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Therapeutic horticulture as a potential tool of preventive geriatric medicine improving health, well-being and life quality – A systematic review

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ABSTRACT

The global population of older people grows systematically and with age, the physical and cognitive abilities of people decline. The amount of evidence that gardening may provide substantial health benefits and enhance the quality of ageing is increasing. This paper presents a systematic review of the therapeutic effects of horticulture and gardening on clients aged ≥60 years. It encompasses articles published in English between January 1, 2010, and December 31, 2021. The literature survey shows that the interest in the topic has grown significantly in recent years as over half of the published studies are from 2019 to 2021. Most of this work was done in Asia (60%), America, Europe, Australia and New Zealand. The most commonly used interventions were active horticultural therapy programs or gardening, but 20% of the studies explored the passive connection of being outside. The fitness of the elderly was measured using 33 psychological tests, 32 physiological and functional parameters and different kinds of self-developed questionnaires and interviews. The most commonly used psychological tests were the Geriatric Depression Scale, Self-rated Health and Quality of Life, Mini-Mental State Examination, Friendship Scale, Lubben Social Network Scale, and the Attitudes to Ageing Questionnaire. The physiological and functional parameters included heart rate variability, blood pressure, electroencephalography, brain nerve growth factors, and different types of biomarkers. The study outcomes demonstrated positive results of horticultural therapy on human health and well-being, particularly in a psychological dimension and to a smaller but still significant extent physiological aspect.

Keywords: agriculture services, gardening, green care, health promotion, horticultural therapy, older people

BACKGROUND

Older people are making an increasing segment of the planet's population. In 2020, 1 in 10 people worldwide were aged ≥60 years, whereas in 2050, the projected proportion will be 1 in 6 (United Nations, 2019). With increasing age, physical and cognitive abilities decrease; thus it becomes necessary to support people in performing everyday activities, and with time, in some cases, to include 24-h care. In response to the increased needs, more and more opportunities for the elderly are created, ranging from day care centres, through different forms of assisted living facilities, to nursing homes with round the clock medical care

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available (Rowles, 2018). In many of those facilities, 'green care', which include horticultural therapy (HT), wilderness therapy animal-assisted therapy, exercising outdoors, and other nature-based treatment, is included in the main treatment plan (Brandes, 2017). For most of the elderly, such nonpharmacological interventions are helpful in maintaining physical and cognitive fitness, as well as improving life quality and social bonds (Tkatch et al., 2016).

Through the years, scientists and doctors have recognised the beneficial influence of the people–plant connection and have started to bring the engagement with plants to the level of occupational therapy (DelSesto, 2017). Watson and Burlingame (1960) attracted attention to the importance and value of horticultural therapy (HT) and defined it as an improvement of physical and mental health that may aid recovery and provide vocational rehabilitation for a client. After 20 years, Relf (1981) presented a model demonstrating the therapeutic benefits of HT and clarified HT definition as a practice of using horticultural activities for human healing and rehabilitation. She also explained the value of this therapy to the researchers and doctors, and these explanations are still valid. Relf (1981, 1992) claimed that the goals of HT programs may differ but their basic assumption is that working and spending time with plants causes improvement in quality of life, illustrated by positive psychological and physical changes. Her approach coincides with the theory of biophilia presented by Wilson (1984), which says that man has an innate need and desire to be in contact with nature, and it evokes positive reactions. The terminology may vary and new aspects in this field may appear but the benefits of the people–plant connection are indisputable, and this is why the use of plants in therapy is gaining popularity (Haller and Kramer, 2006).

Gardening is a common leisure activity among older adults, which makes it a familiar action that can be used to positively influence health and well-being. This has been supported by many studies, which show that gardening may be perceived as a therapeutic intervention (Hartig et al., 2014; Soga and Gaston, 2016; Spilková, 2017). Either active involvement, such as potting up plants and watering them or passive experience such as viewing a garden and listening to the birdsong, may be beneficial for health and well-being and should be considered in a therapeutic process (Scott, 2015).

As stated by a study by Simson and Straus (1998), 'Therapeutic gardening (TG) is the cultivation of plants to promote a healing environment, receive mental and physical health benefits, and increase well-being'.

The primary intention of TG is to improve the client's well-being, which is realised by the gardeners' active and passive time spent in the garden.

In comparison, in horticultural therapy (HT) the presence of a trained professional (horticultural therapist) who carries out a specific plan of care with measurable effects is required. The American Horticultural Therapy Association (AHTA) defines HT as 'the participation in horticultural activities facilitated by a registered horticultural therapist to achieve specific goals within an established treatment, rehabilitation, or vocational plan. HT is an active process that occurs in the context of an established treatment plan where the process itself is considered the therapeutic activity rather than the end product' (AHTA, 2017).

On the other hand, therapeutic horticulture (TH) 'is the process through which clients enhance their well-being through active or passive involvement in plant and plant-related activities' to support program goals (AHTA, 2017) (Table 1).

The research has shown that working closely with plants brings a broad spectrum of health benefits to older adults, starting with the increase in physical activity and continuing with the reduction of physiological changes associated with ageing, improved balance and muscle strength, decreased insomnia and body pain, and reduced blood pressure. Further benefits of contact with nature include mental restoration, cognitive and intellectual stimulation, reduced risk of developing stress-related illness and improved mood. Finally, people may benefit from social interactions such as a stronger sense of unity

Table 1. Main differences between TG, HT and TH.

	TG	HT	TH
Client engagement	Active and/or passive interaction with a garden	Horticultural-related activities	Active and/or passive horticultural-related activities
Participants	Anyone who feels they may benefit from the involvement	Identified disability, illness or life circumstance requiring services	Identified disability, illness or life circumstance requiring services
Facilitator	Professional or non-professional with training in horticulture	Horticultural therapist	Horticultural therapist or professional with training in horticulture
Aims and outcomes	Not documented, general	Documented, specific (an agreed treatment, rehabilitation, or vocational plan)	Not documented, specific

Developed based on AHTA (2017).

AHTA, American Horticultural Therapy Association; HT, horticultural therapy; TG, therapeutic gardening; TH, therapeutic horticulture.

and belonging and decreased risk of dementia (Sugiyam and Thompson, 2005; Clatworthy et al., 2013; Wolf and Housley, 2016).

Currently, more research has been conducted on the impact of the natural environment on the health and well-being of older people. Gardening has many benefits to assist healing and the rehabilitation processes. Seniors associate the garden with a safe and friendly space that is free from stress factors. It allows you to restore a sense of internal order and security, as well as deal with chaos and anxiety resulting from illness or disability. The garden has been recognised as an important tool in the treatment of dementia, as it encourages conversation among seniors, helps people to recover long-forgotten memories, and generally puts the patients in a pleasant frame of mind. The location of the garden within the facilities for the elderly motivates them to be active and to go outside (Jarott et al., 2002; Borgen and Guldahl, 2010; Zawiślak, 2015; Dudkiewicz et al., 2018).

Publications usually focus on the results of horticultural therapy for the elderly with chronic illnesses (Gagliardi and Piccinini, 2019; Tu and Chiu, 2020; Yeo et al., 2020), sometimes differentiating between a physical illness such as cancer (Blaschke, 2017) and mental illnesses such as bipolar disorder, schizophrenia, major depression and dementia (Kamioka et al., 2014; Orr et al., 2016; Cipriani et al., 2017; Zhao et al., 2020; Lu et al., 2021). None of the previously published systematic reviews focused on older people who are healthy according to the WHO definition of health (1948), and for whom HT or other gardening interventions could be used as a preventive measure for the development of serious diseases or as a way of healthy and sustainable ageing.

This systemic review aimed to summarise and synthesise the results of the achievements in the field for a better understanding of the theoretical basis of horticultural therapy to conduct effective therapeutic interventions through gardening for older adults. Our purpose was also to make an objective summary of the effectiveness and efficiency of horticultural therapeutic interventions. When deciding to prepare the review, we were looking for the answers to the questions: what forms of therapy are currently being carried out; what effects they give and whether the effects differ depending on the form of therapy (passive/active); and what research methods are used to evaluate the effectiveness of horticultural therapy. We also found it intriguing in which countries gardening therapy is practised and whether there are cultural differences. And, above all, whether horticultural therapy can be used for the elderly as an effective form of preventive action, improving their health and quality of life?

MATERIALS AND METHODS

Our systematic review of quantitative and qualitative research focused on the influence of horticulture and/or plants on healthy older adults. To ascertain that a similar systematic review had not been performed before, the Cochrane Database of Systematic Reviews (CDSR) was searched.

Terminology

For the purposes of this article, health is, as stated by the WHO in 1948, 'a state of complete physical, mental and social well-being and not merely the absence of disease or infirmity'. According to this definition, a 'healthy person' is one in the state of overall well-being and able to function independently on a daily basis. Positive outcomes are interpreted not only as the amelioration of symptoms of a chronic illness but also as the presence of positive and lack of negative emotions. The term 'gardening' is used to describe growing, cultivating and otherwise taking care of plants in a non-commercial setting. Garden maintenance, care of house plants and floristry are also included in 'gardening'. In this study, horticultural therapy was considered as a form of gardening that engages clients in gardening activities and aims to improve their physical, physiological and social well-being.

