Gardening Intervention for Physical and Psychological Health Benefits in Elderly Women at Community Centers

Sin-Ae Park[1], A-Young Lee[2], Ki-Cheol Son[1,2], Wang-Lok Lee[3,5], and Dae-Sik Kim[4,5,6]

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Summary. **The present study aimed to assess the physical and psychological health benefits of a 15-session gardening intervention in elderly women and to investigate satisfaction of the gardening intervention. Fifty elderly women (age >70 years) at two senior community centers located in Seoul, South Korea, were selected to participate in this study. Twenty-four elderly women at senior community center "A" participated in a twice-weekly gardening intervention (≈50 minutes per session) during the period Sept. to Nov. 2015; 26 elderly women at senior community center "B" comprised a control group. At the completion of the 15-session gardening intervention, physical health parameters such as body composition, physical functional ability, and hand function ability were assessed in both groups. Additionally, psychological health conditions, such as cognitive ability, depression, and sociality, were assessed. The elderly women also answered a questionnaire to assess the amount of physical activity experienced during daily life. Elderly women in the gardening intervention group exhibited significantly improved muscle mass, aerobic endurance, hand dexterity, cognitive ability, and decreased waist circumference ($P < 0.05$). In contrast, significantly decreased muscle mass and agility and increased depression were observed in the control group ($P < 0.05$). Moreover, elderly women in the gardening intervention group reported a significantly higher amount of daily physical activity compared with those in the control group ($P < 0.05$). Additionally, 95.8% of elderly women in the gardening intervention group reported of being very satisfied with the gardening intervention. In conclusion, the gardening intervention maintained and improved the physical and psychological health of elderly women at a senior community center, whereas elderly women in the control group experienced age-related reduced physical and psychological health conditions. More studies are needed to evaluate the effects of a gardening intervention in a larger population of elderly women; in addition, a longer intervention period would provide a better measure of health in elderly women.**

Aging is characterized by a decrease in complex functional abilities related to the physical, psychological, cognitive, and social aspects of life (Brandtstädter and Greve, 1994). In addition, muscle mass, muscle strength, and physical fitness level decline with advancing age (Rikli and Jones, 1999a). Late-life depression is a crucial public health problem because it can increase the risks of morbidity and suicide and decrease an individual's physical, cognitive, and social functional abilities (Fiske et al., 2009). Furthermore, elderly people experience age-related losses of cognitive abilities, such as memory, attention, and learning (Driscoll et al., 2003). The effects of social changes may also affect an elderly individual's social participation ability or social relationships (Brandtstädter and Greve, 1994).

Meanwhile, regular physical activity confers health benefits, including the prevention or improvement of chronic health problems related to the physical, psychological, cognitive, and social aspects of life (DiPietro, 2001; Weir, 2010). Despite the importance of regular physical activity, however, most elderly individuals spend 80% of their daily time in sedentary activities (de Rezende et al., 2014).

Gardening is a popular leisure time physical activity among elderly individuals (Ashe et al., 2009; Rowinski et al., 2015), especially in the United States, Canada, and some European countries (Ashe et al., 2009; Rowinski et al., 2015). In addition, urban agriculture is also increasing in popularity (Mougeot, 2006) and has been implemented in the United States, Canada, European countries, and Asian countries (Lovell, 2010; McClintock, 2010; van Leeuwen et al., 2010). Given the popularity of gardening, the present study aimed to assess the physical and psychological health benefits of gardening as a physical activity intervention for maintaining or improving the health conditions of elderly women at a community senior center and to investigate satisfaction of the gardening intervention.

Materials and methods

Recruitment and experimental design. To recruit elderly women at senior community centers to this study, a flyer containing descriptions of the study purpose, gardening intervention, and health measurements was distributed at ≈40 senior community centers in Seoul, South Korea. Two senior community centers located in the same community, Gangnam-gu, were selected for the study and most of the elderly women (≈98% of the elderly women in each center; 24/25 and 26/27, respectively) decided to participate in this study. Therefore, a total of

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[1]Department of Environmental Health Science, Konkuk University, Seoul 05029, South Korea

[2]Graduate School of Environmental Science, Konkuk University, Seoul 05029, South Korea

[3]Department of Sport Science, Chungnam National University, Daejeon 34134, South Korea

[4]Department of Agricultural and Rural Engineering, Chungnam National University, Daejeon 34134, South Korea

[5]These authors contributed equally to this work

[6]Corresponding author. E-mail: drkds19@cnu.ac.kr.

