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Review Article

The Effectiveness of Horticultural Therapy on Older Adults: A Systematic Review

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A B S T R A C T

Objectives: Although the therapeutic effects of horticulture on older adults have been widely investigated, a recent and comprehensive synthesis of available evidence on outcomes is lacking. We systematically reviewed evidence for the therapeutic effects of horticulture on older adults.
Design: A systematic search of PubMed, MEDLINE, Sage Journals, ProQuest, Science Direct, and CINAHL was conducted. Articles were selected if they were quantitative studies published in English from 2008 to 2018.
Setting and Participants: Articles were selected if they included participants aged 60 years and older and used horticulture as the main intervention.
Measures: Experimental studies were appraised using the Physiotherapy Evidence Database Scale.
Results: The systematic search yielded 20 articles. Significant pre-post improvement was reported in quality of life, anxiety, depression, social relations, physical effects, and cognitive effects. However, between-group results were lacking or nonsignificant.
Conclusions and Implications: There is evidence for benefits of horticulture among older adults, particularly in long-term care facilities. Nonetheless, as the robustness of evidence is lacking, more rigorous randomized controlled trials and between-group effects need to be investigated.

Older adults are susceptible to physical and cognitive decline.[1,2] Studies have also demonstrated a high prevalence of depression[3] and social isolation[4] among older adults that affects their well-being and health.[5–8] Hence, there is a need to attend to the health of older adults holistically by catering to their emotional and psychosocial well-being as well as their physical functioning.[9,10] This can necessitate the use of nonpharmacological interventions,[10] such as horticulture therapy (HT), which is growing in popularity among researchers and health care professionals in various settings.

The participation in horticultural activities is generally referred to as HT or therapeutic horticulture.[11] The American Horticultural Therapy Association has differentiated HT from therapeutic horticulture in terms of goals and processes. Horticultural activity is considered HT if the horticultural activity is aimed at achieving specific goals. This could be for rehabilitative or vocational purposes, and thus is often a process involving active engagement. On the other hand, therapeutic horticulture refers to any activity that uses horticulture as a therapeutic modality to support program goals. It describes both active and passive involvement in plant and plant-related activities.[11] However, these definitions have not been universally used. There are many definitions of HT used by researchers in different settings.[12] In light of this, for this systematic review, we use the term HT to refer to plant-based activities that are used to improve various outcomes among older adults, not limited to specific treatment or rehabilitation goals.

Regardless of terminology used, studies have shown that direct contact with nature confers benefits to the health and well-being of older adults.[13,14] However, there is a lack of recent and comprehensive synthesis of the evidence on the effects of HT for older adults. In the most recent systematic review published on the benefits of gardening,[15] the included studies on older adults were published in 2009 or earlier. Similarly, another recent systematic review on horticultural therapy[16] included only 2 studies on older adults published in 2010. In addition, there is also a need for a more comprehensive synthesis of the evidence, as published systematic reviews had limited scope in intervention and types of participant demographics. For example, the systematic review by Wang and MacMillan[14] focused only on gardening, and excluded articles that used other horticultural

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activities. Another systematic review by Whear and colleagues[17] investigated only the use of garden spaces for people with dementia. Therefore, this systematic review aims to identify and appraise recent evidence on the effects of HT for older adults on a broader scope.

Methods

Search Strategy

The Cochrane Database of Systematic Reviews (CDSR) was searched to ensure that a similar systematic review was not being done. A systematic search was performed for articles published between January 1, 2008 and December 31, 2018. We searched the following databases: PubMed, MEDLINE, Sage Journals, ProQuest, Science Direct, and CINAHL using the following keywords: horticultural therapy, therapeutic horticulture, gardening, elderly, older adults, aged. The combinations of terms in the keyword search are available in Appendix. We included articles on both horticultural therapy and therapeutic horticulture because of the lack of consensus on the definition of horticultural therapy. Titles and abstracts of identified published articles were reviewed for relevance by 4 investigators. References of all relevant articles were hand-searched. Additional search methods included browsing the Cochrane Central Register of Controlled Trials and the first 10 pages of Google Scholar using the aforementioned keywords.

Selection Criteria

Articles were selected for this review if they (1) investigated the effects of horticulture on the older adults (ie, demonstrated a quantitative relationship between HT and a specific outcome variable), (2) recruited participants aged 60 years and older, (3) were full-text articles, and (4) were published in English in peer-reviewed journals.

Assessment of Methodological Quality

We assessed the quality of the included articles using the Johns Hopkins Nursing Evidence-Based Practice Levels of Evidence guidelines.[18] We also identified experimental studies from the included articles and critically appraised the quality of these studies using the Physiotherapy Evidence Database (PEDro) Scale.[19] Experimental studies included randomized controlled trials (RCTs), cluster-randomized controlled trials (CRTs), and studies that had a 2-group pretest-posttest design.

