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To cite this article: Rebecca Briggs, Paul Graham Morris & Karen Rees (2022): The effectiveness of group-based gardening interventions for improving wellbeing and reducing symptoms of mental ill-health in adults: a systematic review and meta-analysis, Journal of Mental Health, DOI: [10.1080/09638237.2022.2118687](https://doi.org/10.1080/09638237.2022.2118687)

To link to this article: <https://doi.org/10.1080/09638237.2022.2118687>



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Published online: 23 Sep 2022.



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# The effectiveness of group-based gardening interventions for improving wellbeing and reducing symptoms of mental ill-health in adults: a systematic review and meta-analysis

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## ABSTRACT

**Background:** There is increasing interest in the association between nature, health and wellbeing. Gardening is a popular way in which interaction with nature occurs and numerous gardening projects aim to facilitate wellbeing among participants. More research is needed to determine their effectiveness.

**Aim:** To systematically evaluate the effectiveness of group-based gardening interventions for increasing wellbeing and reducing symptoms of mental ill-health in adults.

**Methods:** A systematic review of Randomised Controlled Trials was conducted following the protocol submitted to PROSPERO (CRD42020162187). Studies reporting quantitative validated health and wellbeing outcomes of the community residing, adult populations (18+) were eligible for inclusion.

**Results:** 24 studies met inclusion criteria: 20 completed and four ongoing trials. Meta-analyses suggest these interventions may increase wellbeing and may reduce symptoms of depression, however, there was uncertainty in the pooled effects due to heterogeneity and unclear risk of bias for many studies. There were mixed results for other outcomes.

**Research limitations/implications:** Heterogeneity and small sample sizes limited the results. Poor reporting precluded meta-analysis for some studies. Initial findings for wellbeing and depression are promising and should be corroborated in further studies. The research area is active, and the results of the ongoing trials identified will add to the evidence base.

## ARTICLE HISTORY

Received 12 December 2021

Revised 11 April 2022

Accepted 5 August 2022

Published online 29 August 2022

## KEYWORDS

Gardening intervention; horticultural therapy; green care; mental health; wellbeing; health promotion; social prescribing



## Introduction

In recent years, there has been a resurgence of interest in the way in which nature and green space can promote human health and wellbeing (Clatworthy et al., 2013). The evidence for the health benefits of gardening is associated with this wider body of literature (Buck, 2016). Ecological models of health, such as Barton and Grant (2006) Health Map, illustrate the influence that the natural environment has, above all other determinants of health, in providing the context in which we live our lives, including the provision of ecosystem services and opportunities for health-promoting behaviours. Consequently, health interventions that utilise nature as a way of public health promotion have the potential to result in wide-reaching positive effects for both people and the planet (Dean et al., 2011; Harris, 2017). This growing interest in the relationship between humans and the environment has led to the identification of a new research paradigm: 'Human health-environment interaction science', a transdisciplinary approach that encompasses both the effects of humans on the environment and the effect of

the environment on human health and wellbeing (Spano et al., 2020a).

In addition, the current interest in social prescribing, a method of linking patients to non-clinical support within their communities to address the complex multimorbidity and psycho-social needs of patients, represents an opportunity for wider implementation of these interventions across the UK (Howarth et al., 2020; Thomson et al., 2015). As a result, it is essential to determine the effectiveness of gardening interventions and to ensure that the evidence base reflects what is considered quality evidence in the field of medicine and public health.

For the purpose of this review, gardening interventions are defined as organised programmes of group-based gardening activities. This definition includes Social and Therapeutic Horticulture (STH) projects, which aim to use gardening activities to improve the general wellbeing of participants (Sempik, 2010) as well as horticultural therapy, which can be distinguished from STH due to its focus on achieving clinical goals and facilitation by therapists trained in horticulture (Cipriani et al., 2017; Sempik, 2010). However, in practice, there is likely to be some overlap

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PROSPERO registration: CRD42020162187

Date of registration: 09 March 2020

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between these two types of interventions (Annerstedt & Währborg, 2011).

## Background

The salutogenic effects of natural environments are often explained by their restorative qualities whereby restoration is the “process of renewing, recovering or re-establishing physical, psychological and social resources or capabilities” (Hartig, 2004; 273). Two well-evidenced and prominent theories seek to explain the mechanisms through which natural environments facilitate restoration: the Stress Reduction Theory (SRT) (Ulrich, 1984; Ulrich et al., 1991) and the Attention Restoration Theory (ART) (Kaplan, 1995; Kaplan & Kaplan, 1989).

Ulrich’s (1984) Stress Reduction Theory, suggests this restorative quality results from the natural stimuli found in nature which activates the parasympathetic nervous system, facilitating psycho-physiological stress recovery.

The Attention Restoration Theory (ART) (Kaplan, 1995; Kaplan & Kaplan, 1989) proposes that natural environments, and the stimuli they expose us to, facilitate a person-environment interaction, which can restore the capacity for directed attention, by activating involuntary attention (Kaplan, 1995; Kaplan & Kaplan, 1989). The outcome of which is greater positive affect, less negative affect and due to a reduction in mental fatigue, renewed capacity for cognitive tasks.

These psycho-evolutionary theories are related to Wilson’s (1984) Biophilia Hypothesis which proposes humans’ innate affiliation with nature as a result of physiological and psychological evolutionary adaption to natural environments. Both are frequently used to explain how gardening and gardening interventions can benefit health, especially in relation to psychological outcomes. However, Harris (2017) argues that such theories often dominate the literature, overshadowing the contributions of other aspects of the interventions, for example, the physical activity and social interaction they facilitate.

