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Candice Shoemaker (cshoemak)
HFRR
2021 Throckmorton
Manhattan, KS 66506
cshoemak@ksu.edu

ILL Office Hours:
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A PRELIMINARY INVESTIGATION ON EXERCISE INTENSITIES OF GARDENING TASKS IN OLDER ADULTS[1,2]

SIN-AE PARK

Department of Horticulture, Forestry, & Recreation Resources

CANDICE A. SHOEMAKER

Department of Horticulture, Forestry, & Recreation Resources
Community Health Institute, Center on Aging
Kansas State University

MARK D. HAUB

Department of Human Nutrition and Center on Aging
Kansas State University

Summary.—Heart rate (HR) was measured continuously while men ($n=6$) and women ($n=2$) ages 71 to 85 years ($M=77.4$, $SD=4.1$) completed nine gardening tasks. HR and VO_2 from a submaximal graded exercise test were used to estimate gardening VO_2, energy expenditure, % HRmax, and metabolic equivalents (METs). Tasks were low to moderate intensity physical activity (1.6–3.6 METs); those which worked the upper and lower body were moderate intensity physical activity while those that worked primarily the upper body were low intensity physical activity.

Regular physical activity is a crucial factor for healthy aging (Pate, Pratt, Blair, Haskell, Macera, Bouchard, *et al.*, 1995; American College of Sports Medicine, 1998) because it reduces the risk of chronic diseases and cancer and improves aerobic capacity, muscle strength, balance, and bone mineral density (Powell, Thompson, Casperson, & Ford, 1987; Lee, Paffenbarger, & Hsieh, 1991; American College of Sports Medicine, 1993, 1998, 2004; U.S. Department of Health and Human Services, 1996; DiPietro, 2001; Hui & Rubenstein, 2006). Guidelines recommend that older adults should engage weekly in 150 minutes of moderate intensity or 75 minutes of vigorous intensity aerobic physical activity (U.S. Department of Health and Human Services, 2008, p. 30), in at least 10-minute bouts, as well as muscle-strengthening activities of moderate or high intensity involving major muscle groups on two or more days a week.

Gardening or yard work is a prevalent leisure-time physical activity in older adults (Yusuf, Croft, Giles, Anda, Casper, Caspersen, *et al.*, 1996) and is often an example of aerobic and muscle-strengthening activities (U.S. De-

[1]Address correspondence to Candice Shoemaker, Ph.D., Horticulture, Forestry, & Recreation Resources, 2021 Throckmorton Plant Sciences Center, Kansas State University, Manhattan, KS, 66506 or e-mail (cshoemak@ksu.edu).
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partment of Health and Human Services, 2008, p. 31). Ainsworth, Haskell, Whitt, Irwin, Swartz, Strath, *et al.* (2000) calculated 31 gardening tasks requiring moderately intense physical activity (3 to 6 metabolic equivalents: METs) in adults (age range 25 to 65 years) based on published and unpublished data on energy costs of more than 500 physical activities. Ainsworth, *et al.*'s (2000) classification does not include some common gardening tasks and is for adults up to 65 years old. Some of the MET values published in the compendium (Ainsworth, *et al.*, 2000) have been modified for older persons (Stewart, Mills, King, Haskell, Gillis, & Ritter, 2001). The METs for many household, lawn and garden, walking, and other activities frequently performed by older adults were not based on data but rather estimated from activities with similar movement patterns (Gunn, *et al.*, 2005; Withers, *et al.*, 2006). The purpose of this study was to assess the exercise intensities of nine common gardening tasks in older adults.

Method

Participants

The targeted participants for this project were community-dwelling older adults, 60 years of age or above. Participants were asked to engage in a research study on leisure-time physical activity and health in return for a free health assessment. Participants were recruited by phone using the Garden volunteer list of the Kansas State University Gardens and in person at other locations, such as a senior center and coffee shops. A convenience sample of approximately 40 adults was recruited.

Criteria for participation included no uncontrolled chronic diseases, no heart and lung diseases, no pacemaker, ability to kneel, nonsmoking, and having a physician's consent. Six men (75, 75, 77, 79, 80, and 85 years old) and two women (71 and 77 years old) were selected. The sample's mean age was 77.4 yr. (SD=4.1), mean height 169 cm (SD=7.6), mean weight 87.9 kg (SD=13.3), mean BMI 29.2 (SD=5.4), resting heart rate (HR) 71.0 (SD=9.0), and age-predicted maximum heart rate (HRmax) 142.6 beats per minute (SD=4.1). All were Euro-American and had some chronic disease, but none that limited activity (2 high blood pressure, 2 diabetes, 2 cancer, 3 arthritis, 2 asthma, 1 blood clots, and 1 memory loss). Education was high, with three college graduates and five with graduate degrees. Seven were married, one divorced, and six were retired.