Results

Study Selection

The CDSR search revealed that currently no similar systematic review was being done. The search strategy identified a total of 18,713 articles. Four investigators reviewed titles and abstracts and selected 63 articles for further review. Hand search of references of these 63 articles and a search of the Cochrane Central Register of Controlled Trials revealed no additional articles. Articles excluded were duplicates, studies on protocols, botany studies, studies on virtual horticulture, and systematic reviews. Of the 63 articles, 46 articles were further excluded after full-text review. These excluded studies did not have horticulture as a primary intervention, used only qualitative methodology, had participants younger than 60 years old, or were literature reviews. Two studies did not report the mean age or age range of their participants.[20,21] The authors of these 2 studies were contacted; White et al.[21] confirmed that their study recruited individuals aged 51 to 93 years, whereas Lee and Kim[20] did not respond, resulting in the exclusion of both studies. Even though 1 study investigated the effects of farming habits on depressive symptoms, it was excluded because of the nature of participants and purpose of the intervention: in this study, participants were long-term farmers by occupation, hence farming was not an intentional intervention.[22] This resulted in 17 articles being included. Finally, Google Scholar search yielded an additional 3 articles. Therefore, a total of 20 articles were included in this systematic review. A PRISMA flow diagram of the search process can be found in Figure 1. Articles yielded from the search of each database can be found in Table 1.

Characteristics

Using the Johns Hopkins Nursing Evidence-Based Practice Levels of Evidence guidelines, among the included studies, 6 were classified as Class I studies, which include RCTs, CRTs, and experimental studies; 11 were Class II quasi-experimental studies; and 3 were Class III observational studies. PEDro scale scores of the 6 Class I studies ranged from 5 to 8 (Table 2). Five of these studies were high-quality controlled trials,[23–26,28] and 1 study was a controlled trial of fair quality.[27]

A total of 800 participants from all the studies were included in this review, with sample size ranging from 10[29,30] to 129 participants.[27] The mean age of participants ranged from 67.1[25] to 90 years old.[31]

Fifteen studies had both male and female participants. Three studies that used the same sample of individuals[32–34] recruited only men, and 2 studies[35,36] recruited only women.

Almost half of the studies recruited only older adults with dementia, of which one specified that their participants had middle to late-stage dementia.[31] Seven studies recruited older adults without dementia,[25,29,36–39] whereas 2 recruited those with and without dementia.[24,40] The other studies recruited specific populations: 1 study recruited older adults with mental health problems,[4] another recruited older adults with depressive symptoms,[35] and another study recruited only cancer survivors.[23]

Regarding types of HT intervention, we use the term structured horticultural therapy to refer to any form of HT intervention that had a treatment regimen with reported frequency and session duration or protocol. Fifteen studies implemented structured HT, whereas the other 5 studies did not have a fixed treatment regimen,[23,30,32–34] with the frequency and session duration dependent on the participants.[23,30,32–34] Structured HT had specific activities decided for each session; for example, indoor gardening basics taught in week 1, to mulching, pruning, and weeding taught in week 6,[25] although themes and order of activities varied across studies. Activities ranged from a 1-day event[35] to a year-long event,[23,30,32–34] with duration ranging from 15 minutes[35] to 120 minutes,[41] although dosage of wander-garden–based activities were dependent on participants. Detailed characteristics of each study, including type, frequency, and duration of activities can be found in Table 3.

Fifteen studies designed HT activities to encourage active engagement using hands-on gardening activities, for example, transplanting, trimming, and harvesting. The other 5 studies used passive engagement activities, including sensory stimulation in wandering gardens[30,32–34] or garden-viewing.[31]

Effects of HT on Older Adults

Psychosocial effects

Quality of life and well-being. Three RCTs,[23–25] 2 nonequivalent controlled trials[37,38] and 1 single-group study[30] investigated the effects of HT on quality of life (QoL) and well-being of older adults. Outcome measures include the SF-36,[23] Subjective Happiness Scale and Personal Well-being Index,[24] Ryff's Scales of Psychological Well-being and Satisfaction with Life Scale,[25] 7 QoL items in the 100-mm Visual Analogue Scale,[37] Life Satisfaction Index A form,[38]