Units

To convert U.S. to SI, multiply by	U.S. unit	SI unit	To convert SI to U.S., multiply by
0.3048	ft	m	3.2808
0.0929	ft^2	m^2	10.7639
2.54	inch(es)	cm	0.3937
0.4536	lb	kg	2.2046
4.8824	lb/ft^2	$kg \cdot m^{-2}$	0.2048
28.3495	oz	g	0.0353
(°F – 32) ÷ 1.8	°F	°C	(°C × 1.8) + 32

50 Korean elderly women at these centers submitted consent forms to participate.

This study featured a quasi-experimental design with a nonequivalent control group. The 24 elderly women at senior community center "A" participated in the 15-session gardening intervention. An additional 26 elderly women at senior community center "B" did not participate in any gardening intervention during the study period and were considered the control group. Both groups were subjected to health assessments before and after the gardening intervention. Each participant received an incentive (equivalent to $20) at the completion of the study. This study was approved by the institutional review board (7001355–201507-HR-067).

Gardening activity intervention. The 15-session gardening intervention was conducted during the period from Sept. to Nov. 2015 for fall gardening. This intervention was managed primarily by a horticultural therapist with three assistant horticultural therapists, all of whom were certified by the Korean Horticultural Therapy and Wellbeing Association. The intervention involved twice-weekly sessions for an average duration of 50 min per session. A garden plot (8.0 × 5.1 m) had been installed in the front yard of senior community center "A" for this project, and the intervention comprised making plant beds via tasks such as garden design and planning, making furrows in the plots, making name tags for each garden plot, planting transplants, garden maintenance (e.g., fertilizing, weeding, watering, harvesting), and other activities such as flower arrangement and garden parties involving harvested products (Table 1). The participants were allowed to take short breaks during the gardening intervention as needed to address their physical burdens.

The Centers for Disease Control and Prevention and the American College of Sports Medicine recommend that adults participate in at least 150 min of moderate-intensity physical activity per week to improve or maintain health (Nelson et al., 2007; Pate et al., 1995). Moreover, participation in low-intensity physical activity has been suggested to improve the daily living abilities of elderly individuals by increasing balance, flexibility, and muscle strength (Brown et al., 2000; Buman et al., 2010). Therefore, the gardening activities that comprised this intervention were selected to represent low- to moderate-intensity physical activities that would yield similar health improvements or maintenance. Previously reported metabolic cost data were used to select these gardening activities (Park et al., 2011, 2012, 2014a). Specifically, studies conducted by Park et al. (2011, 2012, 2014a) provided exercise intensity data of various gardening activities performed by older adults.

The following seasonal plants were grown in the garden plot or used for indoor horticultural activities as part of the gardening intervention: chives (*Allium ascalonicum*), chinese cabbage (*Brassica rapa* var. *pekinensis*), radish (*Raphanus sativus*), lettuce (*Lactuca sativa*), crown daisy (*Chrysanthemum coronarium* var. *spatiosum*), kohlrabi (*Brassica oleracea* var. *gongylodes*), beet (*Beta vulgaris*), onion (*Allium cepa*), spinach (*Spinacia oleracea*), crown of thorns (*Euphorbia milii* var. *splendens*), chrysanthemum (*Chrysanthemum morifolium*), zinnia (*Zinnia elegans*), rose (*Rosa hybrida*), golden pothos (*Epipremnum aureum*), and peperomia (*Peperomia clusiifolia*). The average weather conditions during the study period included a temperature of (mean ± SD) 17.5 ± 4.4 °C and relative humidity of 56.9% ± 10.0% (Korean Meteorological Administration, 2015).

Health assessments. Researchers prepared rooms at both senior community centers for the health assessments conducted before and after the 15-session gardening intervention. Physical health conditions, including body composition, physical functional ability, and hand function ability, and psychological health conditions, including cognitive ability, depression, and sociality, were assessed.

To measure factors related to body composition such as body weight (kilograms), fat mass (grams), lean mass (grams), and fat (percent), participants were evaluated with a body fat analyzer (ioi 353; Jawon Medical, Gyeongsan, South Korea) after removing shoes. Height was measured using an anthropometer (Ok7979; Samhwa, Seoul, South Korea). Weight and height data were used to calculate the body mass index as the body weight (kilograms) divided by the height squared (square meters). A measuring tape (Pitting measure KMC-220; Komelon, Gyeongsan, South Korea) was used to measure the waist circumference at the area between the bottom of the ribs and the upper crista iliaca (World Health Organization, 2011) and the hip circumference at the most protruding part of the hip. The waist–hip ratio was calculated as the waist circumference (centimeters) divided by the hip circumference (centimeters).

The Senior Fitness Test was used to assess physical functional ability (Rikli and Jones, 2013). This test was developed as a tool for evaluating the functional fitness performance of older adults (Rikli and Jones, 2001) and measures physiologic parameters using functional movement tasks, such as standing, bending, lifting, reaching, and walking. This test meets scientific standards for validity and reliability (Rikli and Jones, 1999b), and age- and gender-based norms determined from more than 7000 older adults in 21 states of the United States have been published for each test item.