Search strategy

The databases searched were PubMed, ProQuest and Google Scholar (the first 10 pages), using the keywords horticultural therapy, therapeutic horticulture, therapeutic gardening, elderly, and older adults. The combinations of the terms in the keyword search are presented in Figure 1. Only the articles published between January 1, 2010, and December 31, 2021, were taken into consideration. Due to the lack of agreement on the actual definition of 'horticultural therapy', articles on horticultural therapy, therapeutic horticulture and therapeutic gardening were also included. Titles and abstracts of the identified published articles were reviewed for relevance. For all substantial articles, references were manually searched for inclusion in other significant articles.

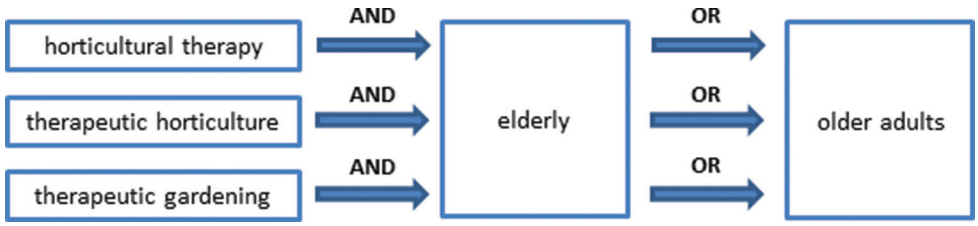

Figure 1. Diagram showing combinations of terms and keywords used during the search process.

Inclusion criteria

Studies were included if they met the following criteria.

- *Population:* The research was included if the participants were older adults (≥60 years), living independently, in assisted living, under personal care or in other kinds of elderly care facilities.
- *Intervention:* The study was included if it investigated the influence of horticulture and/or nature on older adults. Both active and passive interactions with horticulture and/or gardening were taken into consideration. Through active interactions, we understand gardening activities and plant-related crafts in which the action brings about a specific effect, e.g. preparing the soil, seeding, rooting, planting, weeding, watering, harvesting, flower arranging, plant identification, leaf print, potpourri sachet making, etc. Through passive interactions, we understand activities like visiting parks or gardens, garden observation and listening, and other activities which allowed the participants to spend time being surrounded by nature, without producing a specific effect.
- *Study-design:* Quantitative studies were considered suitable if they i randomised controlled trials (RCTs), non-RCTs or other controlled pre-/post-studies. Qualitative studies were deemed suitable if they included any recognised methods of data collection and analysis used in any discipline or theoretical tradition.
- *Formal requirements:* Included papers were published in English in peer-reviewed journals and were full-text articles.

Data extraction

To ensure consistency between the studies, data extraction sheets were developed. The extracted data for each study included (if possible) the author and study design, year of the publication, country, settings, participant characteristics, description of the intervention and control activities (examples of horticultural activities performed during the studies), treatment regimen, outcome measurement methods and results.

Methodological quality assessment

The quality of the included articles was evaluated using the Johns Hopkins Nursing Evidence-Based Practice Levels of Evidence guidelines (JHNEBP), which is a clinician-focused model granting quick and appropriate application of present research and best practices. The model objective is to ensure that patient care is provided with the use of the latest research findings and best practices. It encompasses five levels of evidence that show if the studies are of high, good or low quality based on the study design, sample size, control group type, consistency of results and ability to draw conclusions (Dang and Dearholt, 2019).

RESULTS

Study selection

The CDSR search revealed that no similar systematic reviews were being conducted. The search strategy identified 5731 results, of which we selected 81 for further review. The excluded articles included studies on virtual horticulture and studies in which the participants were <60 years with systematic reviews. After full-text evaluation, a further 30 articles were excluded due to a lack of description of horticultural activities, missing participants' characteristics and/or their age or due to being literature reviews or database duplicates. The next 33 articles were excluded as duplicates between databases. Finally, 35 papers were deemed eligible, including 17 identified following a manual search of references. The search process is summarised in a flow diagram in Figure 2.

General description of studies

An overview of 35 case studies is presented in Table 2. Over half of the studies (19) were published from 2019 to 2021, which shows the increasing interest in researching TH for healthy older adults. Another 16 articles were published between 2010 and 2018. There were no studies between 2011 and 2013 (Figure 3).

Most of the studies (21) came from Asian countries: Korea (6), China (4), Taiwan (5), Singapore (4), Indonesia (1) and Japan (1). The rest came from Europe (5), including Italy (2), the UK (2) and Sweden (1), and from other countries: the USA (4), Canada (1), Australia (3), and New Zealand (1) (Figure 4).

The study groups were highly diverse in terms of size and the age of the participants, although all of them were deemed healthy older people. The sample size ranged from 10 to 3,237 participants, and the participant age from 53 years to 103 years. The research analyses included the elderly residents of nursing homes (13) and independently living seniors (22) (Table 2).

The intervention types included HT programs (15 studies), gardening activities (13 studies) and passive contact with nature (7 studies). The interventions lasted from 1 day to 1 year, but most commonly were from 6 weeks to 12 weeks (15 studies), with the duration of sessions ranging from 5 min to 120 min, but, sometimes, that depended on the participants (Table 2). The studies yielded a wide range of health outcomes of physical, psychological and sociopsychological nature.

Types of people–plant interventions

Our analysis identified two main types of intervention, i.e. passive or active people–plant interactions. The active interventions were applied in 28 studies and the passive ones in 7 studies.

Active interventions included gardening, garden design and planning, plant-related art, plant-related crafts, floristry, garden parties with plant-related

Table 2. Characteristics of included studies.

	Author	Country	Participants (intervention group, control group)	Study design and treatment regimen	Outcome measurements	Results
Active people–plant interactions						
1.	Bassi et al. (2018)	Italy	11 residents of a nursing home (both occupational activities and HT	Crossover study with a baseline measure Two cycles, 6 weeks × 1 × 60 min each	Psychological tests	Increase of cognitive and motivational variables, during both activities, and improved self-satisfaction in comparison with occupational therapy treatment. Horticulture was recognised as more challenging than occupational therapy treatment
2.	Chen and Janke (2012)	USA	3237 seniors (clients gardeners, control nongardeners)	At least 1 h per week	Physiological and functional tests Self-reported measure of health status	Significantly better balance and improved gait were reported by gardeners, they also had fewer functional limitations and chronic conditions than nongardeners Falls in the past 2 years were rarer in the gardeners group than in the nongardeners group
3.	Chen and Ji (2015)	Taiwan	10 residents of a nursing home (clients with indoor HT program)	Preliminary study, combined quantitative and qualitative design 10 weeks × 1 × 90 min	Background data sheet Psychological tests	HT program resulted in encouragement of social connections and companionship, hope, anticipation and a sense of achievement. Levels of depression and loneliness significantly increased
4.	Chu et al. (2021)	Taiwan	88 residents of nursing homes (clients horticultural activities, control leisure activities)	Quasi-experimental, nonequivalent pretest-posttest control group design 8 weeks × 1 × 120 min each	Sociodemographic questioner Psychological tests Physiological and functional tests	'Attitudes toward ageing' and 'sense of hope' increased after the intervention. The experimental group significantly improved the time required to complete the cup stacking test
5.	Freeman et al. (2019)	New Zealand	72 seniors	In-depth, qualitative interviews Not stated	Individual interviews	Older adults highly value the direct engagement with nature, even when limited by health
6.	Han (2017)	Korea	40 female members of I Church (clients with HT program, control no intervention)	Quasi-experimental, nonequivalent pretest-posttest control group design 8 weeks × 1 × 90–120 min	Psychological tests Physiological and functional tests	Significant pre-post improvement in all sub-factors of self-respect and in all sub-factors of personality and talent in the experimental group
7.	Kim et al. (2021)	South Korea	58 seniors (both horticultural and non-horticultural activities)	Cross-over experimental design 1 day × 8 × 2 min	Psychological tests Physiological and functional tests	The results of the POMS showed that during horticultural activities the total mood disorder score was lowered. Brain activity of older adults may be increased by activities such as washing leaves, transplanting, and reading news and that has a positive effect on their cognitive function

(*Continued*)

Table 2. Continued.

