For more accurate classification, variations such as body size should be considered. METs are expressed in terms of oxygen consumption per unit body mass: 1 MET = 3.5 ml·kg^{-1}·min.$^{-1}$. Moderate PA is activity performed at an intensity of 3-6 METs (Pate et al., 1995). An example of a moderate intensity PA is brisk walking at 3-4 mph for most healthy adults. PA measured below 3 METs is considered low intensity and above 6 METs is considered high intensity.

Measuring METs

To determine the METs values of a physical activity, the amount of oxygen used by the body during the activity is measured (VO_2). In order to measure oxygen consumption of a person during PA, two different methods, direct calorimetry and indirect calorimetry can be used. Indirect calorimetry is commonly used because it is simpler and less expensive than direct calorimetry (McArdle et al., 2007). Research comparing the two methods gives certain evidence for the validity of the indirect method (McArdle et al., 2007). The indirect calorimety method described in this paper is a graded exercise test (GXT).

Although it is possible to measure O_2 consumption while gardening, the equipment to do so is costly and may be cumbersome to the gardeners. Thus, a multi-stepped approach was used.

Step 1: Heart Rate (HR) Measurement of Gardening Tasks. To measure HR while gardening, subjects wear a HR monitor under their breast on the skin and a wireless HR storage device on their wrist. The subject's HR is continuously measured and recorded via radiotelemetry (Polar S 610i, Finland) during gardening. The subjects perform each gardening task for 10 minutes followed by a 5-minute resting time while sitting on a chair. In preliminary work, this 10-minute gardening and 5-minute resting schedule was determined to be sufficient to reach a stable maximum HR during the gardening task. For data analysis, the initial minute of HR measurement during each gardening task and during the rest period were not used in order to reduce noise between the end and beginning of a task. After finishing the HR measurement, the subject's HR data can be downloaded by a software program (Polar precision performance SW version 4.01.029, Polar Electro Oy, 2004).

Step 2: Graded Exercise Test (GXT). Using the gardening HR measurements, oxygen uptake (VO_2) can be measured by using a GXT in a lab. Weight, height, and age of each subject are input to the computer system connected to the GXT. The subjects wore a mask over their mouth with their nose plugged to insure they breath through their mouth and a HR monitor (Polar S 610i, Finland) is worn under their breast while they walk on the treadmill (Precor, 964i, USA, 1997). The speed and elevation of the treadmill increases until the subjects reach their maximum HR measured during the gardening tasks (total time is about 15 min.). The initial workload is 1.7 mph at 3% grade. Every 5 min. the speed and grade of the treadmill is increased depending on the HR values monitored. Expired gases collected in the mask are directed to a ParvoMedics metabolic cart (Provo, UT) through a Hans-Rudolph (Kansas City, MO) non-rebreathing mouthpiece. The flow meter and gas analyzers are calibrated prior to testing. From the GXT, a metabolic report of VO_2, HR, and energy expenditure values is obtained.

Step 3: Calculation of METs. The VO_2 and MET values for each gardening task can then be derived from the laboratory GXT results. VO_2 values are continually being recorded as the subjects HR is increasing so the first step in calculating METs is to find the VO_2 value at the average HR for each garden task. If there is not an exact HR/VO_2 match it can be calculated by using a ratio of the closest values. The METs value is calculated using 1 METs = 3.5 ml/kg/min.

For example, suppose a male, aged 67 years old, had a maximum average HR of 74 bpm for digging. From the results of the GXT, VO_2 at a HR of 74 bpm was 11.5 ml/kg/min.

$$\frac{1 \text{ MET}}{3.5 \text{ ml/kg/min.}} = \frac{(x) \text{ METs}}{11.5 \text{ ml/kg/min.}} \qquad x = 3.3 \text{ METs}$$

Thus, digging as a form of physical activity for this subject was of moderate intensity (MET>3.0).

Additionally, the energy expenditure (EE) of each gardening task (kj/kg/h = kal/m·(4.186·60)/kg of body weight) and Percent Gardening HR_{max} (% Gardeing HR_{max} = (Gardening HR_{avg} - Resting HR)/Gardening HR_{max} - Resting HR) • 100) can be calculated. HR_{max} can be a useful tool in determining exercise intensities.

RESULTS AND DISCUSSION

In order to use gardening or horticultural tasks as a way to experience the many health benefits associated with moderate PA, it is important to know the exercise intensity of each gardening task. The method presented in this paper can be used to determine the exercise intensity of a number of gardening tasks. Knowing the exercise intensity of a multitude of gardening tasks can then be used to develop PA interventions with gardening for improvement or maintenance of physical health, and gardening tasks can be applied to the level of various physical abilities.

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