The Senior Fitness Test comprises six assessment items (Rikli and Jones, 2013): a chair stand test, arm curl test, chair sit-and-reach test, back scratch test, 2-min step test, and 8-ft up-and-go test. Before starting each test, the researchers provided an oral explanation and demonstration of how to perform the test to the subjects, who were then allowed to practice the test motions. For the chair stand test, which assesses lower body strength, each subject completed one test trial during which the total number of stands within 30 s was counted. For the arm curl test, which assesses upper body strength, each subject completed one test trial during which the total number of hand weight curls through the full range of motion within 30 s was counted. The 2-min step test assesses aerobic endurance; each subject completed one trial and the score was calculated as the total number of steps within 2 min. The 8-ft up-and-go test assessed agility and dynamic balance; each subject completed two test trials and the score was the shortest time to rise from a seated position, walk 8-ft, turn, and return to the seated position. The chair sit-and-reach test assessed lower body flexibility; each subject completed two repetitions of this test, and the score was the best distance (centimeters) achieved between the extended fingers and the tip of the toe. The back scratch test assessed upper body flexibility; each subject completed two test

Table 1. A 15-session gardening intervention for the improvement of physical and psychological health conditions of elderly women.

Session	Gardening activity	Plant used	Gardening tool	Estimated METs[z]
1	Design garden and making garden plots	—	Drainpipe [50 × 50 cm (19.7 inches)], nonwoven fabric for farming	3.4
2	Planting transplants	Chives	Peatmoss, perlite, shovel, rake	3.7
3	Planting transplants	Beet, chinese cabbage, radish, lettuce, crown daisy, kohlrabi	Trowel, watering can	2.9
4	Making garden signs	—	Wooden boards, paint, saw	2.8
5	Maintaining garden	Golden pothos	Hydroball, pot, bucket, watering can, hose	2.3
6	Fertilizing	—	fertilizer, trowel, hoe	4.0
7	Making flower garden beds	Crown of thorns, chrysanthemum, zinnia	Gardening box, trowel, watering can, peatmoss, perlite	2.5
8	Making vegetable beds	Onion, lettuce	Gardening box, trowel, watering can, peatmoss, perlite	2.7
9	Making organic fertilizers	—	Egg, vinegar, plastic bottle, watering can	2.8
10	Maintaining garden	—	Fertilizer, straw for mulching	2.7
11	Planting plants	Peperomia, rose	Peatmoss, perlite, pot, watering can, name tag	2.4
12	Maintaining garden	—	Spray, organic fertilizers, straw for mulching	3.3
13	Flower arrangement	Chrysanthemum	Vase, floral form, wrapping, ribbon	2.3
14	Harvesting and sowing seeds	Spinach	Shovel, rake, trowel, straw for mulching	3.3
15	Garden party	—	—	2.5

[z]Estimated metabolic equivalents (METs) based on the previous studies for measuring exercise intensities of gardening tasks (Park et al., 2011, 2012, 2014a) and a study for compendium of physical activities (Ainsworth et al., 2000). Intensities below 3.0 METs indicate a low-intensity physical activity and above 3.0 to 6.0 METs presents moderate-intensity physical activities.

repetitions and the score was the best distance (centimeters) achieved between the extended middle fingers.

Grip strength, pinch force, and hand dexterity were measured using a digital grip dynamometer (KS-301; Lavisen, Namyangju-si, South Korea), Jamar hydraulic pinch gauge (749805; Sammons Preston, Ashburn, VA), and grooved pegboard (32025; Lafayette, Lafayette, CA), respectively. Triplicate grip strength and pinch force measurements of the dominant hand were performed, whereas duplicate hand dexterity measurements were performed. Hand dexterity (fine motor skill) is defined as the ability to coordinate small muscle movements that usually involve the synchronization of hands and fingers with the eyes (Barnsley and Rabinovich, 1970; Fleishman, 1972).

Cognitive function ability was measured using the Korean Mini Mental State Examination [K-MMSE (Kang et al., 1997)]. The K-MMSE comprises the following subscales: disorientation of time (five scores), disorientation of place (five scores), memory (three scores), attention and calculation (five scores), memory recall (three scores), language (eight scores), and composition of time and space (one score). Total scores range from 0 to 30. A score of ≥24 indicates normal ability, a score of 18–23 indicates mild cognitive impairment, and a score of ≥17 indicates severe cognitive impairment. The test–retest reliability of this instrument is 0.86 (Kang et al., 1997).

Depression was assessed using the Korean Version of the Short Form of Geriatric Depression Scale (Ki, 1996; Yesavage and Sheikh, 1986). This scale includes 15 questions related to depression in the elderly. A higher score indicates stronger symptoms of depression; specifically, a score of less than 5 indicates a normal state, a score of 6–9 indicates moderate depression, and a score of more than 10 indicates severe depression (Ki, 1996). Cronbach's α of this instrument is 0.88 (Ki, 1996).

To evaluate the social behaviors of elderly subjects, a sociality survey developed by Song (2000) and Seok (2005) was used. Twenty-two questions addressed issues related to competence, expandability, and intimacy. Total scores range from 0 to 110 points, with a higher score indicating better social behaviors. Cronbach's α of this survey is 0.80 (Bae, 2009).