	Author	Country	Participants (intervention group, control group)	Study design and treatment regimen	Outcome measurements	Results
8.	Lai et al. (2018)	China	111 residents of nursing homes (clients with HT program, control no intervention)	RCT 8 weeks × 1 × 60 min	Psychological tests Physiological and functional tests	Significant increase in the subjective happiness after the HT program
9.	Lee (2019)	Korea	58 residents of a nursing home (clients with HT program, control no intervention)	Quasi-experimental, pretest-posttest control group design 10 weeks × 1 × 50 min	Physiological and functional tests	Significant pre-post decrease in the positive domain in the control group and non-significant in the experimental group Significant pre-post decrease in mean score of neuroticism and physiological domain in the experimental group
10.	Lo et al. (2019)	China	22 residents of nursing homes (clients with HT program)	RCT with a qualitative descriptive approach 8 weeks × 1 × 60 min	Individual semi-structured interviews	Clients of nursing homes saw HT as an enjoyable activity and a good pastime, which made them happier. Horticultural activities resulted in socialisation among the residents
11.	Masuya et al. (2014)	Japan	18 residents of a nursing home (clients with HT program, control no intervention)	Quasi-experimental, nonequivalent pretest-posttest control group design 6 weeks × 1 × 30–40 min	Psychological tests Physiological and functional tests	Significant improvement in satisfaction with life and a significant decrease in GDS score after the intervention No significant pre-post change in vitality Index, Activities of Daily Living Scale, and MMSE scores in both groups
12.	Ng et al. (2018)	Singapore	59 seniors recruited from the neighbourhood (clients with HT program, control no intervention)	RCT Stage 1 3 months × 1 × 60 min Stage 2 3 months × once a month × 60 min	Physiological and functional tests Psychological tests	A significant reduction in plasma IL-6 level in the HT intervention group Social connectedness significantly improved in the HT group Significant reductions in plasma CXCL12 (SDF-1), CXCL5 (RANTES) and BDNF in the control group
13.	Ng et al. (2021)	Singapore	59 seniors (clients HT intervention, control waitlist)	Secondary analysis of an RCT Stage 1 3 months × 1 × 60 min Stage 2 3 months × once a month × 60 min	Psychological tests Physiological and functional tests	Social connectedness significantly increased and Log10 IL-6 levels significantly decreased after HT.
14.	Park et al. (2016)	South Korea	50 seniors recruited from senior community centres (clients with gardening intervention, control no intervention)	Quasi-experimental, nonequivalent pretest-posttest control group design 3 months × 2 × 50 min	Physiological and functional tests Sociality survey Psychological tests	Significant pre-post improvement in hand dexterity, aerobic endurance, muscle mass, cognitive ability, and decreased waist circumference in the gardening group. Significant pre-post decrease in agility and muscle mass, and a significant increase in depression in the control group.

(*Continued*)

Table 2. Continued.

	Author	Country	Participants (intervention group, control group)	Study design and treatment regimen	Outcome measurements	Results
15.	Park et al. (2019)	South Korea	41 seniors recruited from community and welfare centres (clients with gardening intervention)	Quasi-experimental, one group pretest-posttest design 1 day × 1 × 20 min	Physiological and functional tests	Significant increase in levels of PDGF and BDNF after the gardening activity
16.	Park et al. (2020)	South Korea	40 seniors recruited from the senior welfare centre (clients with gardening intervention, control no intervention)	Quasi-experimental, nonequivalent pretest-posttest control group design 12 weeks × 2 × 60 min	Physiological and functional tests Psychological tests	Significant pre-post improvements in BDNF levels, hand dexterity, better cognitive ability and improvements in cognitive health in the gardening group Significantly higher scores in MMSE of the gardening group after the program None of the groups showed significant differences in the pre-/post- scores of all SFT items
17.	Perkins (2012)	USA	31 seniors recruited from independent, community-based, age-restricted residences (clients with HT program, control no intervention)	Quasi-experimental, pretest-posttest control group design 6 weeks × 1 × 90 min	Psychological tests Garden Questionnaire developed by the investigator	Significant variance in self-esteem and garden knowledge between the groups No significant differences in psychological well-being, garden experience, or social connectedness between the treatment group and the control group Most helpful parts of classes were learning about herbs and their uses, growing and using herbs, participating in the class (the social aspect)
18.	Robbins and Seibel (2019)	USA	27 older African Americans	In-depth, qualitative interviews Not stated	Individual interviews	Gardening lay a part in the well-being of older adults. Plants and gardening practices provided perspectives on the transformations of social dimensions
19.	Scott et al. (2014)	Australia	331 senior gardeners	A self-administered survey Median time per week – 8 h	Gardening benefits questionnaire Gardening activity inventory Psychological tests	Participants felt that gardening was more than a casual leisure activity, they emphasised it as crucial to their psychological and physical wellbeing They reported that gardening has numerous psychological, physiological and tangible benefits
20.	Scott et al. (2016)	Australia	331 senior gardeners	A self-administered survey Median time per week – 8 h	Gardening benefits questionnaire Gardening activity inventory Psychological tests	Leisure gardening derived numerous benefits for the participants. Gardening was seen as a crucial activity to their well-being and to ageing positively
21.	Scott et al. (2019)	Australia	331 senior gardeners	A self-administered survey Median time per week – 8 h	Gardening benefits questionnaire Gardening activity inventory Psychological tests	Positive ageing self-perceptions were mostly influenced by restoration and physical benefits of gardening More physical and social benefits were reported by gardening group members than non-members

(*Continued*)

Table 2. Continued.

	Author	Country	Participants (intervention group, control group)	Study design and treatment regimen	Outcome measurements	Results
22.	Sia et al. (2020)	Singapore	47 seniors recruited from senior day care centres (clients with HT program)	Experimental, one group pretest-posttest design 24 weeks × 1 × 60 min	Psychological tests Physiological and functional tests	Significant increase in cognitive functions and mean happiness. Reduction in anxiety. Sustained psychological health and sleep patterns
23.	Tse (2010)	China	53 residents of a nursing home (clients with indoor gardening program, control no intervention)	Quasi-experimental, nonequivalent pretest-posttest control group design 8 weeks × not stated	Psychological tests Physiological and functional tests	Life satisfaction and social network significantly improved and perception of loneliness significantly decreased in the experimental group after the intervention
24.	Tu et al. (2020)	Taiwan	27 seniors who attended Fooyin University Senior Citizens Learning Camp (clients with HT program)	One group pretest-posttest design 2 weeks × 2 × 60 min	Physiological and functional tests Psychological tests	Significantly lower SAA and pulse rate after activities Mood states significantly improved for Rocky Leaf Prints and Herb Tasting and Smelling
25.	Widodo et al. (2019)	Indonesia	14 senior residents of Batu City (clients with the gardening program, control no intervention)	Quasi-experimental, pretest-posttest control group design 6 months × daily × not stated	Physiological and functional tests	Pre-post improvement in anxiety and stress levels in the experimental group (42.9%) and in the control group (28.6%)
26.	Wong et al. (2021)	Singapore	59 seniors (clients HT intervention, control waitlist)	RCT Stage 1 3 months × 1 × 60 min Stage 2 3 months × once a month × 60 min	Sociodemographic questioner Physiological and functional tests	Reduction in the levels of biomarkers that indicates the extent of T-cell exhaustion and inflammation in older adults is associated with HT. Pre-post reduction of IL-6 levels
27.	Wu et al. (2020)	Taiwan	17 seniors recruited from a community care centre for the elderly (clients with HT program)	Quasi-experimental, one group pretest-posttest design 12 weeks × 1 × 120 min	Psychological tests Semi-structured interviews	Immediate and significant improvement in overall cognitive function after the HT program. Interviews revealed that: 'the *HT program was meaningful and encouraged the elderly to be engaged in the activities and recall the past, improved enjoyment and learning motivation and ensured new planting experience*'
28.	Yao and Chen (2017)	Taiwan	85 senior residents of nursing homes (clients with HT program, control no intervention)	Quasi-experimental, pretest-posttest control group design 8 weeks × 1 × 60 min	Psychological tests Physiological and functional tests	Significant pre-post improvement in physical abilities, happiness, meaning of life, and interpersonal intimacy in the experimental group

(*Continued*)

Table 2. Continued.

	Author	Country	Participants (intervention group, control group)	Study design and treatment regimen	Outcome measurements	Results
Passive people–plant interactions						
29.	Dahlkvist et al. (2016)	Sweden	290 residents of nursing homes (self-motivated garden visits)	Multi-level, cross-sectional, correlational design Not stated	Psychological tests	Positive and significant effect of greenery on self-perceived health Health appears to be affected by garden greenery by providing possibilities to experience the outdoor environment as interesting and encouraging and enhancing a sense of being away
30.	Finlay et al. (2015)	Canada	141 community-dwelling older adults (everyday experiences with green spaces)	In-depth, qualitative interviews Not stated	Individual interviews	Green and blue spaces have an influence on physical wellbeing (motivation for physical activity), mental wellbeing (sense of improvement, feelings of renewal, restoration, rejuvenation, relaxation and stress reduction) and social wellbeing (social interactions, multi-generation enjoyment)
31.	Gagliardi et al. (2020)	Italy	19 seniors who joined the environmental volunteering and socialising activities in a city park program (park restoration and social activities)	Quasi-experimental, one group pretest-posttest design 1 year × 2 × depends on participants	Physiological and functional tests Psychological tests Individual interviews	Volunteers increased their weekly engagement in gardening activities and time spent performing voluntary work. They also cared for other people more and had better life satisfaction
32.	Hassan et al. (2019)	China	50 women residents of a nursing care facility (clients with visual stimulation with a money plant, control visual stimulation without any plant)	Quasi-experimental, pretest-posttest control group design 2 days × 2 × 5 min	Physiological and functional tests Psychological tests	Significant pre-post decrease of systolic blood pressure and total state-trait anxiety scores in the experimental group No change in diastolic blood pressure between conditions. Variations in both high alpha and high beta brainwaves in the experimental group
33.	Irvine et al. (2020)	UK	13 seniors recruited from Group Outdoor Health Walk Program (outdoor walks)	Observational pretest–posttest study with convergent mixed methods design 12 weeks × depends on the route	Physiological and functional tests Psychological tests Individual interviews	Self-reported physical activity improved during the study. Participants experienced more positive emotions and felt they had more energy Clinically relevant changes in experiencing vibrant senses, feeling energised, focused, joyful and calm, as well as sleeping well

(*Continued*)

Table 2. Continued.