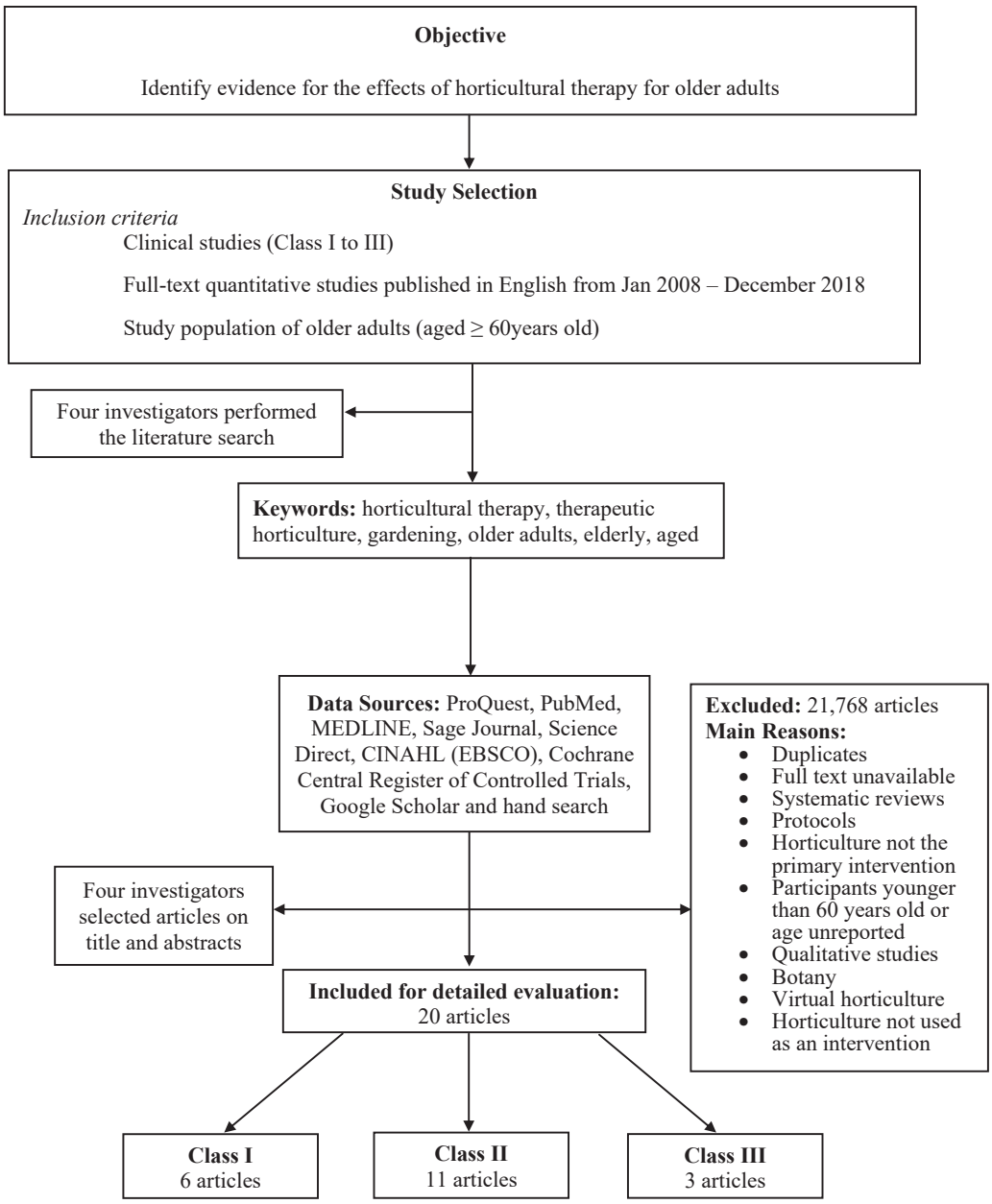

Fig. 1. PRISMA flow diagram of systematic search process, indicating search criteria, databases searched, reasons for exclusion of articles, and classification of articles by quality.

and Dementia Quality of Life Instrument.[30] Significant pre-post improvement in these scores following HT was reported in all these studies. However, all RCTs either reported no significant between-group results[24,25] or did not report between-group differences in QoL.[23]

Anxiety and depression. Anxiety was investigated in an RCT using the Zung Self-rating Anxiety Scale,[25] in a CRT using Apparent Affect Rating Scale (AARS),[27] and in a cross-over study using State Trait Anxiety Inventory.[35] Hassan and colleagues[35] reported a significant pre-post decrease in anxiety, whereas the 2 controlled trials reported no significant between-group differences in anxiety.[25,27]

The Geriatric Depression Scale (GDS) was the most common tool used to measure depressive symptoms, notably in 1 single-group study,[29] 1 nonequivalent controlled trial,[37] and 1 RCT.[24] Another single-group study used the Cornell Scale for Depression in Dementia[30] and another RCT used the Zung Self-rating Depression Scale.[25] All these Class II studies reported a significant pre-post reduction in depressive symptoms among older adults after HT, whereas the 2 RCTs found no significant between-group differences.[24,25]

Agitation. Agitation among older adults with dementia was investigated by 3 exploratory studies,[32–34] 1 single-group study,[30] and 1 experimental study.[28] All used the Cohen-Mansfield Agitation Inventory as outcome measure of agitation. Most studies reported a significant decrease in agitation associated with wander garden visits. Wander gardens allow people with dementia to access nature in a safe environment that promotes visual, olfactory, and tactile stimulation.[32] Only the experimental study by Luk and colleagues[28] reported no significant reduction in agitation within group and between groups.

