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Reduced stress and improved physical functional ability in elderly with mental health problems following a horticultural therapy program

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ABSTRACT

Objectives: This study aimed to determine the effects of a plant cultivation-based horticultural therapy program for elderly people with mental health problems.
Design: Pre- and post-test design with experimental and control groups.
Setting: Twenty-eight elderly Korean people with mental health problems participated from April to June 2017 at a farm located in Suwon, South Korea.
Interventions: The participants were randomly assigned to either the control (n = 14) or horticultural therapy group (n = 14); the latter participated in once-weekly sessions of a previously designed 10-session horticultural therapy program.
Main outcome measures: The pre-test occurred 1 week before starting the horticultural therapy program. The post-test was completed within 1 week after finishing the final program session. Cortisol levels were measured in saliva samples collected from both groups. The Senior Fitness Test was used to assess physical functional ability in both groups.
Results: In the horticultural therapy group, the cortisol levels decreased significantly from before to after the horticultural therapy program, and the post-test scores for six subtests of the Senior Fitness Test improved significantly. No significant improvements were seen in either measure in the control group.
Conclusions: This study demonstrates the potential ability of horticultural therapy to improve the stress levels and physical functional abilities of elderly people with mental health problems. In future studies, it would be interesting to verify the long-term effects of this horticultural therapy program and to compare its effects with regard to sex, age, and various mental symptoms.

1. Introduction

Currently, the elderly population is increasing both worldwide[1] and in South Korea, where adults older than 65 years accounted for 13.8% of the national population in 2017.[2] Further projections suggest that the elderly population in South Korea will increase to 24.5% in 2030 and 41% in 2060.[2] Accordingly, and it will be expected to live in an aging society with the highest proportion of Organization for Economic Co-operation and Development (OECD) countries.[3]

Normal aging is associated with a decrease in physical functional ability, which includes muscle strength, agility, flexibility, balance, and aerobic endurance.[4,5] These decreases are attributed to age-related decreases in muscle mass, bone mineral density, maximum oxygen consumption, and/or increased fat mass.[6] For example, a person's muscle mass decreases by 1–2% annually during the sixth decade of life, and the total muscle mass of the human body is expected to decrease by 50% by the ninth decade of life.[7,8] As the muscle mass is closely associated to physical and cognitive functional abilities,[4,5] these decreases have a significant effect on well-being.

According to a 2014 report by the Ministry of Health and Welfare of South Korea, 89.2% of elderly residents had chronic diseases, 33.1% had depressive symptoms, and 31.5% experienced cognitive impairment.[9] A 2008 report from the same government ministry indicated that depressed elderly people reported significantly less satisfaction with their health condition, compared to their counterparts with normal mental health.[10] Additionally, a 2012 report indicated that the number of elderly people who reported experiencing stress in their lives increased to 52.9%, compared to 43.0% in 2008.[11]

Among elderly adults, stress and a limited physical ability were found to confer a higher risk of depression relative to chronic illness,[12]

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and stress and depression were found to correlate strongly in that population.[13] The hormone cortisol is used as an index for stress assessment,[14] and prolonged exposure to high cortisol levels can lead to hypertension, osteoporosis, muscle atrophy, fatigue, coronary heart disease, and weakened immunity.[15,16] Notably, a high level of cortisol has been associated with depression, and cortisol reduction has been used successfully to treat depression.[17,18]

Previous studies have demonstrated the benefits of gardening in terms of both physical and psychological health.[19] A 15-session gardening intervention involving low- to moderate-intensity aerobic exercise was found to improve muscle mass, aerobic endurance, hand dexterity, cognitive ability, and waist circumference in a population of elderly women (> 70 years of age),[19] and a 20-session horticultural therapy program significantly reduced the cortisol levels, depression, and anxiety in hospice patients.[20] Furthermore, a 16-session horticultural therapy program reduced symptoms of depression in elderly stroke patients.[21] However, few studies have evaluated the effects of plant cultivation activities in a practical farm setting on elderly people with mental health problems. Therefore, this study aimed to determine the effects of a plant cultivation-based horticultural therapy program on stress levels and physical functional abilities in a population of elderly people with mental health problems.