	Author	Country	Participants (intervention group, control group)	Study design and treatment regimen	Outcome measurements	Results
34.	Reynolds (2016)	USA	32 residents of facilities (independent living, assisted living, personal care) (garden use)	A qualitative study of participant observations with behaviour mapping and individual and focus-group interviews, using a grounded theory methodology Depends on participants	Participant observations Individual interviews	High value for nature reported by all participants (essential to their well-being) Nature was valued as an affinity for life, and plants almost as people
35.	Wood and Smyth (2020)	UK	45 healthy participants recruited from the University of the Third Age (Green exercise)	Pilot study 24 h	Physiological and functional tests Psychological tests	Nature exposure and Green Exercise in childhood significantly predicted nature exposure and Green Exercise in adulthood CN was negatively linked to stress and positive linked to HRV during sleep Higher CN was correlated with less stress reactions and higher rate variability during sleep which both are indicators of health

CN, connectedness to nature; GDS, Geriatric Depression Scale; HRV, heart rate variability; MMSE, mini-mental state examination; POMS, profile of mood states; RCT, randomised controlled trial; SAA, salivary amylase activity; SFT, senior fitness test; PDGF, Platelet-Derived Growth Factor: RANTES, Regulated upon Activation, Normal T cell Expressed and Secreted; SDF-1, Stromal cell-derived factor 1.

cooking, and an environmental volunteering program (Table 3). Most of the studies combined more than one active intervention. Gardening was the most popular of all interventions and was used in 24 studies. Gardening activities were more often held outdoors (14 studies) than indoors (10 studies) and included actions such as seeding, propagating, planting, replanting, watering, weeding, fertilising, trimming, compost making, harvesting, plant care, and garden bed making. The second-most popular activity was plant-related art which included making name tags and fans using dried flowers, flower pockets, grass dolls, pressed flower frames and cards, sun-catchers, origami flowers and nature art collage. It also covered rock art, leaf printing and sketching, jigsaw puzzles of weeds and decorating flower pots. Plant-related art activities were used in eight studies. The remaining activities included floristry (eight studies) – flower and plant arrangements, making praising and dry bouquets, wreath making, planting succulents in bottles, kokedama and terrarium making; making plant-related items (five studies) such as potpourri, lavender soap, herbal heating pads, body scrubs, anti-mosquito herbal repellents, multi-functional herbal creams, monopoly maps of plant landscapes of the community and herb tea; garden design and planning (four studies); garden parties with plant-related cooking (four studies) and an environmental volunteering program (one study).

Passive interactions were differential and included garden visits (two studies), visual stimulation with plants (two studies), outdoor walking group (one study) and green exercise (one study) (Table 3).

Effects of interventions and applied tests

Three groups of specified test measurements were used for this research. Thirty-three different psychological tests were used in 21 studies, and 32 different physiological and functional parameters were assessed in 23 studies. Also, 16 studies used questionnaires developed by the investigators or interviews, of which the most popular were the individual interviews which were used in 11 studies (Table 4).

Psychological and cognitive effects

The studies focused on psychological effects and explored depression, anxiety, well-being, life satisfaction, quality of life, self-respect, self-esteem, happiness, stress and attitudes to ageing. Most commonly, the psychological tests used in three or more of the studies were the Geriatric Depression Scale (GDS), Self-rated Health and Quality of Life (SF-36), Mini-Mental State Examination (MMSE), Friendship Scale (FS), Lubben Social Network Scale (LSNS) and the Attitudes to Ageing Questionnaire (AAQ).

Depression and anxiety were investigated in eight studies using the GDS, Zung Self-Rating Depression Scale (SDS), Zung Self-Rating Anxiety Scale (SAS) and State-Trait Anxiety Inventory (STAI). All studies showed a decrease in depression and anxiety levels after the completion of HT programs. Masuya et al. (2014)

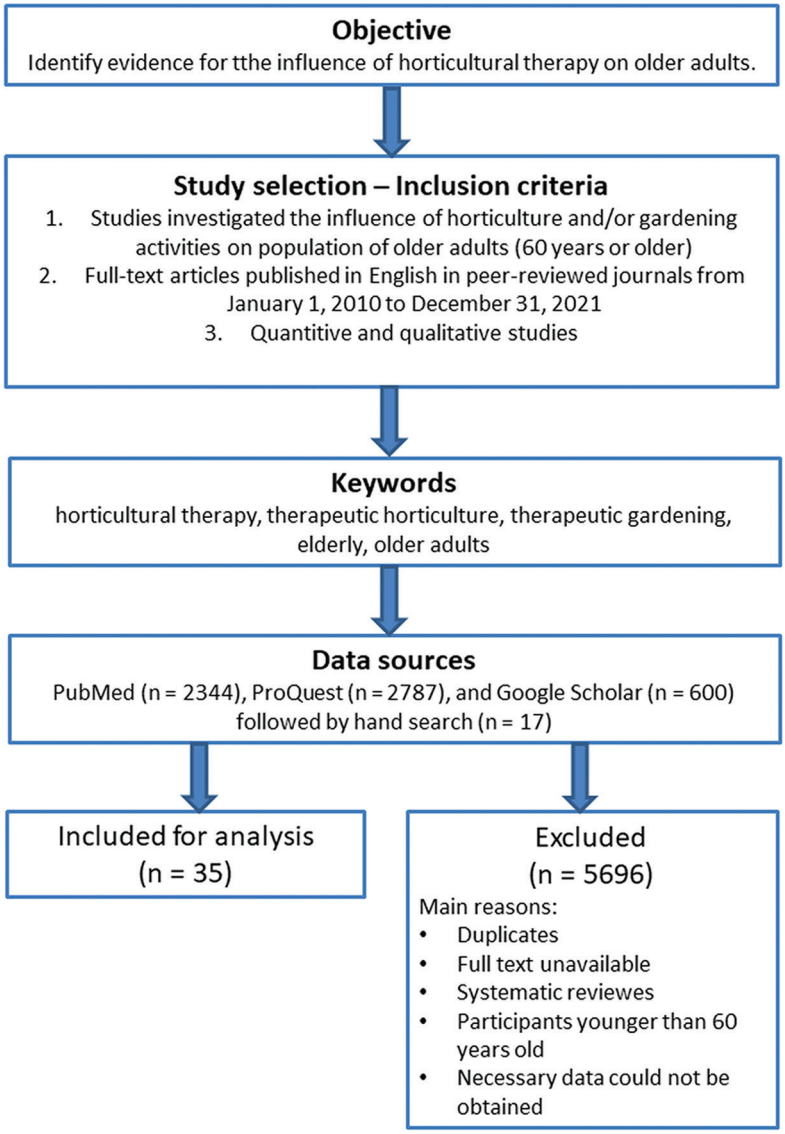

Figure 2. Flow diagram of literature search and study selection process – diagram showing process of literature search.

obtained scores of great significance on the GDS-15 scale that showed the benefits of their HT program on short-term depression. This may be attributed not only to the participant's ability to take care of plants but also to share their experiences with each other. Chen and Ji (2015) registered a lowering of the depression scale from 8.1 before the treatment to 3.6 after the study ($p < 0.001$). Also, Sia et al. (2020) reported that SAS scores significantly developed after the intervention. The TH interventions induced improvements in mean SAS scores at time points 2 and 3, by –2.18 ± 0.90 ($p < 0.05$) and –1.87 ± 0.60 ($p = 0.03$) in comparison to the baseline. That supports the assumption that HT reduces the depression and anxiety of older residents in nursing homes. Only one study (Park et al., 2016) showed enhanced depression levels in pre-post measurements in the control group (not participating in any gardening or other activity), from normal before gardening to slightly depressive symptoms by the end of the study.

Well-being, quality of life and life satisfaction were measured in 11 studies. The outcome scores for well-being included the Personal Well-Being Index (PWI), Ryff's Scales of Psychological Well-Being (SPWB), World Health Organization Well-Being Index (WHO-5) and Warwick Edinburgh Mental Well-Being Scale (WEMWBS). The outcome scores for the quality of life and satisfaction with life studies included Quality of Life (QoL), Satisfaction with Life Scale (SWL), Self-rated Health and Quality of Life (SF-36), Life Satisfaction Index (LSI) and Meaning of Life Scale (MLS). Four of the studies revealed a significant increase in life satisfaction (Masuya et al., 2014; Tse, 2010; Yao and Chen, 2017; Gagliardi et al., 2020). Masuya et al. (2014) stated that high QoL scores may be due to the commitment to caring for plants daily and the ability to share this experience with others. As people age, they tend to lose interest in their surroundings, and these results are of great significance for further

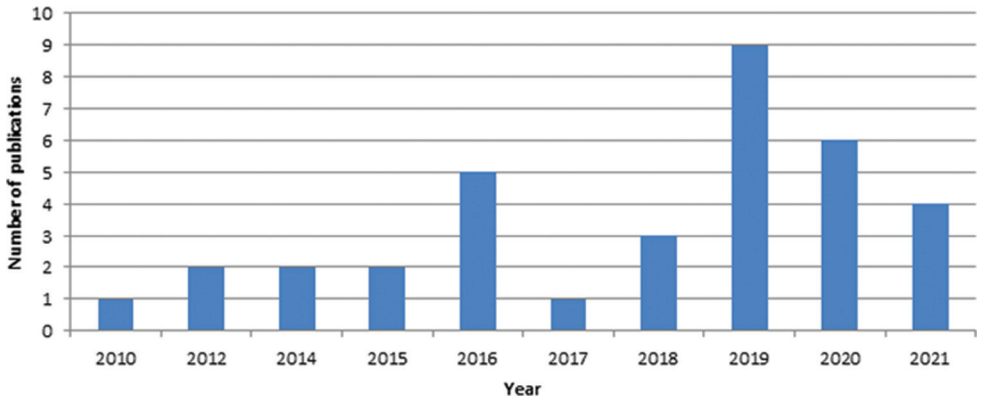

Figure 3. Studies on the topic published in the years 2010–2021 – graph showing the number of studies on the topic published in the years 2010–2021.