Mood and engagement. Mood and engagement among older adults with dementia were measured using Menorah Park Engagement

Table 1
Article Selection Process

Database	Articles Yielded	Articles Included for Full-Text Review	Articles Included for Analysis
ProQuest	4333	20	11
PubMed	339	18	15
Medline	3059	7	4
Sage Journal	9887	14	8
ScienceDirect	4151	6	3
CINAHL	20	5	2
Subtotal	18,647	70	43
Total (excluding duplicates)			17
Final total (including hand search)			20

Scale and AARS in a CRT[27] and by Dementia Care Mapping in a single-group study.[41] Both studies reported improvement in mood and engagement, with significantly higher levels of engagement reported in the intervention group in 1 study.[27]

Social relations. Social effects of HT were investigated only among older adults without dementia who participated in structured HT. Of 5 studies, 2 used the Lubben Social Network Scale,[24,38] whereas others used various tools, including a sociality survey,[36] Interpersonal Intimacy Scale,[39] and Friendship Scale.[25] One RCT[25] and 2 nonequivalent controlled trials[38,39] reported significant pre-post improvement in social relations. On the other hand, another RCT[24] and nonequivalent controlled trial[36] found no significant within and between-group differences in social relations.

Loneliness was measured using the University of California Los Angeles (UCLA) Loneliness Scale Version 3 and UCLA Scale Revised in 1 single-group study[29] and 1 nonequivalent controlled trial,[38] respectively. Both studies reported significant pre-post decrease in loneliness scores among older adults without dementia after structured HT.

Physical and functional effects

All studies that examined physical effects of HT recruited only older adults without dementia. Two RCTs,[23,24] 1 experimental 2-group pretest-posttest study,[26] and 1 nonequivalent controlled trial[36] investigated the effect of HT on physical and functional abilities. Three studies found significant pre-post improvement in aerobic endurance using the Senior Fitness Battery[23] and the Senior Fitness Test.[26,36] However, 1 RCT reported no significant within and between-group differences in physical frailty after completion of structured HT.[24]

Three nonequivalent controlled trials[37–39] and 1 single-group study[42] examined the functional effects of HT on older adults after structured HT. Two studies showed significant pre-post improvement in functional ability using the Vitality Index (VI)[42] and Barthel Index (BI),[39] whereas the other 2 reported no significant pre-post improvement using the VI[37] and a modified BI.[38]

Physiological effects

Five studies investigated the physiological effects of HT on older adults using a variety of measures, such as blood[23,25] and saliva samples.[23,26] Except for Goto and colleagues,[31] all other studies recruited older adults without dementia. One RCT found no significant between-group difference in blood cortisol level after structured HT,[25] whereas another experimental study reported a significant decrease in salivary cortisol after structured HT.[26] Other quasi-experimental studies revealed a significant pre-post decrease in heart rate[31] and blood pressure after viewing a Japanese garden and a single transplanting task, respectively.[35] Only 1 cross-over study, which examined brain waves, found increased high alpha and low alpha wave activities after a single transplanting task.[35]

Cognitive effects

All but 1 study[42] that investigated cognitive effects of structured HT recruited older adults without dementia. Most studies used mini-mental state examination (MMSE) or a variation of it as a measure of cognition.[36,37,42] Among older adults without dementia, only 1 nonequivalent controlled trial demonstrated significant pre-post improvement in MMSE,[36] whereas a single-group study reported no significant pre-post improvement in MMSE[37] and an RCT reported no significant between-group difference in MoCA.[25] Only 1 single-group study investigated the cognitive effects of HT on older adults with dementia and found significant pre-post improvement in MMSE scores.[42]

Other effects

Two exploratory studies investigated the effect of wander garden visits on medication use.[32,33] Both studies reported a negative association between wander garden use and medication, but only 1 study reported the association to be significant.[33] The same study also found a significant negative association between wander garden use and the number and severity of falls.[33] One RCT[23] and 1 nonequivalent controlled trial[36] examined the effects of HT on anthropometric measurements. Both studies found significant pre-post reduction in waist circumference after a year-long gardening program[23] and after a 15-session gardening program.[36]