The International Physical Activity Questionnaire-Short Form (IPAQ Research Committee, 2005) was used to determine the duration and exercise intensity of daily physical activities during the previous 7 d. Self-reported physical activities were measured in units

of the metabolic equivalent (MET) of a task. Specifically, a MET-min is computed by multiplying the MET score by the minutes performed.

At the beginning of the study, demographic information, such as age, education level, marital status, and monthly income, was obtained via questionnaire from subjects in both groups. Additionally, a satisfaction survey regarding the gardening intervention (Park et al., 2015) was modified for this study and completed by participants in the gardening intervention group at the end of the 15-session gardening intervention. This satisfaction survey comprised a total of seven questions, including questions about overall satisfaction with the gardening intervention (e.g., what is your overall satisfaction for the gardening intervention?), the duration per session in the intervention (e.g., were you satisfied with the 50 min per session?), and frequency in the intervention (e.g., were you satisfied with the frequency of twice per week?). The responses were conducted based on a 5-point Likert-scale (very satisfied, satisfied, moderately satisfied, not satisfied, or very not satisfied). Moreover, a question regarding self-reported benefits of gardening intervention (e.g., what are the benefits of gardening?) was answered subjectively. Questions regarding desire to continue participating in the gardening intervention (e.g., do you wish to continue participating in the gardening intervention?) and the intention of recommending the program to others (e.g., do you recommend the gardening intervention to others?) were answered with a simple yes or no. Question regarding preference for the performed gardening activities (e.g., what was the most preferred activity in the gardening intervention?) asked participants to choose their three most preferred activities.

Data analysis. The Wilcoxon signed-rank test and SPSS software (version 18 for Windows; IBM, Armonk, NY) were used to compare the results of pre- and post-intervention tests to evaluate physical, psychological, and cognitive health aspects in the control and gardening intervention groups. Demographic information and satisfaction with the gardening intervention were analyzed using Excel software (Office 2007; Microsoft Corp., Redmond, WA); additional analyses involving the chi-square test were conducted using SPSS software. A probability value <0.05 was considered to indicate statistical significance.

Results and discussion

Demographic characteristics. The elderly women who participated in the gardening intervention and control groups were aged (mean ± SD) 79.4 ± 4.8 and 84.5 ± 4.7 years, respectively, and this difference was significant [$P < 0.05$ (Table 2)]. The average height of the gardening intervention group was taller than that of the control group (Table 2). No significant differences were observed in other variables [e.g., educational level, marital status, monthly income, and current chronic diseases (Table 2)]. Elderly women in both groups reported a low level of education (elementary school graduation or less) and a low monthly income [<$1000 (Table 2)]. The most common chronic diseases in both groups were high blood pressure and diabetes (Table 2).

Additionally, the administration type of the senior centers is similar because the two senior centers are located in the same community. The senior centers provided leisure time activities, such as stretching exercises or yoga, as well as part-time job opportunities. Most elderly attendees at the senior centers participate in sitting activities such as playing card games, which comprise a sedentary lifestyle (Dunstan et al., 2012).

The intervention attendance rate among elderly women in the gardening intervention group was 80%, and regular checkups and sickness were cited as reasons for absence.

Physical health assessments. The elderly women in the gardening intervention exhibited a significant decrease in waist circumference from 88.0 ± 10.9 cm (pre-intervention) to

Table 2. Comparisons of demographic information of the subjects in a study for the improvement of physical and psychological health conditions of elderly women through a 15-session gardening intervention by using chi-square and Mann–Whitney *U* tests.[z]

Variable	Gardening (n = 24)	Control (n = 26)	Significance
	Mean (SD)		
Age (years)	79.4 (4.8)	84.5 (4.7)	**
	Percentage (N)		
Disease			
Hypertension	82.6 (19)	76.0 (19)	NS
Diabetes	30.4 (7)	40.0 (10)	NS
Hyperlipidaemic	8.7 (2)	4.0 (1)	NS
Arthritis	4.3 (1)	20.0 (5)	NS
Lumbar disc	0.0 (0)	12.0 (3)	NS
Osteoporosis	0.0 (0)	12.0 (3)	NS
Angina	0.0 (0)	8.0 (2)	NS
Neuralgia	4.3 (1)	4.0 (1)	NS
Cataract	0.0 (0)	4.0 (1)	NS
Liver cirrhosis	4.3 (1)	0.0 (0)	NS
Hyperthyroidism	4.3 (1)	0.0 (0)	NS
Hip disease	0.0 (0)	4.0 (1)	NS
Parkinson's disease	0.0 (0)	4.0 (1)	NS
Breast cancer	0.0 (0)	4.0 (1)	NS
Education			
Elementary school graduate or less	91.3 (21)	100.0 (25)	NS
Middle school graduate	8.7 (2)	0.0 (0)	
Marital status			
Widowed	82.6 (19)	88.0 (22)	NS
Married	17.4 (4)	12.0 (3)	
Monthly income			
Less than $850	95.7 (22)	96.0 (24)	NS
$850 to $1,700	4.3 (1)	0.0 (0)	
$1,700 to $2,550	0.0 (0)	4.0 (1)	

[z]Chi square was used to compare values at $P < 0.05$ for disease, education, marital status, monthly income, and Mann–Whitney *U* test was used to compare means at $P < 0.05$ for the age.
NS, **Nonsignificant or significant at $P < 0.05$, respectively.