2. Materials & methods

2.1. Research subjects

This study was approved by the Institutional Review Board of Konkuk University (7001355-201703-HR-165). Twenty-eight elderly Korean adults with mental health problems were recruited from two elderly mental health centres located in Suwon, South Korea. A psychiatrist and social workers affiliated with the centres explained the study, after which voluntary participants were recruited. Each participant, as well as a person in charge of the facilities, provided a consent form before starting the study.

The 28 participants were randomly assigned to either the control group (n = 14) or the horticultural therapy group (n = 14). A demographic questionnaire that addressed age, sex, and type of mental health issue was administered to each participant during an orientation session. The current cognitive ability of the participants was assessed using the Korean version of Mini-Mental State Examination for Dementia Screening (MMSE-DS),[22] which was developed and standardized as a dementia screening tool for elderly Korean adults, based on existing evaluation tools such as the Mini-Mental State examination,[23] Korean version of the Mini-Mental State Examination,[24] and Korean Mini-Mental State Examination.[25] The MMSE-DS has been used in Korea as a primary screening tool for national dementia checkups since 2011. A lower score indicates a higher risk of dementia.[22] A previous study reported a Cronbach's alpha of 0.826 for the MMSE-DS.[26]

2.2. Horticultural therapy program

The horticultural therapy program was conducted from April to June 2017 (10 sessions) and comprised once-weekly 90-min sessions. The program was largely designed to include plant-cultivating activities such as making plant beds, planting transplants, watering, weeding, and harvesting (Table 1). The participants cultivated seasonal plants, such as potato (*Solanum tuberosum*), lettuce (*Lactuca sativa*), tomato (*Lycopersicon esculentum Mill*), pepper (*Staphylea bumalda*), and herbs (*Anethum graveolens, Matricaria chamomilla, Mentha* species).

The horticultural therapy program was conducted at a farm (area: 991.7 m^2) located in Suwon, South Korea. The farm included an indoor space for lectures and relaxation and an outdoor garden with a water supply. The program was conducted by a researcher (a master's student in horticultural therapy) and three assistant therapists (also master's students in horticultural therapy), with assistance from a social worker and staff member from the mental health centres in Suwon. The participants in the horticultural therapy program were asked to wear comfortable clothes, shoes, and hats. Before starting each session, the instructors provided explanations and demonstrations of the activities, and the assistant therapists, social worker, and staff monitored the participants to ensure safety.

Table 1
A 10-session horticultural therapy program for reducing stress and improving physical functional ability of elderly with mental health problems.

Session	Horticultural activities	Horticultural crops
1	Making garden plot, fertilizing, planting	Potato (*Solanum tuberosum*)
2	Making a garden sign, hydroponics	Tiny ardisia (*Ardisia pusilla 'Variegata'*)
3	Making garden plot, planting, weeding, watering	Herbs (*Mentha* species, *Anethum graveolens, Matricaria chamomilla*) Lettuce (*Lactuca sativa*)
4	Making garden plot, mulching, planting, harvesting	Tomato (*Lycopersicon esculentum Mill*) Pepper (*Staphylea bumalda*) Lettuce (*Lactuca sativa*)
5	Setting up plant stakes, weeding, harvesting	Lettuce (*Lactuca sativa*), Potato (*Solanum tuberosum*)
6	Tying stakes, picking a side, watering, weeding, harvesting	Lettuce (*Lactuca sativa*), Potato (*Solanum tuberosum*)
7	Tying stakes, picking a side, weeding, harvesting, packing	Tomato (*Lycopersicon esculentum Mill*) Pepper (*Staphylea bumalda*) Lettuce (*Lactuca sativa*), Potato (*Solanum tuberosum*)
8	Weeding, watering, covering up crops with soil, harvesting, tying stakes, picking a side	Tomato (*Lycopersicon esculentum Mill*) Pepper (*Staphylea bumalda*) Lettuce (*Lactuca sativa*), Potato (*Solanum tuberosum*)
9	Harvesting, making herb tea	Herbs (*Mentha* species) Lettuce (*Lactuca sativa*)
10	Harvesting, farm party	Lettuce (*Lactuca sativa*) Potato (*Solanum tuberosum*)