Table 2
PEDro Scores of Experimental Studies

PEDro Items Authors	Demark-Wahnefried et al. (2018)[23]	Lai et al. (2018)[24]	Ng et al. (2018)[25]	Han et al. (2018)[26]	Jarrott and Gigliotti (2010)[27]	Luk et al. (2011)[28]
1. Eligibility	Yes	Yes	Yes	No	Yes	Yes
2. Random allocation	Yes	Yes	Yes	Yes	Yes	Yes
3. Concealed allocation	Yes	Yes	Yes	Yes	No	No
4. Baseline comparability	Yes	Yes	Yes	Yes	Yes	Yes
5. Blind participants	No	No	No	No	No	No
6. Blind therapists	No	No	No	No	No	No
7. Blind assessors	Yes	Yes	Yes	No	No	Yes
8. Adequate follow-up	Yes	Yes	Yes	Yes	Yes	Yes
9. Intention-to-treat analysis	Yes	Yes	Yes	No	Yes	No
10. Between-group comparisons	Yes	Yes	Yes	Yes	Yes	Yes
11. Point estimates and variability	Yes	Yes	Yes	Yes	No	Yes
Total score	8	8	8	6	5	6
Quality of study	High	High	High	High	Fair	High

PEDro, Physiotherapy Evidence Database.
Note. PEDro scores are given out of 10; the first item (ie, eligibility) is not given a point.

Table 3
Characteristics of Included Studies

Authors Study Design	*n*	Settings, Country Participants	1. Intervention 2. Control	Treatment Regimen (Wk × Frequency/ Week × Duration/Session)	Examples of HT Activities	Outcome Measures	Results
Bassi et al., 2018[40] Quasi-experimental, cross-over design (Class II)	13	Nursing home, Italy. Older adults with and without dementia	1. Structured horticultural therapy 2. Occupational activities	6 wk × 1 × 60 min	Sowing, planting, propagation, transplanting, flowery plants arrangement, plant care	• Experience Sampling Method (ESM)	Significant improvement in all components of ESM in intervention group.
Chen et al., 2015[29] Quasi-experimental, one group pretest - posttest design (Class II)	10	Nursing home, Taiwan. Older adults without dementia	1. Structured horticultural therapy	10 wk × 1 × 90 min	Planting, propagating, flower arrangement, discussing plant care techniques	• Geriatric Depression Scale − Short Form (GDS-SF) • UCLA Loneliness Scale Version 3	Significant pre-post reduction in GDS and UCLA Loneliness scores.
Demark-Wahnefried et al., 2018[23] Experimental, randomized controlled trial (RCT) (Class I)	46	Participants' homes, USA. Older adults (cancer survivors)	1. Gardening 2. Waitlist control	52 wk × Depends on participants	Monthly visits with master gardener, social media forum with other participants, gardening supplies and information	• Eating at America's Table Screener(EATS) • Godin Leisure-Time Exercise Questionnaire • Senior Fitness Battery • Anthropometric measures • Biomarkers − nail, saliva, blood • Perceived Stress Scale (PSS) • Quality of Life (Short Form-36 Health Survey) • Reassurance of worth subscale of Social Provision Scale (SPS)	Significant pre-post improvement in EATS, waist circumference, 2-minute step test, timed 8-foot walk and 8-foot up-and-go, and telomerase activity in intervention group. Intervention group significantly higher reassurance of worth than control group.
Detweiler et al., 2008[32] Exploratory, correlational/ predictive (Class III)	34	Dementia facility, USA. Older adults with dementia	1. Wander garden	52 wk × Depends on participants	Visual, olfactory, and tactile stimulation from plants	• Cohen-Mansfield Agitation Inventory Short Form (CMAI) • Pro re nata (PRN) medications • Incident reports	Effect size of wander garden on CMAI was 0.64. More days in garden significantly predicted lower CMAI scores. In terms of incident reports, no change in verbal inappropriate behaviors; physical incidents decreased and participants required less PRN.
Detweiler et al., 2009[33] Exploratory, correlational /predictive (Class III)	28	Dementia facility, USA Older adults with dementia	1. Wander garden	52 wk × Depends on participants	Visual, olfactory, and tactile stimulation from plants	• Number and severity of falls • Medications	Significant reduction in number and severity of falls and in high-use group (HUG) as compared with low-use group (LUG). LUG required significantly more antipsychotics than HUG. LUG required ^{second} dosage of antidepressants but HUG did not.
Edwards et al., 2013[30] Quasi-experimental, one group pretest-posttest design (Class II)	10	Dementia facility, Australia Older adults with dementia	1. Wander garden	52 wk × Depends on participants	Raised growing beds where residents can dig and pick produce, finch aviary	• CMAI • Dementia Quality of Life Instrument (DEMQOL) • Cornell Scale for Depression in Dementia (CSDD)	Significant pre-post improvement in CMAI, DEMQOL, and CSDD.