87.1 ± 10.6 cm [post-intervention, $P < 0.05$ (Table 3)]. Although there was no standard index value of waist circumference for elderly, the appropriate cutoff point of waist circumference for obesity for Koreans was suggested to be 90 cm for men and 85 cm for women (Lee et al., 2007). Meanwhile, there was no significant difference of waist circumference in the control group, but it showed a tendency to slightly increase. In contrast to the reduced waist circumference observed among elderly women in the gardening intervention group, waist circumference has been reported to increase with age (Ford et al., 2003). Lahti-Koski et al. (2007) reported an average 15-year increase in waist circumference of 2.7 cm among male adults and 4.3 cm among female adults. Both the waist circumference and waist–hip ratio are important indicators of the risks of cardiovascular disease and abdominal obesity (Huxley et al., 2010). Accordingly, this study suggests gardening as a physical activity intervention could reduce the risks of chronic diseases, such as cardiovascular disease, abdominal obesity, and diabetes.

Additionally, no differences in body weight, lean mass, fat mass, and body mass index were observed because of the gardening intervention. Elderly women in the control group exhibited significant reductions in body weight from 54.1 ± 7.3 kg (pre-test) to 53.4 ± 7.3 kg (post-test, $P < 0.05$), as well as lean mass from 31.1 ± 3.2 kg (pre-test) to 30.8 ± 4.2 kg [post-test (Table 3)]. Reduced lean mass was thought to explain the reduced body weight among elderly women in the control group.

The elderly women in the gardening intervention group maintained their lean mass, whereas those in control group lost lean mass over the 2-month study period (Table 3). Muscle mass maintenance during aging is important because the muscle mass decreases by 1% to 2% annually during the sixth decade of life, and the total muscle mass of the human body decreases by 50% by the ninth decade of life (Baumgartner et al., 1998; Buford et al., 2010). In addition, muscle mass is closely related to both physical and cognitive function abilities (Baumgartner et al., 1998; Burns et al., 2010; Janssen et al., 2002). Gardening activities, such as digging, lifting soil, and weeding, use the whole body and incorporate weight-bearing motions, thus helping to maintain or improve muscle strength (Park et al., 2014b; Turner et al., 2002). For example, Park et al. (2014b) described how five gardening activities—digging, raking, troweling, weeding, and hoeing—used both the upper and lower muscles. In particular, forearm muscles, such as the right flexor carpi ulnaris and brachioradialis, were used more actively than the other measured upper and lower limb muscles. Additionally, weight-bearing activities with ground and joint reaction forces, such as gardening, have been reported to effectively promote increases in bone mineral density (Bassey and Ramsdale, 1995; Kelley et al., 2013).

In the Senior Fitness Test, the gardening intervention group experienced an increase in the score of the 2-min step test for aerobic endurance from 79.4 ± 31.4 (pre-intervention) to 95.1 ± 22.5 [post-intervention, $P < 0.05$ (Table 4)]. However, the control group did not show any improvement in the 2-min step test for aerobic endurance. Meanwhile, the control group exhibited a significant decrease in agility, as indicated by an increase in the score of the 8-ft up-and-go test from 7.2 ± 1.4 s (pre-intervention) to 8.1 ± 1.4 s [post-intervention (Table 4)], but there were no changes in the gardening intervention group. There were no significant differences in the scores of other Senior Fitness Test sub-items (Table 4).

Cardiopulmonary endurance is defined as the ability to perform aerobic exercise and to supply oxygen to the skeletal muscles to facilitate this exercise (Aaron et al., 2004; Libardi et al., 2012; Stewart, 2005). Aging causes a 5% to 10% decrease in maximum oxygen consumption every

Table 3. Wilcoxon test comparisons of body compositions of elderly women before and after a gardening intervention.