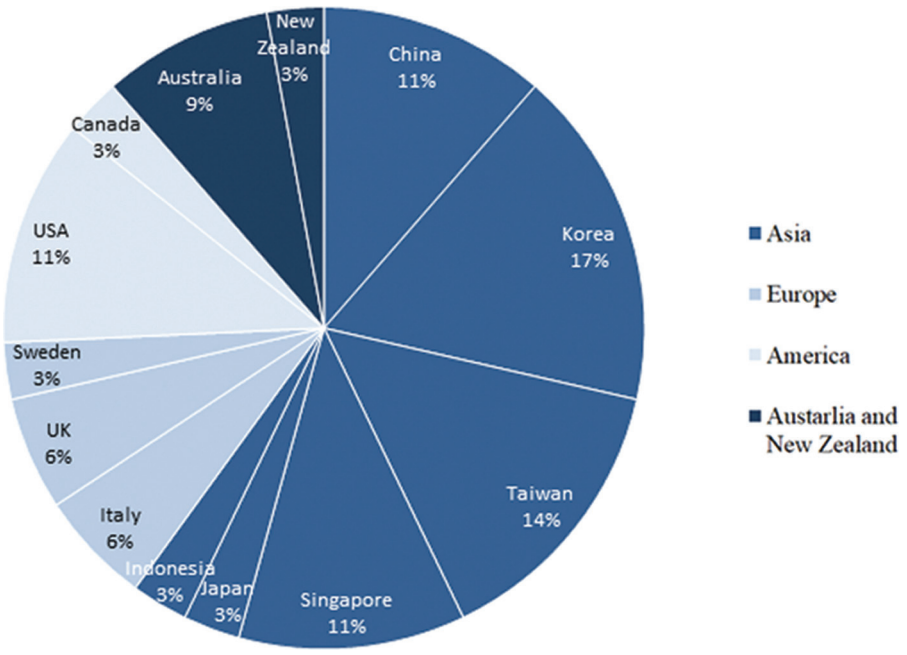

Figure 4. Studies per country of performance – graph showing the number of studies on the topic published per country of performance.

investigation. An Italian study (Gagliardi et al., 2020) demonstrated a boost in satisfaction with life from 7.2 in the pre-intervention tests to 8.0 in the post-intervention ones. These findings are of huge importance, as Italian national insights show that older people are generally less satisfied with life than the entire population, and the national mean value of life satisfaction is 7.6. The other studies did not report any significant changes in well-being and life satisfaction between the intervention and the groups without intervention.

Other psychological outcome measurements included the Positive Self-Respect Scale (PSRS), Subjective Happiness Scale (SHS), Chinese Happiness Inventory (CHI), Rosenberg Self-Esteem Scale (RSES), AAQ, Herth Hope Index (HHI), Profile of Mood States (POMS), Perceived Stress Scale (PSS), Connectedness to Nature Scale (CN) and Perceived Restorativeness Scale (PRS). All investigated variables improved after nature exposure and HT activities. Yao and Chen (2017) reported a significant increase in the sense of happiness after HT activities, which they correlated with the ability to express creativity during intervention sessions and satisfaction and joy at completing the work. Scott et al. (2019, 2020) indicated that gardeners show a more positive attitude towards ageing, and this facilitated the development of necessary resilience to health and physical changes. They discovered that the physical benefits obtained from gardening and the restorative benefits of a garden were associated with positive self-perceptions of ageing. Wood and Smyth (2020) revealed that an essential role in predicting physiological health outcomes during adulthood may be played by CN, but to develop such a connection to nature, it is essential to be exposed to it as a child.

Table 3. The type of people–plant interventions used in the analysed studies.

Interaction with client		Activity setting	Type of activity	Percentage of studies that applied this intervention	Publications in which this type of activity was used (according to Table 2)
Active*	Outdoor	Garden	Gardening (plant care, pruning, watering, weeding, etc.)	40	2, 5, 8, 12, 13, 14, 15, 16, 18, 19, 20, 21, 22, 26
			Garden design and planning	11	14, 16, 17, 27
			Garden parties	9	3, 9, 14, 16
		Park	Environmental volunteering program	3	31
	Indoor	Common room, workshop, atelier	Indoor gardening (seeding, propagating, transplanting, etc.)	29	1, 3, 4, 7, 11, 17, 23, 25, 26, 28
			Plant-related art (creating flower pockets, grass dolls, nature art collage, etc.)	23	3, 6, 9, 12, 14, 22, 24, 27
			Plant-related items (making soaps, teas, potpourri, etc.)	14	4, 17, 22, 27, 28
Passive**	Outdoor	Garden	Floristry classes	23	1, 3, 4, 6, 7, 9, 22, 27
			Garden visits (educational or sensory strolls in gardens)	11	13, 26, 29, 34
		Park	Green exercise	3	35
			Walking group	3	33
	Indoor	Common room, workshop, atelier	Pot plant visual stimulation	6	30, 32

*Active interaction means gardening activities and plant-related craft in which the outcome of the action brings about a specific effect.
**Passive interaction means activities like visiting parks or gardens, garden observation and listening, and other activities which allowed participants to spend time being surrounded by nature, without bringing a specific effect.

The study also showed a significant relation between nature connectedness and levels of stress and heart rate variability (HRV) during sleep. Those with lower CN scores were approximately more stressed and had a lower HRV during sleep, both of which are signs of poorer health.

Cognitive functions were measured in nine studies using the Montreal Cognitive Assessment (MoCA), Visual Analogue Scale (VAS), MMSE and the Clinical Dementia Rating (CDR). Significant improvement in overall cognitive function after the HT program was shown in five of those studies (Bassi et al., 2018; Park et al., 2016; Park et al., 2020; Sia et al., 2020; Wu et al., 2020). Meaningful changes in MoCA were observed by Wu et al. (2020). The mean of the pre-test (M = 15.06) was significantly lower than that of the post-test (M = 21.18), demonstrating improvement in cognitive functions of the participants following the HT program. Also, Park et al. (2016) reported significant improvement in the cognitive functions of elderly women after a 15-session gardening intervention, with an increase in K-MMSE scores from 22.6 ± 4.2 to 23.6 ± 2.8 ($p < 0.05$).

Social effects were investigated in eight studies. The most commonly used tools were the FS, LSNS and UCLA Loneliness Scale. The other tools included the Social Engagement Scale (SES), Positive Relations with Others Sub-Scale (PROS) and Interpersonal Intimacy Scale (IIS). Half of the studies showed improvement in social connections after plant-related interventions (Chen and Ji, 2015; Ng et al., 2018; Tse, 2010; Yao and Chen, 2017). Chen and Ji (2015) and Tse (2010) mentioned that the horticultural activities offered the participants new subjects for conversations. New horticultural experiences and an increase in personal knowledge contributed to socialising and the formation of meaningful connections with others. Ng et al. (2018) demonstrated a significant increase in the mean scores of positive relations with others by 2.14 points (95% confidence interval (CI) 0.52–3.76) in HT participants (p = 0.001). Also, Yao and Chen (2017) established that HT was conducive

Table 4. The type of tests and measurements used in the analysed studies.