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Table 3 (*continued*)

Authors Study Design	*n*	Settings, Country Participants	1. Intervention 2. Control	Treatment Regimen (Wk × Frequency/ Week × Duration/Session)	Examples of HT Activities	Outcome Measures	Results
Goto et al., 2017[31] Quasi-experimental, one group pretest-posttest design (Class II)	11	Hospital, Japan Older adults with middle − late-stage dementia	1. Viewing Japanese garden 2. Viewing unstructured garden space	2 wk × 2 × 15 min	Viewing Japanese garden with gravel, stepping stones, bamboo and Japanese maple tree	• Assessment checklist for attention and behavior • Eye movement (eye tracking monitor) • Heart rate	Participants scanned a wider area when viewing garden compared with a control space but significance was not reported. Significant pre-post increase in attention. Significant pre-post decrease in heart rate.
Hall et al., 2018[41] Quasi-experimental, 1 group pretest-posttest design (Class II)	14	Dementia day facility, Australia. Older adults with dementia	1. Structured horticultural therapy	10 wk × 2 × 60−120 min	Gardening-related activities in an outdoor garden	• Dementia Care Mapping (DCM)	Participants had enhanced well-being as measured by DCM.
Han et al., 2018[26] Experimental, pretest-posttest control group design (Class I)	28	Farm, South Korea Older adults with mental health problems	1. Structured horticultural therapy 2. No program	10 wk × 1 × 90 min	Making plant beds, planting transplants, watering, weeding, and harvesting	• Senior Fitness Test (SFT) • Biomarkers - saliva • Satisfaction Scale	Significant pre-post decrease in cortisol levels and increase in SFT scores in intervention group. 100% satisfied or very satisfied with the program.
Hassan et al., 2018[35] Quasi-experimental, cross-over design (Class II)	40	Nursing homes, China (Older adults with psychological stress and depression)	1. Transplanting using soil with plants 2. Transplanting using soil without plants	One day × 15 min	Transplanting	• Blood pressure • Pulse • Brain state (electroencephalogram) • State-Trait Anxiety Inventory (STAI) • Semantic Differential method (SDM)	Significant pre-post decrease in blood pressure. Significantly lower STAI after intervention than after the control task. High alpha and low alpha wave activities were higher in the plant task than in the control task indicative of higher relaxation levels in former group.
Jarrott and Gigliotti, 2010[27] Experimental, cluster-RCT (Class I)	129	Nursing homes, dementia facilities, USA. Older adults with dementia	1. Structured horticultural therapy 2. Standard therapeutic activities	6 wk × 2 × ~50 min each	Sowing seeds, training topiaries, plant-based craft	• Apparent Affect Rating Scale (AARS) • Menorah Park Engagement Scale (MPES)	Intervention group had higher levels of adaptive engagement and lower levels of maladaptive engagement. No significant differences between both groups on pleasure, interest and anxiety based on AARS.
Lai et al., 2018[24] Experimental, RCT (Class I)	110	Nursing homes, Hong Kong Older adults with mild dementia or without dementia	1. Structured horticultural therapy 2. Social activities not including plants, eg, card games	8 wk × 1 × 60 min	Fertilizing, repotting, watering, trimming, propagation, species introduction, seeding	• Frailty Index • General self-efficacy scale • GDS • Subjective Happiness Scale (SHS) • Social Engagement Scale (SES) • Lubben Social Network Scale (LSNS) • Personal Well-being Index	Significant pre-post improvement in subjective happiness in intervention group. No other significant differences within and between groups.
Luk et al., 2011[28] Experimental, two-group pretest-posttest design (Class I)	13	Nursing homes, Hong Kong Older adults with dementia	1. Outdoor gardening 2. Sensory stimulation and social activities, eg, origami	6 wk × 2 × 30 min	Fertilizing, seeding, flower arranging, planting	• C-CMAI	No significant differences in total C-CMAI scores between intervention and control group, and no significant pre-post decrease in intervention group.