		Group	
		Gardening	Control
Variable		Mean (SD)	Mean (SD)
Height (cm)[z]	Pre-test	149.3 (3.6)	147.9 (4.4)
	Post-test	148.4 (3.5)	147.6 (4.7)
	Significance	***	NS
Body weight (kg)[z,x]	Pre-test	58.6 (9.3)	54.1 (7.3)
	Post-test	58.4 (9.5)	53.4 (7.3)
	Significance	NS	**
Lean mass (kg)[z,x]	Pre-test	32.9 (2.4)	31.1 (3.2)
	Post-test	32.5 (2.2)	30.8 (4.2)
	Significance	NS	*
Fat (kg)[z,x]	Pre-test	36.3 (4.2)	31.1 (3.2)
	Post-test	36.2 (4.4)	30.8 (3.3)
	Significance	NS	NS
Body mass index ($kg \cdot m^{-2}$)[z,x]	Pre-test	25.7 (4.0)	24.6 (3.5)
	Post-test	25.7 (4.2)	24.5 (3.4)
	Significance	NS	NS
Percent fat (%)[x]	Pre-test	36.3 (4.2)	36.4 (4.1)
	Post-test	36.2 (4.4)	36.4 (4.2)
	Significance	NS	NS
Waist circumference (cm)[z,y]	Pre-test	88.0 (10.9)	84.3 (8.4)
	Post-test	87.1 (10.6)	85.3 (8.3)
	Significance	*	*
Hip circumference (cm)[z,y]	Pre-test	99.5 (9.2)	96.0 (5.4)
	Post-test	98.6 (9.3)	96.3 (5.8)
	Significance	NS	NS
Waist–hip ratio[y]	Pre-test	0.88 (0.04)	0.88 (0.05)
	Post-test	0.88 (0.05)	0.88 (0.06)
	Significance	NS	NS

[z]1 cm = 0.3937 inch, 1 kg = 2.2046 lb, 1 $kg \cdot m^{-2}$ = 0.2048 lb/ft^2.
[y]Measured using a measuring tape (Pitting measure KMC-220; Komelon, Gyeongsan, Korea). Waist circumference is measured at the midpoint between the lower margin of the least palpable rib and the top of the iliac crest. Hip circumference is measured around the widest portion of the buttocks, with the tape parallel to the floor. Waist–hip ratio is calculated as waist measurement divided by hip measurement (World Health Organization, 2011).
[x]Measured using a body fat analyzer (ioi 353; Jawon Medical, Gyeongsan, Korea).
NS, *, **, ***Nonsignificant or significant at $P < 0.05$, respectively.

10 years (Jackson et al., 1995; Ogawa et al., 1992; Wilson and Tanaka, 2000). The results achieved with the low- to moderate-intensity gardening intervention in the present study indicated that such regular aerobic exercise could improve cardiopulmonary endurance in elderly women. Fifty percent of elderly older than 60 years experienced decreased function for agility and dynamic balance (Chevalier et al., 2008). This occurs as a result of either reduced muscle mass and bone mineral density or increased fat mass (Fraga et al., 2011; Guzmán et al., 2011); furthermore, the decreased mass increases the risk of falling (Rockwood et al., 2000) as well as making performance of daily living activities, such as walking, climbing stairs, or standing from a chair, more difficult (Motl and McAuley, 2010; de Noronha et al., 2011).

A significant improvement in hand dexterity was observed among elderly women in the gardening intervention group as indicated by the improvement from 136.9 ± 69.3 s (pre-intervention) to 133.5 ± 113.9 s [post-intervention, $P < 0.05$ (Table 5)]. The control group showed a decreased tendency for hand dexterity, although there was no significant difference between pre- and post-tests. Moreover, the intervention and control groups did not differ with respect to grip strength and pinch force (Table 5). In previous studies, horticultural activity programs were found to significantly improve hand dexterity in subjects with intellectual or developmental disabilities (Lee et al., 2010; Lee and Kim, 2007; Lee and Yoo, 2010; Moon and Yoo, 2009). Various horticultural activities are known to have kinematical properties that promote improved hand dexterity. For example, the subject's hand must approach and grasp horticultural materials and then transfer the materials to the target point (Lee et al., 2015). Accordingly, elderly women who participated in the gardening intervention repeatedly performed motions involving hand dexterity. Previous studies also showed improvements in grip strength and pinch force (Kim and Kim, 2008; Park et al., 2009; Yun and Kim, 2009). Park et al. (2009) reported that older gardeners exhibited significantly greater hand strength and pinch force, compared with older nongardeners. Indoor horticultural activity programs were found to increase grip strength in elderly subjects with stroke or dementia (Kim and Kim, 2008; Yun and Kim, 2009). In an observation of motions performed while gardening, Park and Shoemaker (2009) reported that gripping was the most frequently observed motion performed by older gardeners. Moreover, Park et al. (2013) measured muscle activation in the upper limb and hand muscles during 15 common horticultural activities and found that hand muscles such as the thenar eminence and hypothenar eminence were actively used during these activities.

Table 4. Wilcoxon test comparisons of Senior Fitness Test of elderly women before and after a gardening intervention.