Participants were asked to not consume caffeine and to eat breakfast at least three hours before arrival, to reduce the thermal effect of food. Participants were also asked to wear comfortable clothes and shoes for gardening. Written informed consent was obtained at an orientation that explained the experimental procedures, possible risks (physical fatigue), and how their par-

ticipation would contribute. All volunteers provided written consent from their primary health care provider prior to beginning the investigation. The Kansas State University Committee for Research Involving Human Subjects (IRB) approved this study.

Measures

Confidence to garden was operationalized with a 5-item scale, which was developed in accordance with the self-efficacy theory (Bandura, 1997). Participants were asked to rate their confidence to garden for 30 min. on 1, 2, 3, 4, 5, or more days in a week on a 0: Not at all confident to 10: Completely confident scale for the next four weeks.

Types and amount of moderate physical activity.—Participants were given a definition of moderate intensity physical activity and then asked which moderate activities they did for at least 15 min. at a time, how many days per week they did these activities, and the total minutes per day. The definition of moderate intensity physical activity was "moderate physical activity or exercise includes activities such as gardening, yard work, brisk walking, swimming, cycling, and dancing. Moderate activities cause small increases in breathing or heart rate. You should be able to carry on a conversation when doing moderate activities" (Marcus & Forsyth, 2003, pp. 4-5). The questionnaire also included the Short Form–36 Health Survey (SF–36), which assesses eight health concepts: physical functioning, usual physical role activities, bodily pain, general health, vitality, social functioning, usual emotional role activities, and mental health (Ware, Snow, Kosinski, & Gandek, 1993). The SF–36 was scored using SF Health Outcomes Scoring Software (QualityMetric, Lincoln, Rhode Island); mean scores on all measures were above standard for this age group: 48.7, 49.2, 51.2, 51.7, 57.9, 51.7, 50.1, and 54.7, respectively, for the health concepts as listed above.

Procedure

Sixteen 8' × 4' garden plots were created for this study. Located next to the garden plots were four compost bins (1.2 m × 1.1 m × 0.9 m for one bin) with compost and a grassy area with weeds. Nine gardening tasks were performed by the participants in the morning (Table 1).

The nine gardening tasks included a mix of tasks performed in the ground and at a work bench with various motions such as kneeling, squatting, bending or standing. The participants did each task for 10 min. followed by a 5-min. rest while sitting on a chair. In preliminary work, a 10-min. task was determined to be sufficient for reaching maximum heart rate (HR) for older adults, and a 5-min. rest time was sufficient to return HR to resting rate. During the 5-min. rest the researcher demonstrated each gardening task. The participants were closely monitored while performing each gardening task.

TABLE 1
DESCRIPTIONS OF GARDENING TASKS PERFORMED BY PARTICIPANTS

Task*	Description
Hand weeding	With a hand fork (0.1 kg), squatting or sitting in a grassy area with weeds, some moving as they completed an area
Raking	With a rake (1.0 kg), raking up small stones, bark, and weeds in an 8'×4' garden plot
Digging	With a shovel (1.7 kg), digging a raked 8'×4' garden plot (did not make a big hole)
Turning compost	With pitch fork (1.5 kg), turning compost in previously prepared compost bins (1.2 m×1.1 m×0.9 m)
Transplanting plants	With hand trowel (0.2 kg), transplanting tomato plants (average 15 plants per each person) in an 8'×4' garden plot
Mulching	With straw, applied mulch around the transplanted plants in an 8'×4' garden plot
Mixing soil	With a bucket, mixing soil in the bucket with their hands, adding water from watering can and mixing with soil
Filling containers with soil	With 4 cm pots, filling pots with soil by hands or small container (average 65 pots per each person)
Transplanting seedlings	With tomato seedlings, transplanting seedlings from the tray by making a hole with finger in the center of the pots (average 25 transplants per each person)

*Participants were standing for all gardening tasks except hand weeding.

Each set of tasks was replicated twice on different days in the same week. The average weather conditions were warm ($M=19.7^{\circ}$ C, $SD=2.1$) and relative humidity was moderate ($M=66.9\%$, $SD=2.2$). In Week 1, the testing session included hand weeding, raking, digging, and turning compost. The second week tasks were transplanting plants, mulching, mixing soil, filling containers with soil, and transplanting seedlings. The order of the gardening tasks was the same for all participants and in the replication. The order of gardening tasks was based on preliminary work and was to reflect regular home gardening.

The participants' HRs were continuously measured and recorded via radiotelemetry (Polar S 610i, Finland) during tasks. For data analysis, the initial minute of HR measured during each gardening task and during the rest period was not used, to reduce noise between the end and beginning of a task. The two replications of each gardening task were used to calculate HR.