Masuya and Ota, 2014[42] Quasi-experimental, one group pretest-posttest design (Class II)	11	Nursing home Older adults with mild to moderate dementia	1. Structured horticultural therapy	6 wk × 1 × 30 min	Planting, transplanting, pruning, harvesting	• Vitality Index (VI) • Mini-mental state examination (MMSE)	Significant pre-post improvement in VI and MMSE scores, but also significantly decreased 1 month later.
Masuya et al., 2014[37] Quasi-experimental, nonequivalent pretest-posttest control group design (Class II)	18	Nursing home Older adults without dementia	1. Structured horticultural therapy 2. Routine care	6 wk × 1 × 30 min	Planting, transplanting, pruning, harvesting	• VI • GDS-15 • Activities of Daily Living-20 (ADL-20) • 7 QoL items in 100-mm Visual Analogue Scale • MMSE	No significant pre-post change VI, ADL-2 and MMSE scores in both groups. GDS-15 scores and "satisfaction with life" component of QoL had significant pre-post improvement in intervention group.
Murphy et al., 2010[34] Exploratory, correlational/ predictive (Class III)	34	Dementia facility, USA. Older adults with dementia	1. Wander garden	52 wk × Dependent on participants	Visual, olfactory, and tactile stimulation from plants	• CMAI	Visiting garden associated with decrease in CMAI scores but rate of change dependent on ambulation ability.
Ng et al., 2018[25] Experimental, RCT (Class I)	59	Community parks, Singapore. Older adults without dementia	1. Structured horticultural therapy 2. No intervention	13 wk × 1 × 60 min (first 3 mo) + 13 × 0.25 × 60 (monthly for next 3 mo)	Indoor gardening, growing, maintaining and harvesting vegetables and herbs, guided walks in various parks	• Montreal Cognitive Assessment (MoCA) • Zung Self-rating Depression Scale • Zung Self-rating Anxiety Scale • Ryff's Scales of Psychological Well-being • Satisfaction with Life Scale • Friendship scale • Biomarkers - blood	Significant decreases in plasma CXCL5 (RANTES), CXCL 12 (SDF-1a) and BDNF (brain-derived neurotrophic factor) in waitlist control but not in intervention group. Significant pre-post increase in positive relations in intervention group. No significant differences in cortisol and all other scales between intervention and control group.
Park et al., 2016[36] Quasi-experimental, Nonequivalent pretest-posttest design (Class II)	50	Senior community centers Older adults without dementia	1. Structured horticultural therapy 2. No intervention	15 sessions × 2 × 50 min	Gardening (eg, making plant beds, planting transplants, fertilizing, weeding, harvesting), floral arrangement	• Body composition • Anthropometric measurements • SFT • Grip strength, pinch force, hand dexterity • K-MMSE (Korean) • K-GDS-SF (Korean) • Sociality Survey • International Physical Activity Questionnaire (IPAQ-SF)	Significant pre-post improvement in muscle mass, aerobic endurance, hand dexterity, MMSE scores, and waist circumference in intervention group. Significant pre-post decrease in muscle mass and agility and increase in GDS scores in control group. Intervention group reported higher amount of physical activity than control group. No significant within and between-group differences in sociality.
Tse, 2010[38] Quasi-experimental, nonequivalent pretest-posttest control group design (Class II)	26	Nursing homes, Hong Kong. Older adults without dementia	1. Structured horticultural therapy 2. Regular care	8 wk Not stated	Gardening, making pesticides, discussions, planting diary	• Modified Chinese Barthel Index (BI) • LSNS • Life Satisfaction Index A form • R-UCLA Loneliness Scale	Significant pre-post increase in life satisfaction and LSNS scores, significant decrease in R-UCLA Loneliness scores for intervention group but not control group. No significant improvement in BI for both groups.

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Table 3 (*continued*)

Authors Study Design	*n*	Settings, Country Participants	1. Intervention 2. Control	Treatment Regimen (Wk × Frequency/Week × Duration/Session)	Examples of HT Activities	Outcome Measures	Results
Yao and Chen, 2017[39] Quasi-experimental, nonequivalent pretest-posttest design (Class II)	85	Nursing homes, Taiwan. Older adults without dementia	1. Structured horticultural therapy 2. Standard nursing home care	8 wk × 1 × 60 min	Plant cultivation, floral arrangement, debriefs	• BI • Chinese Happiness CHI • Meaning of life scale (MLS) • Interpersonal intimacy scale (IIS)	BI, CHI, IIS scores significantly better in intervention than in control group. Also significant pre-post improvement in BI, CHI, IIS. No significant difference in MLS.

Discussion

As most of the studies included in this review were quasi-experimental studies, such as single-group studies or nonequivalent controlled trials, most of the results reported were within-group effects. Nonetheless, there were 6 experimental studies included, of which 4 were RCTs or CRTs. Since the last systematic review of RCTs investigating the effects of HT done by Kamioka and colleagues in 2014,[16] there have been 3 more RCTs done on HT for older adults. As appraised by the PEDro scale, these RCTs were of high quality (Table 2).

Effects of HT on Older Adults

Various effects of HT were investigated, including psychosocial, cognitive, physical, and physiological effects, with psychosocial effects being the most widely investigated. Most studies reported significant pre-post improvement in QoL and well-being, anxiety and depression, social relations, physical effects, and cognitive effects. In terms of pre-post improvement, there were mixed results on the functional effects of HT. The 9 studies that recruited older adults with dementia investigated agitation, mood and engagement, falls, medication use, QoL, and depressive symptoms. Most studies reported significant association or improvement in these effects with HT.