		Group	
		Gardening	Control
Sub tests		Mean (SD)	Mean (SD)
Chair stand (n)	Pre-test	15.6 (3.1)	12.1 (3.4)
	Post-test	16.5 (3.2)	12.8 (3.8)
	Significance	NS	NS
Arm curl (n)	Pre-test	19.9 (3.6)	16.7 (3.2)
	Post-test	20.3 (4.0)	18.0 (4.1)
	Significance	NS	NS
2-min step (n)	Pre-test	79.4 (31.4)	53.4 (21.6)
	Post-test	95.1 (22.5)	64.6 (30.1)
	Significance	*	NS
8-ft[z] up-and-go (s)	Pre-test	7.0 (1.6)	7.2 (1.4)
	Post-test	7.2 (1.5)	8.1 (1.4)
	Significance	NS	*
Chair sit-and-reach (cm)[z]	Pre-test	3.9 (6.9)	11.6 (7.5)
	Post-test	8.0 (9.2)	13.3 (8.5)
	Significance	NS	NS
Back scratch (cm)[z]	Pre-test	–20.9 (14.9)	–17.2 (11.5)
	Post-test	–22.2 (12.2)	–20.7 (13.3)
	Significance	NS	*

[z]1 cm = 0.3937 inch, 1 ft = 0.3048 m.
NS, *Nonsignificant or significant at $P < 0.05$, respectively.

Table 5. Wilcoxon test comparisons of hand function ability of elderly women before and after a gardening intervention.

		Group	
		Gardening	Control
Hand function		Mean (SD)	Mean (SD)
Grip force	Pre-test	17.6 (4.8)	16.9 (3.1)
	Post-test	18.5 (3.6)	16.4 (2.9)
	Significance	NS	NS
Pinch force	Pre-test	6.7 (0.9)	6.2 (1.0)
	Post-test	6.4 (1.0)	5.9 (0.8)
	Significance	NS	NS
Hand dexterity	Pre-test	136.9 (69.3)	125.4 (43.0)
	Post-test	133.5 (113.9)	137.4 (75.4)
	Significance	*	NS

NS, *Nonsignificant or significant at $P < 0.05$, respectively.

Psychological health assessments. According to the K-MMSE, elderly women in the 15-session gardening intervention experienced a significant improvement in cognitive function, with an increase in scores from 22.6 ± 4.2 to 23.6 ± 2.8 [$P < 0.05$ (Table 6)], although both scores remained in the mild cognitive impairment range (18–23) (Kang et al., 1997). A score in the range of 24–30 indicates no cognitive impairment (Kang et al., 1997). The pre- and post-intervention scores of the control group did not significantly differ and remained in the mild cognitive impairment range. Similar to both groups in this study (Table 6), 10% of individuals older than 65 years and 50% of those older than 85 years have mild cognitive impairment (Jorm and Jolley, 1998),

showing that mild cognitive impairment is common in the elderly. Previously, a program that comprised 16 horticultural therapy sessions yielded improvements in cognitive function parameters, such as attention, memory, and visuospatial perception, in 10 male and female elderly individuals with dementia, and the brain metabolic rate was also shown to have increased via positron emission tomography (Cho, 2008). The positive results achieved in this and previous studies suggest that gardening activities provide opportunities for attention and orientation through caring for plants in the garden, which requires the consideration of weather conditions and plants' water and nutritive conditions (Bryant, 1991; Hass et al., 1998).

Notably, elderly women in the control group exhibited a significant increase in depression scores [$P < 0.05$ (Table 6)], with symptoms progressing from normal before the intervention period to moderate depression symptom at the end of the study. Meanwhile, the depression scores of elderly women in the gardening intervention group did not change during this period (Table 6), and the pretest depression scores indicated a normal condition. In the elderly, depression can lead to a loss of cognitive function, decreased life satisfaction, and suicide (Almeida et al., 2006). Joshi et al. (2016) reported that elderly individuals who participate in physical activity have low levels of depression symptoms and that gardening acted to prevent depression in this population. A 12-session gardening program was previously found to improve depression symptoms and life satisfaction in an elderly population (Kim et al., 2013). The positive psychological effects of gardening can be attributed to the increased production of alpha waves in the brain as a result of the restful sensations from green plants, as determined in a previous study (Son et al., 1999).

Neither study group experienced a difference in sociality following the intervention period (Table 6). Sociality is a crucial factor associated with life satisfaction and wellbeing in later life (Carstensen, 1995; Nezlek et al., 2002). Although elderly women in this study did not experience improved sociality, previous studies have reported positive effects of gardening interventions on sociality. For example, Tse (2010) reported significantly improved social relationships among 26 elderly nursing home residents after participating in an 8-session gardening program. Moreover, 12 independently living elderly subjects who participated in a gardening intervention reported improved social support (Oh and Yoo, 2010). An expanded gardening intervention period or customized gardening program by considering the subject characteristics could be applied to improve sociality among elderly participants.

In this study, elderly women who participated in the gardening intervention experienced a significant increase in the amount of daily physical activity (Table 7). In particular, the amount of time spent on vigorous physical activities increased from 134.7 ± 515.1 MET-min/week (pre-intervention) to 976.9 ± 1290.0 MET-min/week (post-intervention, $P = 0.02$). In contrast, elderly women in the control group exhibited a nonsignificant tendency toward a reduced amount of daily physical activity (Table 7). Compared with indoor activities, outdoor activities such as gardening might help to motivate individuals to participate in exercise interventions and remain physically active (Department of Health, 2004; Park et al., 2008a, 2009). Seasonal variations and plant growth cycles also contribute to the

Table 6. Wilcoxon test comparisons of cognitive ability, depression, and sociality of elderly women before and after a gardening intervention.