2.3. Measurements

The pre-test was conducted 1 week before starting the horticultural therapy program, and the post-test was completed within 1 week after finishing the last session of the program. Saliva samples were collected noninvasively from all participants and subjected to cortisol measurements. All samples were collected at the same time of the morning. Prior to saliva collection, chemical components that might affect cortisol levels (e.g., lipstick) were removed. None of the participants were taking steroid medications. Collected saliva samples were sent to a commercial laboratory for analysis.

Both study groups also participated in the Senior Fitness Test to assess physical functional ability. The Senior Fitness Test comprises six subtests and measures muscle strength in the upper and lower body, flexibility, agility, aerobic endurance, and balance.[27] Lower body strength was assessed using the chair stand test, for which the researcher counted the total number of stands within 30 s. Upper body strength was determined using the arm curl test, and the total number of hand weight curls through the full range of motion within 30 s was counted. Aerobic endurance was determined by counting the total number of steps made by the subject within 2 min. Agility and dynamic balance were assessed using the 8-feet-and-go test: from two trials, the shortest time measured to rise from a seated position, walk 8 feet, turn, and return to the seated position was selected for the data analysis. Lower and upper body flexibility were assessed using the chair sit-and-reach test and back scratch test, respectively. In the chair sit-and-reach test, the best distance achieved between the extended fingers and the tip of the toe was recorded for each subject. In the back scratch test, the

best distance achieved between the extended middle fingers was recorded. The researchers provided demonstrations of each test to the participants, who then participated in two trials of each test. The better score was included in the data analysis. All tests of both groups were performed at the mental health centres.

2.4. Data analysis

Differences between the horticultural therapy group and control group for the cortisol analysis and Senior Fitness Test were assessed using a paired *t*-test and SPSS (version 24.0; IBM Corp., Armonk, NY, USA). Age and MMSE-DS were assessed using an independent *t*-test, and other demographic factors were analysed using the chi-square test. A probability value of $P < 0.05$ was considered to indicate statistical significance. One subject in the control group for cortisol test and two subjects in the control group for physical functional ability test were excluded because of health problems or personal events.

3. Results and discussion

3.1. Demographics

No significant differences were observed between the groups in terms of demographic characteristics and cognitive abilities (Table 2). The average participant age was 80.1 ± 2.9 years in the horticultural therapy group and 77.4 ± 5.9 years in the control group. The therapy and control groups had MMSE-DS scores of 25 ± 2.6 and 24.7 ± 3.5, respectively, indicating that participants in both groups had a normal cognitive state. Most participants in both groups were found to have depressive disorders. The participants in both groups participated in introductory lecture classes for depression, anxiety, sleep disorder, and dementia symptoms and indoor activity programs such as crafts, cooking, or game that were provided at the mental health centres. In the horticultural therapy program, the participant attendance rate was 86%, and the reasons for absence included personal events and health problems.

3.2. Cortisol level

In the horticultural therapy group, the cortisol levels decreased significantly from an average of 7.56 before and the program to 3.80 after the program ($P < 0.05$) (Table 3). By contrast, no significant difference in cortisol levels was observed in the control group. As a higher level of cortisol correlates with a higher level of stress,[14] these results indicate that participation in the horticultural therapy program can reduce stress in elderly adults with mental health problems, compared to non-participation. Previous studies have reported similar results. For example, elderly adults with dementia who participated in an 8-session horticultural therapy program exhibited significantly reduced levels of cortisol and subjective stress.[28] Furthermore, a 20-session horticultural therapy program significantly reduced cortisol levels, depression, and anxiety in hospice patients who participated in a horticultural therapy program, compared to those in a control group.[20] An 8-session horticultural therapy program was found to improved salivary cortisol and alpha amylase levels in subjects with post-traumatic stress disorder, compared to their counterparts in a stress education intervention group.[29]