However, most of the studies that reported significant pre-post effects with HT were quasi-experimental Class II studies, 9 of which had fewer than 50 participants. Between-group effects were either not investigated because of the study design or were not significant in RCTs. Only 1 CRT found significant between-group effects in engagement levels among older adults with dementia.[27] The lack of between-group effects prevent causal statements on the effects of HT on older adults from being made. In addition, as most studies were done in long-term care or dementia day care facilities, results cannot be generalized to other settings, such as palliative and acute care.

Most studies used self-reported questionnaires or observational tools to investigate psychosocial effects. Few recent studies used physiological outcome measures, such as blood, saliva, hair or nail samples, blood pressure, brain waves, and gaze tracking. These measures can function as objective markers of change that can complement existing subjective measures.

Implications

As nearly all horticultural interventions were conducted in nursing homes and other long-term care facilities, results from this review can be used to guide the practice and design of long-term care professionals and facilities, particularly those catering to older adults with dementia.

Passive engagement activities, notably wander garden usage, were investigated only in studies that recruited older adults with dementia, and all these studies reported positive effects on agitation. Other studies that recruited older adults with dementia used structured HT and outdoor gardening, although, as compared with wander gardens, the impact of these interventions was mixed: although there was no improvement in agitation, well-being was enhanced postintervention. Long-term care facilities can thus consider incorporating wander gardens into their design, as the studies suggest that they have some effect on agitation among older individuals with dementia. Wander gardens offer sensory stimulation, such as tactile stimulation, which is associated with psychological and physiological calmness,[43] and can be designed to be suitable for individual cultural contexts.[30]

For older adults without dementia, our review suggests that active engagement activities, notably structured HT, can be considered both in long-term care facilities and out-in-the-community settings, such as in parks and community centers, in order to improve different outcomes. Structured HT in long-term care facilities was conducted for

minimally 30 minutes per session and was associated with improvement in QoL and emotional well-being, whereas out-in-the-community HT was conducted for minimally 60 minutes per session and was associated with improvement in social and physical parameters. Hence, depending on the goal of the organization, structured HT with varying dosage can be conducted in different settings.

Directions for Future Studies

Future studies on HT for older adults can consider using physiological measures in addition to self-reported and observational measures. Other areas of future research include the reporting of any adverse effects or unpleasant outcomes of HT, which were not mentioned in any study. Participant satisfaction with the HT used also was not adequately examined. In addition, long-term benefits of HT for older adults can be further examined; this was investigated in only 1 study after a wash-out period of 1 month.[42] Finally, only 2 studies in this review examined medication use,[32,33] and 1 examined falls as an outcome measure.[33] As these are salient areas in geriatric care, more studies should investigate the effects of HT on older adults' fall risk and frequency, as well as medication use.

Strengths and Limitations of the Systematic Review

We adopted a systematic approach in identifying articles and used relevant scales to critically appraise the evidence.

Nonetheless, our systematic review has several limitations. First, because of the heterogeneity of the included studies, meta-analyses could not be done. Although most studies used structured HT, each differed in frequency, duration, and time period; the most optimal intervention dose remains ambivalent. Furthermore, studies used differing tools within and between outcomes; for example, even though GDS was commonly used, all studies used different versions of it. In addition, even though experimental studies compared the use of HT to a control group, control conditions were different across studies, which prevents reliable conclusions to be drawn on the effectiveness of HT in older adults. Although we were able to offer recommendations for long-term care professionals, the heterogeneity of the included studies nonetheless prevents our systematic review from providing clinical guidance on the optimal treatment regimen of HT for older adults.

Second, we included only studies published in English. During our search, there were several studies on HT for older adults that were published in Korean and Japanese but were not included based on language.

Last, as studies on the use of HT might be published in journals from various fields, it is possible that search in other nonclinical databases could have yielded additional relevant studies.

Conclusions and Implications

In conclusion, HT is widely used in many settings for older adults, particularly in long-term care facilities. Hence, the results from this review can be used to guide the design and practice of long-term care facilities. Nonetheless, although the evidence for various effects of HT on older adults appears promising, more robust evidence is still needed to draw firm conclusions on the effects of HT for older adults across psychosocial, cognitive, and physical domains. In particular, more experimental studies are needed to investigate between-group effects of HT on older adults.

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Appendix. Search Term Combinations

Horticultural therapy AND elderly OR horticultural therapy AND aged OR horticultural therapy AND older adults

Gardening AND elderly OR gardening AND aged OR gardening AND older adults

"Therapeutic horticulture" AND elderly or "therapeutic horticulture" AND aged OR "therapeutic horticulture" AND older adults