		Test name	Studies that applied the test/ measurement (%)	Publications in which this type of test/measurement was used (according to Table 2)*
Physiological and functional tests	Depression, anxiety and stress	GDS – Geriatric Depression Scale	11	3, 8, 11, 14
		SAS – Zung Self-Rating Anxiety Scale	6	12, 22
		SDS – Zung Self-Rating Depression Scale	6	12, 22
		STAI – The State-Trait Anxiety Inventory	3	32
		PSS – Perceived Stress Scale	3	35
	Well-being, life satisfaction, quality of life	LSI – Life Satisfaction Index	6	23, 31
		MLS – Meaning of Life Scale	3	28
		PWI – Personal Well-being Index	3	8
		QoL – Quality of Life	3	11
		SF-36 – Self-rated Health and Quality of Life	9	19, 20, 21
		SPWB – Ryff's Scales of Psychological Well-Being	3	12
		SWL – Satisfaction with Life Scale	3	12
		WEMWBS – Warwick Edinburgh Mental Well-being Scale	3	35
		WHO-5 – World Health Organization Well-Being Index	3	17
	Cognitive functions	CDR – The Clinical Dementia Rating	3	22
		MMSE – Mini-Mental State Examination	14	1, 11, 14, 16, 17, 22
		MoCA – The Montreal Cognitive Assessment	6	12, 27
		VAS – Visual Analogue Scale	6	22, 29
	Socio-psychological	FS – Friendship Scale	9	12, 17, 22
		IIS – Interpersonal Intimacy Scale	3	28
		LSNS – Lubben Social Network Scale	9	8, 23, 31
		PROS – Positive Relations with Others Sub-Scale	6	12, 13
		SES – Social Engagement Scale	3	8
		UCLA – UCLA Loneliness Scale	6	3, 23
	Happiness and attitudes to yourself	AAQ – Attitudes to Ageing Questionnaire	11	4, 19, 20, 21
		CHI – Chinese Happiness Inventory	3	28
		CN – Connectedness to Nature Scale	3	35
		HHI – Herth Hope Index	3	4
		POMS – Profile of Mood States	6	7, 24
		PRS – The Perceived Restorativeness Scale	3	29
		PSRS – The Positive Self-Respect Scale	3	6
		RSES – Rosenberg Self-Esteem Scale	3	17
		SHS – Subjective Happiness Scale	3	8

(*Continued*)

Table 4. Continued.

		Test name	Studies that applied the test/ measurement (%)	Publications in which this type of test/measurement was used (according to Table 2)*
Physiological and functional tests	Brain activity and emotions	Brain Nerve Growth Factors (BDNF, VEGF, PDGF)	6	15, 16
		Brain mapping (EEG and QEEG)	9	7, 25, 32
		PSQI – Pittsburgh Sleep Quality Index	3	22
		VibraImage 8 PRO	3	9
	Circulatory system	Blood pressure	6	24, 32
		HRV – heart rate variability	6	24, 35
		Pulse rate	3	24
	Endocrine system and biomarkers	SAA – salivary amylase activity	3	24
		Biomarkers (IL-1, IL-6, sgp-130, CXCL12/SDF-1, CCL-5/RANTES, hs-CRP, cortisol, DHEA)	9	12, 13, 26
	Metabolic activity	Metabolomics Study	3	16
		MNA – Mini-Nutritional Assessment	3	8
	Body composition	BMI	6	14, 35
		Fat mass	6	14, 16
		Height	6	14, 16
		Lean mass	6	14, 16
		Per cent fat	3	16
		Waist–hip ratio	3	14
		Weight	6	14, 1
	Fitness and self-efficiency	ADL-20 – The Activities of Daily Living Scale	3	11
		BI – Modified Barthel Index	11	8, 22, 23, 28
		FFI – The Fried Frailty Index the General Self-Efficacy Scale	3	8
		IADL – Lawton's Instrumental Activities of Daily Living scale	3	8
		IPAQ-SF – The International Physical Activity Questionnaire-Short Form	6	14, 16
		PASE – The Physical Activity Scale for the Elderly	3	31
		TFI – The Tilburg Scale	3	5
		Scot-PASQ – Scottish Physical Activity Screening Question	3	33
		SFT – The Senior Fitness Test	6	14, 16
		Side-by-side/semitandem/full-tandem balance tests	3	2
		The Cup Stacking Test	3	4
		Timed walk test	3	2
		VI – Vitality index	3	11
		VIA-IS – VIA Inventory of Strengths	3	6

(*Continued*)

Table 4. Continued.

	Test name	Studies that applied the test/ measurement (%)	Publications in which this type of test/measurement was used (according to Table 2)*
Self-developed questionnaires or interviews	Demographic information questions	9	3, 4, 26
	Focus-group interviews	9	2, 34, 35
	Gardening activity inventory	9	19, 20, 21
	Garden questionnaire	11	17, 19, 20, 21
	Individual interviews	31	5, 10, 17, 19, 20, 21, 27, 30, 31, 33, 34

*Numbers in this column refer to the publication number in Table 2.
EEG: Electroencephalography; POMS: Profile of mood states; VEGF, Vascular endothelial growth factor.

to making supportive relationships amongst older adults in nursing homes and that HT, when implemented as a group activity, encouraged interpersonal relations among the participants. They observed that with each session, the participants were not only more engaged in gardening activities but also helped their neighbours more. In the last sessions, the formed bonds were strong enough to get the participants to share their thoughts and cheer for others.

Physiological and functional effects

Physiological effects were investigated in 13 studies using a variety of indices. The most common ones included HRV, blood pressure, electroencephalography (EEG), brain nerve growth factors (BDNF, PDGF, VEGF) and different types of biomarkers. The nerve growth factors are implicated in several molecular processes in the central nervous system and play an important role in neurogenesis. The status of cognitive health in humans is characterised by their levels (Park and Poo, 2013). BDNF is present in the hippocampus and its content increases during participation in physical activities. This stimulation contributes to the growth of new nerve cells in the brain for learning and long-term memory, as well as other cognitive functions (Cotman and Berchtold, 2002). Physical activity also affects VEGF and PDGF but a greater association is shown with vascular formation, permeability and connective tissue changes, which can promote cell proliferation and growth as well as neuronal development and function (Czarkowska-Paczek et al., 2006).

Only four studies showed significant differences in the physiology of the participants. Tu et al. (2020) reported decreased salivary amylase activity (SAA) and pulse rate after a horticultural program. Pulse rate and SAA, which represent the current state of mental stress and physical fatigue, decrease in a state of relaxation. Based on these results, it can be assumed that horticultural activities in this study lead to the relaxation of older adults.

Hassan et al. (2019) observed a drop in systolic blood pressure, which is the indicator of calmness in older adults, and variations in high alfa and beta brainwaves, after visual stimulation with a money plant (*Pilea peperomioides*). Different mental states are linked to different waves in the human brain, and relaxation is indicated by alpha waves and activity by beta waves. During the visual stimulation with a money plant, higher alpha waves were observed when compared with the control, revealing improved calmness after viewing the plant versus viewing the control stimulus. The significant increase in beta activity indicated alertness and a higher activity state in the participants. Park et al. (2019, 2020) observed a significant increase in the levels of BDNF and PDGF following a gardening activity.

Nine studies examined the physical and functional effects of active or passive interventions. The majority of them reported no significant changes in the Modified Barthel Index (BI), Lawton's Instrumental Activities of Daily Living scale (IADL), Fried Frailty Index (FFI), General Self-Efficacy Scale, Activities of Daily Living Scale (ADL-20), Senior Fitness Test (SFT), International Physical Activity Questionnaire-Short Form (IPAQ-SF), Physical Activity Scale for the Elderly (PASE) or Scottish Physical Activity Screening Question (Scot-PASQ). Yao and Chen (2017) found a significant increase in BI and ADL-20 after their HT program. The elderly that joined the HT activities became more self-sufficient in everyday tasks like eating meals. Chu et al. (2021) observed a significant decrease (from 33.56 s to 25.38 s) in the time needed to perform The Cup Stacking Test in the experimental group and no significant change in the control group. These observations confirm improvement in the hand–eye coordination after horticultural activities. In addition, HT can provide physiological adjustment, the enhancement of small and large motor skills and improve self-care amongst the elderly. The results foster the theory that suitable horticultural activities can improve the ADL of elderly people living in nursing homes.

Self-developed questionnaires and interviews

Self-developed questionnaires and interviews were used in 16 studies. The most common were individual interviews (11 studies), but their duration and structure varied between the studies. The second most popular

were garden questionnaires (four studies), which were different in every study. All of them were used to gain qualitative data, such as the participant's opinion on the HT program, their attitude to gardening, their favourite gardening activities and gardening-related problems that cropped up with age. Most of the participants showed interest in gardening activities, recognised them as pleasant and were willing to continue them after the HT program finished. The enjoyment of their horticultural experiences and gaining personal knowledge allowed new discussions and even caused more of a team effort while performing other institutional activities. Nature was reported as a high value with an affinity to life. Some seniors perceived plants almost as people and their gardens as a really important element of their life with gardening activities as a part of their daily schedule.

CONCLUSIONS

As ageing becomes a global problem, more attention should be devoted to finding non-pharmacological solutions to prevent a decrease in the health and well-being of older people.

1. Recent years have witnessed an increasing number of studies on the effects of HT as a tool in preventive medicine, helping healthy older adults to improve and maintain their well-being. The trend is particularly visible not only in Asian countries (59% of the studies) but also in America, Europe, Australia and New Zealand. Healthy elderly participants of the studies were residents of nursing homes and seniors living independently. Therapeutic interventions included active ones, such as HT programs or gardening, and passive contact with nature.
2. The quantitative and qualitative effects were measured with:
   - Thirty-three diverse psychological tests (most often GDS, Self-rated Health and Quality of Life (SF-36), MMSE, FS, LSNS and AAQ.
   - Thirty-two physiological and functional indices (most often HRV, blood pressure, EEG and brain nerve growth factors (BDNF, PDGF, VEGF) and different types of biomarkers.
   - Self-developed questionnaires and interviews.
3. The research results show that HT is most effective in improving the psychological sphere, while to a smaller but still significant extent, it improves the physiological realm. The referenced studies demonstrated that the applied actions were most effective in promoting well-being, a sense of happiness and social bonds, and reducing depression and anxiety levels. The physiological results that deserve special attention (Park et al., 2019, 2020) concerned the growth of brain nerve factors that are largely responsible for improving the cognitive functions of the elderly.
4. None of the studies showed that people–plant interventions have any harmful influence on the elderly. Instead, they present promising evidence that both passive and active people–plant interactions can improve psychological, physical and social health and may be used as a tool to positively affect the ageing process and self-sufficiency of the elderly.