		Group	
		Gardening	Control
Variable		Mean (SD)	Mean (SD)
Mini mental state examination (0–30 scale) (K-MMSE)[z]	Pre-test	22.6 (4.2)	22.1 (3.7)
	Post-test	23.6 (2.8)	21.8 (3.5)
	Significance	*	NS
Geriatric depression scale (0–15 scale) (GDSSF-K)[y]	Pre-test	4.9 (2.8)	3.3 (2.5)
	Post-test	4.7 (2.7)	5.1 (2.9)
	Significance	NS	***
Sociality	Pre-test	80.0 (9.5)	71.4 (7.8)
	Post-test	83.0 (5.1)	73.4 (7.7)
	Significance	NS	NS

[z]K-MMSE: 0–17 = severe cognitive impairment, 18–23 = mild cognitive impairment, 24–30 = no cognitive impairment (Kang et al., 1997).
[y]GDSSF-K: <5 = normal, 6–9 = moderate, >10 = severe (Ki, 1996).
NS, *, ***Nonsignificant or significant at $P < 0.05$ and $P < 0.001$, respectively.

Table 7. Wilcoxon test comparisons of physical activity level of elderly women before and after a gardening intervention.

		Group	
		Gardening	Control
Physical activity[z] (MET-min/week)		Mean (SD)	Mean (SD)
Walking[y]	Pre-test	1,313.1 (855.4)	745.8 (656.4)
	Post-test	1,507.6 (1,100.6)	483.6 (546.0)
	Significance	NS	NS
Moderate[y]	Pre-test	709.5 (709.8)	360 (802.0)
	Post-test	685.3 (466.3)	221.5 (316.9)
	Significance	NS	NS
Vigorous[y]	Pre-test	134.7 (515.1)	166.2 (431.4)
	Post-test	976.9 (1,279.0)	443.0 (1,597.5)
	Significance	*	NS
Total[y]	Pre-test	2,157.3 (973.3)	1,237.8 (1,243.8)
	Post-test	3,169.7 (1,832.5)	1,148.2 (1,557.5)
	Significance	NS	NS

[z]Self-reported physical activity measured in metabolic equivalent of task (MET)-min. A MET-min is computed by multiplying the MET score by the minutes performed (IPAQ Research Committee, 2005).
[y]Walking MET-min/week = 3.3 × walking minutes × walking days, moderate MET-min/week = 4.0 × moderate-intensity activity minutes × moderate days, vigorous MET-min/week = 8.0 × vigorous-intensity activity minutes × vigorous-intensity days. A combined total physical activity MET-min/week can be computed as the sum of walking + moderate + vigorous MET-min/week scores (IPAQ Research Committee, 2005).
NS, *Nonsignificant or significant at $P < 0.05$, respectively.

motivation to participate in a gardening exercise intervention (Park et al., 2008b) because of the need to continuously care for plants in the garden and an interest in the plants' growth cycles (Lekies and Sheavly, 2007; Park et al., 2008b).

Satisfaction with the gardening intervention. Overall, most elderly women in the gardening intervention group reported being very satisfied (87.5%, 21 respondents), satisfied (8.3%, 2 respondents), or moderately satisfied (4.2%, 1 respondent) with the gardening intervention. Participants were very satisfied (70.8%, 17 respondents) and satisfied (25%, 6 respondents) with the average duration of 50 min per session. Similarly, participants were very satisfied (91.7%, 22 respondents) and satisfied (8.3%, 2 respondents) with the session frequency of twice per week. Regarding preferences for gardening activities, planting transplants (54.7%, 1.6 points) was the most preferred activity, followed by flower arrangement (48%, 1.4 points), harvesting (40%, 1.2 points), garden parties (30.7%, 0.9 points), and making eco-friendly fertilizers (21.3%, 0.6 points). Regarding the benefits of gardening, elderly women who participated in the gardening intervention subjectively reported they enjoyed group activity (91.7%, 22 respondents), psychological relaxation (87.5%, 21 respondents), the fun of raising plants (83.3%, 20 respondents), and leisure time activity (70.8%, 17 respondents). Moreover, all participants (100%, 24 respondents) reported that they wished to continue participating in the gardening intervention and would recommend it to other elderly people.

In conclusion, the gardening intervention, as a low- to moderate-intensity physical activity, improved the physical and psychological health conditions of elderly women who participated in this study at a senior community center. The elderly women in the 15-session gardening intervention significantly reduced waist circumference and improved aerobic endurance, hand dexterity, cognitive function, and their amount of daily physical activity. On the other hand, the elderly women in the control group experienced age-related reduced physical and psychological health conditions for lean mass, agility, and depression. Moreover, satisfaction with the gardening intervention as a leisure time physical activity for health conditions of elderly women was very high. Future studies should include a larger population and longer gardening intervention period to determine the effects of the intervention and improve the health conditions of the elderly participants.

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