Psychophysiological studies of the effects of a green environment or horticultural activities on humans have previously been conducted. For example, compared to a lack of visible foliage plants, viewing foliage plants was shown to induce physiological and psychological relaxation by reducing prefrontal cortex activity, increasing parasympathetic nervous activity, and improving the emotional state.[30,31] Furthermore, viewing forest scenery increased parasympathetic nervous activity, suppressed sympathetic nervous activity, and reduced blood pressure and heart rate.[32–35] Tasks such as transferring foliage plants in pots were found to promote physiological and psychological relaxation by decreasing sympathetic nerve activity and oxy-haemoglobin concentrations in the left prefrontal cortex, compared to a transferring task without foliage plants,[36] and working with real plants was found to improve the psychological condition, compared to working with artificial plants.[37] Moreover, Lowry et al.[38] reported that touching soil stimulates the secretion of serotonin, which produces feelings of happiness, in response to *Mycobacterium* species present in the soil. These previous reports are consistent with the findings of the present study, in which various activities involving the cultivation of living plants within a 10-session horticultural therapy program reduced the participants' stress levels by promoting psychophysiological relaxation.

Table 2
Demographic characteristics of participants.

Variable	Horticultural therapy group (n = 14)	Control group (n = 14)	Significance
Average (SD)			
Age	80.1 (2.9)	77.4 (5.9)	NS (0.14)
MMSE-DS[a]	25.0 (2.6)	24.7 (3.5)	NS (0.81)
Percent (N)			
Sex			
Male	7.1 (1)	23.1 (3)	NS (0.28)
Female	92.9 (13)	78.6 (11)	
Type of mental disease			
Cognitive impairment	14.3 (2)	14.3 (2)	NS (1.00)
Depressive disorder	92.9 (13)	92.9 (13)	NS (1.00)
Anxiety disorder	7.1 (1)	14.3 (2)	NS (0.54)

SD, standard deviation; NS, non-significant.
[a] Korean version of Mini-Mental State Examination for Dementia Screening (MMSE-DS).[22] The lower the score, the higher the risk of dementia.

Table 3
Cortisol levels before and after the 10-session horticultural therapy program.

Variable		Gardening (n = 14) Mean (SD)	Control (n = 13)
Cortisol	Pre-test	7.56 (4.36)	6.72 (4.72)
	Post test	3.80 (3.00)	4.76 (4.94)
	Significance	*(0.02)	NS (0.06)

SD, standard deviation; NS, non-significant.
* $P < .05$.

3.3. Senior Fitness Test

In the horticultural therapy group, the post-test scores in six subtests of the Senior Fitness Test were significantly improved, compared to the pre-test scores (Table 4). By contrast, there was no significant difference between the pre- and post-test scores in the control group except in the back scratch test score, which was significantly reduced in the post-test (Table 4). Therefore, the 10-session horticultural therapy program appeared to have improved the fitness of elderly participants in terms of upper and lower muscle strength, flexibility, agility, aerobic endurance, and balance.

The elderly participants in the control group appeared to exhibit age-related losses in upper limb flexibility (Table 4),[6] which occur along with decreases in muscle mass, agility, balance, and aerobic endurance.[6] As noted previously, muscle mass decreases with age and affects physical and cognitive functional abilities.[4,5] Similarly, maximum oxygen consumption decreases by 5–10% every 10 years,[39,40] which reduces an individual's cardiopulmonary endurance, defined as the ability to perform aerobic exercise and supply oxygen to the skeletal muscles.[41,42] In one study, 50% of elderly people (> 60 years) experienced decreases in agility and dynamic balance[43] because of decreases

Table 4
Results of the Senior Fitness Test[a] before and after the 10-session horticultural therapy program.