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AUTHORS' CONTRIBUTIONS

A.H. searched for valid articles for the systemic review, created tables and graphics and was a major contributor to writing the manuscript. B.P. and B.S.-T. double-checked the validity of articles and attributed their knowledge and experience in the topic and publication writing. All authors read and approved the final manuscript.

CONFLICT OF INTEREST

The authors have no conflicts of interest to declare that are relevant to the content of this article.

REFERENCES

American Horticultural Therapy Association. (2017). American Horticultural Therapy Association (AHTA) definitions and positions paper. Retrieved from https://www.ahta.org/ahta-definitions-and-positions.

Bassi, M., Rassiga, C., Fumagalli, N., and Senes, G. (2018). Quality of experience during horticultural activities: An experience sampling pilot study among older adults living in a nursing home. *Geriatric Nursing, 39*(4), 457–464, doi: 10.1016/j.gerinurse.2018.01.002.

Blaschke, S. (2017). The role of nature in cancer patients' lives: A systematic review and qualitative meta-synthesis. *BMC Cancer*, *17*(1), 370, doi: 10.1186/s12885-017-3366-6.

Borgen, L., and Guldahl, A. S. (2010). Great-granny's garden: A living archive and a sensory garden. *Biodiversity and Conservation*, *20,* 441–449, doi: 10.1007/s10531-010-9931-9.

Brandes, H. (2017). *The potential of green care interventions to promote positive youth development with a one health lens.* PhD dissertation, University of Denver, Colorado, 1318.

Chen, T. Y., and Janke, M. C. (2012). Gardening as a potential activity to reduce falls in older adults. *Journal of Aging and Physical Activity, 20*(1), 15–31, doi: 10.1123/japa.20.1.15.

Chen, Y. M., and Jeng, J. Y. (2015). Effects of horticultural therapy on psychosocial health in

older nursing home residents: A preliminary study. *Journal of Nursing Research, 23*(3), 167–171, doi: 10.1097/jnr.0000000000000063.

Chu, H.-Y., Chan, H.-S., and Chen, M.-F. (2021). Effects of horticultural activities on attitudes toward aging, sense of hope and hand–eye coordination in older adults in residential care facilities. *International Journal of Environmental Research and Public Health, 18,* 6555, doi: 10.3390/ijerph18126555.

Cipriani, J., Benz, A., Holmgren, A., Kinter, D., Mcgarry, J., and Rufino, G. (2017). A systematic review of the effects of horticultural therapy on persons with mental health conditions. *Occupational Therapy in Mental Health*, *33*(1), 47–69, doi: 10.1080/0164212X.2016.1231602.

Clatworthy, J., Hinds, J., and Camic, P. M. (2013). Gardening as a mental health intervention: A review. *Mental Health Review Journal*, *18*(4), 214–225, doi: 10.1108/MHRJ-02-2013-0007.

Cotman, C. W., and Berchtold, N. C. (2002). Exercise: A behavioral intervention to enhance brain health and plasticity. *Trends in Neurosciences, 2*(6), 295–301, doi: 10.1016/S0166-2236(02)02143-4.

Czarkowska-Paczek, B., Bartłomiejczyk, I., and Przybylski, J. (2006). The serum levels of growth factors: PDGF, TGF-Beta and VEGF are increased after strenuous physical exercise. *Journal of Physiology and Pharmacology, 57*(2), 189–197.

Dahlkvist. E., Hartig, T., Nilsson, A., Högberg, H., Skovdahl, K., and Engström, M. (2016). Garden greenery and the health of older people in residential care facilities: A multi-level cross-sectional study. *Journal of Advanced Nursing, 72*(9), 2065–2076, doi: 10.1111/jan.12968.

Dang, D., and Dearholt, S. L. (2019). *Johns Hopkins nursing evidence-based practice: Model and guidelines.* Indianapolis, USA: Sigma Theta Tau International.

DelSesto, M. (2017). Green care for human therapy, social innovation, rural economy, and education. *Agriculture and Human Values, 34*, 239–240, doi: 10.1007/s10460-016-9735-y.

Dudkiewicz, M., Pudelska, K., Parzymies, M., and Durlak, W. (2018). Rola hortiterapii i bukieciarstwa w leczeniu dzieci i dorosłych. *Kosmos, 4*, 813–821, doi: 10.36921/kos.2018_2418.

Finlay, J., Franke, T., Mckay, H., and Sims-Gould, J. (2015). Therapeutic landscapes and wellbeing in later life: Impacts of blue and green spaces for older adults. *Health and Place, 34*, 97–106, doi: 10.1016/j.healthplace.2015.05.001.

Freeman, C., Waters, D. L., Buttery, Y., and Van Heezik, Y. (2019). The impacts of ageing on connection to nature: The varied responses of older adults. *Health and Place, 56*, 24–33, doi: 10.1016/j.healthplace.2019.01.010.

Gagliardi, C., and Piccinini, F. (2019). The use of nature-based activities for the well-being of older people: An integrative literature review. *Archives of Gerontology and Geriatrics, 83*, 315–327, doi: 10.1016/j.archger.2019.05.012.

Gagliardi, C., Pillemer, K., Gambella, E., Piccinini, F., and Fabbietti, P. (2020). Benefits for older people engaged in environmental volunteering and socializing activities in city parks: Preliminary results of a program in Italy. *International Journal of Environmental Research and Public Health, 17*(11), 37–72, doi: 10.3390/ijerph17113772.

Haller, R., and Kramer, C. L. (2006). *Horticultural therapy methods.* New York: Haworth Press.

Han, S. J. (2017). The effect of positive horticultural therapy on the self-respect, personality and talent of elderly women. *Journal of Korea Society for Plants People and Environment, 20*(2), 149–157, doi: 10.11628/ksppe.2017.20.2.149.

Hartig, T., Mitchell, R., De Vries, S., and Frumkin, H. (2014). Nature and health. *Annual Review of Public Health, 35*, 207–228, doi: 10.1146/annurev-publhealth-032013-182443.

Hassan, A., Qibing, C., Yinggao, L., Tao, J., Li, G., Jiang, M., Nian, L., and Bing-Yang, L. (2019). Psychological and physiological effects of viewing a money plant by older adults. *Brain and Behaviour, 9*(8), 1–7, doi: 10.1002/brb3.1359.

Irvine, K. N., Marselle, M. R., Melrose, A., and Warber, S. L. (2020). Group outdoor health walks using activity trackers: Measurement and implementation insight from a mixed methods feasibility study. *International Journal of Environmental Research and Public Health, 17*(7), 2515, doi: 10.3390/ijerph17072515.

Jarott, S., Kwack, H., and Relf, D. (2002). An observational assessment of a dementia-specific horticultural therapy program. *HortTechnology, 12*, 403–410, doi: 10.21273/HORTTECH.12.3.403.

Kamioka, H., Tsutani, K., Yamada, M., Park, H., Okuizumi, H., Honda, T., Okada, S., Park, S. J., Kitayuguchi, J., Abe, T., Handa, S., and Mutoh, Y. (2014). Effectiveness of horticultural therapy: A systematic review of randomized controlled trials. *Complementary Therapies in Medicine, 22*(5), 930–943, doi: 10.1016/j.ctim.2014.08.009.

Kim, S.-O., Pyun, S.-B., and Park, S.-A. (2021). Improved cognitive function and emotional condition measured using electroencephalography in the elderly during horticultural activities. *HortScience*, *56*(8), 985–944, doi: 10.21273/HORTSCI15818-21.

Lai, C. K. Y., Kwan, R. Y. C., Lo, S. K. L., Fung, C. Y. Y., Lau, J. K. H., and Tse, M. M. Y. (2018). Effects of horticulture on frail and prefrail nursing home residents: A randomized controlled trial. *Journal of the American Medical Directors Association, 19*(8), 696–702, doi: 10.1016/j.jamda.2018.04.002.

Lee, S. (2019). Effects of a horticultural activity program based on validation therapy on the mental functions of elderly patients in nursing homes. *Journal of*

People, Plants, and Environment, 22(6), 611–619, doi: 10.11628/ksppe.2019.22.6.611.

Lo, S. K. L., Lam, W. Y. Y., Kwan, R. Y. C., Tse, M. M.Y., Lau, J. K. H., and Lai, C. K. Y. (2019). Effects of horticultural therapy: Perspectives of frail and pre-frail older nursing home residents. *Nursing Open, 6*(3), 1230–1236, doi: 10.1002/nop2.323.

Lu, S., Zhao, Y., Liu, J., Xu, F., and Wang, Z. (2021). Effectiveness of horticultural therapy in people with schizophrenia: A systematic review and meta-analysis. *International Journal of Environmental Research and Public Health 18*(3), 964, doi: 10.3390/ijerph18030964.

Masuya, J. (2014). The effect of a horticultural activities program on the psychologic, physical, cognitive function and quality of life of elderly people living in nursing homes. *International Journal of Nursing & Clinical Practices, 1*(1), 1:IJNCP-109, doi: 10.15344/2394-4978/2014/109.