Based on the gardening HR measurements, oxygen uptake (VO_2) was measured by using a submaximal graded exercise test on a motor-driven treadmill (Precor 964i, USA, 1997) with the test terminating after a minute of exercise at the peak HR attained during gardening. The participants' expired gases were directed to a metabolic cart (ParvoMedics, Provo, Utah) through a nonrebreathing mouthpiece (Hans-Rudolph, Kansas City, Missouri). The flow meter and gas analyzers were calibrated according to the manufacturer's specifications prior to all testing. A radiotelemetry HR monitor

(Polar S 610i, Finland) was worn around their chest while they walked on the treadmill. HR and VO_2 have a linear relationship at submaximal exercise intensities, so by measuring HR and VO_2 values over several intensities, the gardening VO_2 values could be calculated (Bot & Hollander, 2000; McArdle, Katch, & Katch, 2007). More direct measures were not available or deemed inappropriate for this study.

The VO_2 and MET values for each gardening task were interpolated from the laboratory VO_2 treadmill test, then the energy expenditure of each gardening task was calculated (kj/kg/hr. = Kcal/m (4.186·60)/kg of body weight). Percent of maximum HR (HRmax) was also calculated (% HRmax = (Average gardening HR – Average resting HR)/(HRmax – Average resting HR) · 100). Height and weight were measured with a wall stadiometer (Seca 216 Stadiometers, USA) and electronic balance (Ohaus, ES200L, USA). Body Mass Index (mass(kg)/height(m)^2) and age-predicted HRmax (220 – age) were calculated.

Data Analysis

Duncan's multiple range test and *t* test were used to compare means by the Statistical Analysis System (SAS Version 9 for Windows, SAS Institute Inc., Cary, North Carolina).

Results

The average number of days per week participants reported participating in at least 15 min. of moderate intensity physical activity in a typical week was four. Average time spent doing moderate intensity physical activity per day was 2 hr. Moderate intensity physical activities reported most frequently were gardening, yard work, mowing the lawn, walking, using exercise machines, and swimming. When asked about their confidence regarding the gardening activity, 75% reported they were completely sure they could garden for 30 min. or more on five or more days in a week; 12.5% were certain they could garden 30 min. or more on two days in a week; 12.5% remaining represents missing data.

Gardening tasks were low to moderate intensity physical activity in healthy older adults (Table 2). Tasks were found to require moderate or low intensity of activity.

Discussion

Gardening may provide the same health benefits received from nongardening forms of physical activity (Reynolds, 2002). Garden tasks that used both the upper and lower body such as digging, turning compost, raking, transplanting plants, and mulching were shown to require moderate intensity activity, while others using only the upper body required low intensity physical activity. This could be valuable information for recommending tasks for therapeutic purposes.

TABLE 2
AVERAGE METABOLIC MEASUREMENTS FROM TWO REPLICATIONS FOR NINE DIFFERENT GARDENING TASKS AS PERFORMED BY OLDER ADULTS

Task	HR (bpm)		HRmax (%)		VO_2		EE		METs	
	M	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*
Digging	100^{a}	16	42.2^{a}	19	12.6^{a}	3.0	15.7^{a}	3.8	3.6^{a}	0.8
Turning compost	99^{a}	15	40.9^{a}	17	12.1^{a}	2.7	15.2^{a}	3.6	3.5^{a}	0.8
Raking	93^{ab}	15	31.6^{ab}	17	9.4^{ab}	3.5	13.3^{ab}	3.1	2.7^{ab}	1.0
Transplanting plants	88^{ab}	13	24.5^{abc}	12	8.9^{ab}	2.0	11.1^{abc}	2.4	2.6^{ab}	0.6
Mulching	88^{ab}	14	24.6^{abc}	13	8.8^{ab}	1.6	10.3^{bc}	2.6	2.5^{ab}	0.5
Hand weeding	85^{ab}	14	24.2^{abc}	13	7.9^{b}	3.0	9.5^{bcd}	4.0	2.3^{b}	0.9
Mixing soil	86^{ab}	11	20.9^{abc}	8	7.6^{b}	2.2	9.8^{bcd}	2.2	2.2^{b}	0.6
Filling containers with soil	83^{ab}	13	17.9^{bc}	8	7.1^{bc}	1.8	8.8^{bcd}	2.2	2.0^{bc}	0.5
Transplanting seedlings	81^{ab}	11	14.6^{bc}	8	5.7^{bc}	1.9	7.4^{cd}	2.2	1.6^{bc}	0.5
Resting, 5 min.	71^{b}	9	0.0	0	3.4^{c}	0.6	5.0^{d}	0.7	0.9^{c}	0.2

Note.—HR = heart rate; VO_2 is $ml \cdot kg^{-1} \cdot min.^{-1}$; EE = Energy expenditure, $KJ \cdot kg^{-1} \cdot hr.^{-1}$; METs = Metabolic equivalents. ^{abcd}Means sharing a common letter are not significantly different by Duncan's multiple range test at $p = .05$.

A limitation was the small sample. Future research could measure exercise intensities of gardening tasks in a practical garden setting, in different seasons and regions of the country for use in a year-round physical activity intervention.

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