Variable		Gardening (n = 14) Mean (SD)	Control (n = 12)
Chair Stand Test	Pre-test	11.92 (3.22)	11.33 (5.10)
	Post test	14.71 (3.77)	11.58 (3.62)
	Significance	***(0.00)	NS (0.72)
Arm Curl Test	Pre-test	14.64 (2.70)	13.75 (3.54)
	Post test	18.00 (3.25)	13.75 (4.43)
	Significance	***(0.00)	NS (1.00)
2-Minute Step Test	Pre-test	67.14 (17.48)	63.00 (22.11)
	Post test	77.28 (13.68)	65.33 (23.08)
	Significance	*(0.03)	NS (0.55)
Chair Sit-and-Reach Test	Pre-test	2.39 (10.56)	1.29 (8.59)
	Post test	12.10 (8.64)	3.29 (9.37)
	Significance	**(0.00)	NS (0.41)
Back Scratch Test	Pre-test	−16.25 (9.61)	−15.70 (11.89)
	Post test	−12.78 (12.01)	−21.45 (12.42)
	Significance	*(0.02)	**(0.01)
8-Foot Up-and-Go Test	Pre-test	7.45 (1.26)	8.71 (2.93)
	Post test	6.86 (1.30)	9.09 (2.90)
	Significance	**(0.01)	NS (0.30)

SD, standard deviation; NS, non-significant.
* $P < .05$, ** $P < .01$, *** $P < .001$.
[a] The Senior Fitness Test comprises six subtests and measures muscle strength in the upper and lower body, flexibility, agility, aerobic endurance, and balance[27].

in muscle mass and bone mineral density and/or an increase in fat mass.[44,45] These declines all contribute to a decrease in physical activity,[46] and a sedentary lifestyle itself is a risk factor for declines of functional abilities related to of muscular strength, endurance, flexibility, balance, and cardiopulmonary capacity in elderly people.[47] The present study results demonstrate that a horticultural therapy program comprising low- to moderate-intensity gardening activities could improve the physical functional abilities of elderly individuals.

Previous studies have verified gardening, including activities digging, raking, and weeding, as a means of encouraging low- to moderate-intensity physical activity involving both the upper and lower body in elderly people.[48–51] Low-intensity gardening activities such as mixing soils, planting transplants, watering, and harvesting use the upper body and incorporate sitting, squatting, or standing.[48,50] Furthermore, various gardening activities require the use of both upper- and lower-limb muscles (i.e., whole-body) and incorporate weight-bearing motions, thus promoting increased muscle strength.[51–53] One study observed superior hand functional abilities such as grip strength and pinch force in older gardeners, compared to their non-gardening counterparts,[54] because the gardeners significantly more frequently performed gripping motions involving muscles such as the thenar eminence and hypothenar eminence.[52] A 10-session gardening intervention involving low- to moderate-intensity aerobic exercise was found to significantly improve muscle mass and other functional outcomes in elderly women (> 70 years),[19] as well as blood lipid profiles, blood pressure, inflammatory marker levels, and oxidative stress levels.[36]

3.4. Satisfaction

Upon completing the final session of the horticultural therapy program, all participants completed an 8-item questionnaire regarding their satisfaction with the program. The survey was developed by Park et al.[55] and modified for this study. Regarding overall satisfaction, 93% and 7% of the elderly participants were very satisfied and satisfied with the program, respectively. Regarding duration, 71%, 22%, and 7% were very satisfied, satisfied, and moderately satisfied, respectively, with the 90-min sessions. Regarding the number of sessions per week, 65% were very satisfied and 14% were satisfied, whereas 21% reported that they would prefer two sessions per week. Moreover, 93% and 7% of the participants reported a strong willingness and willingness, respectively, to continue the program, and 57%, 36%, and 7% would highly recommend, recommend, and moderately recommend the program to others, respectively. Regarding the program activities, harvesting was the most preferred (23.1%), followed by planting transplants (20.4%), weeding (17%), garden maintenance (e.g., tying stakes and removing suckers) (16.3%), making plant beds (13.3%), and watering (9.9%).

In conclusion, the results of this study demonstrate the potential ability of horticultural therapy to improve the stress levels and physical functional abilities of elderly participants with mental health problems. To generalize the results of the study, a study with more samples would be valuable. In future studies, it would be interesting to verify the long-term effects of the horticultural therapy program, and compare the effects with regard to sex, age, and various mental symptoms.

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