Ng, K. S. T., Sia, A., Ng, M. K. W., Tan, C. T. Y., Chan, H. Y., Tan, C. H., Rawtaer, I., Feng, L., Mahendran, R., Larbi, A., Kua, E. H., and Ho, R. C. M. (2018). Effects of horticultural therapy on Asian older adults: A randomized controlled trial. *International Journal of Environmental Research and Public Health, 15*(8), 1705, doi: 10.3390/ijerph15081705.

Ng, T. K. S., Gan, D. R. Y., Mahendran, R., Kua, E. H., and Ho, R. C. M. (2021). Social connectedness as a mediator for horticultural therapy's biological effect on community-dwelling older adults: Secondary analyses of a randomized controlled trial. *Social Science & Medicine, 284,* 114191, doi: 10.1016/j.socscimed.2021.114191.

Orr, N., Wagstaffe, A., Briscoe, S., and Garside, R. (2016). How do older people describe their sensory experiences of the natural world? A systematic review of the qualitative evidence. *BMC Geriatrics, 16(1)*, 116, doi: 10.1186/s12877-016-0288-0.

Park, H., and Poo, M. M. (2013). Neurotrophin regulation of neural circuit development and function. *Nature Reviews Neuroscience, 14*(1), 7–23, doi: 10.1038/nrn3379.

Park, S. A., Lee, A. Y., Park, H. G., and Lee, W. L. (2019). Benefits of gardening activities for cognitive function according to measurement of brain nerve growth factor levels. *International Journal of Environmental Research and Public Health, 16*(5), 7–60, doi: 10.3390/ijerph16050760.

Park, S. A., Lee, A. Y., Son, K. C., Lee, W. L., and Kim, D. S. (2016). Gardening intervention for physical and psychological health benefits in elderly women at community centres. *HortTechnology, 26*(4), 474–483, doi: 10.21273/HORTTECH.26.4.474.

Park, S. A., Son, S. Y., Lee, A. Y., Park, H. G., Lee, W. L., and Lee, C. H. (2020). Metabolite profiling revealed that a gardening activity program improves cognitive ability correlated with BDNF levels and serotonin metabolism in the elderly. *International Journal of Environmental Research and Public Health, 17*(2), 541, doi: 10.3390/ijerph17020541.

Perkins, P. (2012). Impact of a horticultural therapy program on the well-being of low-income community dwelling older adults. *Acta Horticulturae*, 954, 123–132, doi: 10.17660/ActaHortic.2012.954.14.

Relf, P. D. (1981). Dynamics of horticultural therapy. *Rehabilitation Literature, 42*(5–6), 147–150.

Relf, P. D. (1992). Human issues in horticulture. *HortTechnology, 2*(2), 159–171, doi: 10.21273/HORTTECH.2.2.159.

Reynolds, L. (2016). A valued relationship with nature and its influence on the use of gardens by older adults living in residential care. *Journal of Housing for the Elderly, 30*(3), 295–311, doi: 10.1080/02763893.2016.1198740.

Robbins, J. C., and Seibel, K. A. (2019). Temporal aspects of wellbeing in later life: gardening among older African Americans in Detroit. *Ageing and Society, 40*(12), 2614–2634, doi: 10.1017/S0144686 × 19000813.

Rowles, G. D. (2018). *Housing for older adults. In environmental psychology and human well-being:* Effects of built and natural settings. Anna Sloan Devlin, Holland: Elsevier Academic Press.

Scott, T. L. (2015). Horticultural therapy. In N. Pachana (Ed.), *Encyclopedia of geropsychology* (pp. 1–5). Singapore: Springer.

Scott, T. L., Masser, B. M., and Pachana, N. A. (2020). Positive aging benefits of home and community gardening activities: Older adults report enhanced self-esteem, productive endeavours, social engagement and exercise. *SAGE Open Medicine, 8*, 1–13, doi: 10.1177/2050312120901732.

Sia, A., Tam, W. W. S., Fogel, A., Kua, E. H., Khoo, K., and Ho, R. C. M. (2020). Nature-based activities improve the well-being of older adults. *Scientific Reports, 10*(1), 18178. doi: 10.1038/s41598-020-74828-w.

Simson, S. P., and Straus, M. C. (1998). *Horticulture as therapy: Principles and practice*. New York, USA: The Haworth Press.

Soga, M., and Gaston, K. J. (2016). Extinction of experience : Evidence, consequences and challenges of loss of human-nature interactions. *Frontiers in Ecology and the Environment, 81*(0), 94–101, doi: 10.1002/fee.1225.

Spilková, J. (2017). Producing space, cultivating community: The story of Prague's new community gardens. *Agriculture and Human Values, 34*(4), 887–897, doi: 10.1007/s10460-017-9782-z.

Sugiyama, T., and Thompson, C. W. (2005). Environmental support for outdoor activities and older people's quality of life. *Journal of Housing for the Elderly, 194*(3), 167–185, doi: 10.1300/J081v19n03_09.

Tkatch, R., Musich, S., Macleod, S., Alsgaard, K., Hawkins, K., and Yeh, C. S. (2016). Population

health management for older adults. *Gerontology and Geriatric Medicine, 18*(2), 2333721416667877, doi: 10.1177/2333721416667877.

Tse, M. M.y. (2010). Therapeutic effects of an indoor gardening programme for older people living in nursing homes. *Journal of Clinical Nursing, 19*(7–8), 949–958, doi: 10.1111/j.1365-2702.2009.02803.x.

Tu, H. M., and Chiu, P. Y. (2020). Meta-analysis of controlled trials testing horticultural therapy for the improvement of cognitive function. *Scientific Reports, 10*(1), 14637, doi: 10.1038/s41598-020-71621-7.

Tu, P. C., Cheng, W. C., Hou, P. C., and Chang, Y. S. (2020). Effects of types of horticultural activity on the physical and mental state of elderly individuals. *International Journal of Environmental Research and Public Health, 17*(14), 5225. doi: 10.3390/ijerph17145225.

United Nations Department of Economic and Social Affairs Population Division (2019). *World population prospects 2019: Demographic profiles, Vol. II.* New York, USA: United Nations.

Watson, D. P., and Burlingame, A. W. (1960). *Therapy through horticulture.* New York, USA: MacMillan.

WHO (1948). Preamble to the constitution of the World Health Organization as adopted 959 by the International Health Conference, New York, 19–22 June, 1946; signed on 22 960 July 1946 by the representatives of 61 States (Official Records of the World Health 961 Organization, No. 2, p. 100) and entered into force on 7 April 1948.

Widodo, D., Widjajanto, E., Wardiyati, T., and Yusuf, A. (2019). Stress of brain mapping in elderly people before and after giving horticultural therapy in planting flowers. *Indian Journal of Forensic Medicine and Toxicology, 13*(4), 1622–1626, doi: 10.5958/0973-9130.2019.00538.3.

Wilson, E. O. (1984). *Biophilia: The human bond with other species*. Cambridge, USA: Harvard University Press.

Wolf, K. L., and Housley, E. (2016). *The benefits of nearby nature in cities for older adults*. Annapolis, USA: NKF Foundation.

Wong, G. C. L., Ng, T. K. S., Lee, J. L., Lim, P. Y., Chua, S. K., Tan, C., Chua, M., Tan, J., Lee, S., Sia, A., NG, M. K. W., Mahendran, R., Kua, E. H., Ho, R. C. M., and Larbi, A. (2021). Horticultural therapy reduces biomarkers of immunosenescence and inflammaging in community-dwelling older adults: A feasibility pilot randomized controlled trial. *Journals of Gerontology: Medical Sciences, 76*(2), 307–317, doi: 10.1093/gerona/glaa271.

Wood, C. J., and Smyth, N. (2020). The health impact of nature exposure and green exercise across the life course: A pilot study. *International Journal of Environmental Health Research, 30*(2), 226–235, doi: doi: 10.1080/09603123.2019.1593327.

Wu, Y. L., Chao, S. R., Tsai, W. F., and Chen, M. L. (2020). The effect of horticultural program with life contexts on the cognitive function of the elderly in Taiwan. *Problems of Education in the 21st Century, 78*(5), 856–872, doi: 10.33225/pec/20.78.856.

Yao, Y. F., and Chen, K. M. (2017). Effects of horticulture therapy on nursing home older adults in Southern Taiwan. *Quality of Life Research 26*(4), 1007–1014, doi: 10.1007/s11136-016-1425-0.

Yeo, N. L., Elliott, L. R., Bethel, A., White, M. P., Dean, S. G., and Garside, R. (2020). Indoor nature interventions for health and wellbeing of older adults in residential settings: A systematic review. *Gerontologist, 60*(3), E184–E199, doi: 10.1093/geront/gnz019.

Zawiślak, G. (2015). Hortiterapia jako narzędzie wpływające na poprawę zdrowia psychicznego i fizycznego człowieka. *Annales UMCS 25, EEE*, 21–31.

Zhao, Y., Liu, Y., and Wang, Z. (2020). Effectiveness of horticultural therapy in people with dementia: A quantitative systematic review. *Journal of Clinical Nursing, 20,* 1–15, doi: 10.1111/jocn.15204.

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