As Hartig et al. (2014) explain, it is likely that the proposed mechanisms for how gardening interventions can benefit health interact with each other. Similarly, Sempik (2010) emphasises that it is a result of the interaction of the various components of gardening interventions: the activities, the setting, and the social environment, that makes them therapeutic. Gardening-based interventions, including horticultural therapy, can incorporate other activities that may not be directly related to gardening, such as mindfulness or craft activities (Corazon et al., 2010; Harris, 2017; Sempik, 2010).

A recent systematic review and meta-analysis on gardening interventions for psychosocial wellbeing, which assessed outcomes such as trust, social cooperation and social networks, found positive results, with moderate effects reported (Spano et al., 2020b). The findings provide quantitative evidence of the benefit of such interventions for psychosocial outcomes and can also lend support to the importance of the community and social aspects of these interventions for

wellbeing outcomes. The results also align with the findings of Soga et al. (2017) meta-analysis into the benefits of gardening outdoors for health, where an overall significant positive effect was found from the results of 21 quantitative studies (76 comparisons). Sub-group analysis also demonstrated significant benefits, with the greatest effect sizes reported on wellbeing variables, when participants were patients, and where the gardening type was described as a therapy.

Of the reviews that have focused on gardening interventions for adults’ mental health (see Cipriani et al., 2017; Clatworthy et al., 2013; Kamioka et al., 2014) all have reported positive effects of the interventions. However, the authors highlighted the various limitations of the included studies which impacted the conclusions that could be drawn from the results. For example, while the studies in Clatworthy et al. (2013) review all reported positive effects, such as significant reductions in symptoms of depression and anxiety, the lack of control groups in many of the studies led the authors to conclude that research methods more suited to asserting causation were required. Similarly, the four Randomised Controlled Trials (RCTs) assessed by Kamioka et al. (2014) all reported some positive outcomes, for example, reductions in symptoms of depression, which led the authors to conclude that horticultural therapy may be effective for a range of mental health conditions. However, due to the small number of studies and heterogeneity of the populations, they also concluded that more evidence was needed. More recently, Cipriani et al. (2017) review, which focussed on horticultural therapy recommended its wider use within occupational therapy. Nevertheless, the authors acknowledged the various methodological and reporting limitations of the studies, and that the population group was predominantly older adults.

Since these reviews, there has been an increase in the quality and quantity of research in the field which represents an opportunity to reassess the effectiveness of gardening interventions for improving adults’ mental health and wellbeing and further the evidence base for this research area so that the policy implications highlighted by many authors in the field have the potential to be realised (Buck, 2016; Howarth et al., 2020; Sempik et al., 2010; Soga et al., 2017; Thompson, 2018).

## Methodology

### Aim

To systematically evaluate the effectiveness of gardening interventions for increasing wellbeing and reducing symptoms of mental ill-health in adults.

### Methods

A systematic review was conducted in line with the protocol submitted to PROSPERO (CRD42020162187).

## Search strategy

The search was conducted in the following databases from database inception to 10<sup>th</sup> July 2021 PsychINFO; Excerpta Medica database (EMBASE); Web of Science Applied Social Sciences Index and Abstracts (ASSIA); Cochrane Central Register of Controlled Trials (CENTRAL); Cumulative Index to Nursing and Allied Health Literature (CINAHL); Allied and Complementary Medicine (AMED) and Medical Literature Analysis and Retrieval System Online (MEDLINE). Trial registers (WHO ICTRP and Clinicaltrials.gov) were also searched to identify ongoing trials. Reference lists of included studies were hand searched to identify any further studies.

The following text word terms were used to search each database: ("Garden\*" OR "Horticultur\*" OR "Nature based") AND ("Therap\*" OR "Program\*" OR "Intervention\*" OR "Group\*" OR "Project\*" OR "Activit\*" Or "Course\*" OR "Rehabilitat\*" OR "Recover\*" OR "Restor\*") AND ("Mental health" OR "Mental illness\*" OR "Wellbeing" OR "Well-being" OR "Anxi\*" OR "Depress\*" OR "Stress" OR "Distress").

## Inclusion and exclusion criteria

Inclusion and exclusion criteria were created in line with the PICOS approach (Centre for Reviews & Dissemination, 2008) and studies were independently assessed for eligibility by two reviewers (RB & KR) for all stages (screening titles and abstracts, full-text reviews, data extraction and quality appraisal).

## Participants/Population

Adults of any age (18+) and ethnicity living in the community. A mental health diagnosis was not a requirement for inclusion. Previous reviews have focused on interventions within residential care settings and people with dementia, therefore these groups were excluded (see Nicholas et al., 2019; Wang & MacMillan, 2013; Yeo et al., 2020).

## Intervention

Participation in any gardening intervention; an organised programme of group-based and time-bound gardening activities. The interventions must be led by someone in a coordinating role. No exclusion was set based on the level of therapist input. Gardening interventions that also included non-gardening activities were included if gardening was considered to form the majority of the intervention.

## Comparator/Control

The control group condition could include individuals undertaking another type of intervention, those on a wait-list, no treatment or treatment/care as usual.

## Outcomes

Studies were included if they reported on mental health, wellbeing and/or quality of life outcomes using validated scales administered pre and post-intervention.

## Types of studies included

Randomised controlled trials.

## Quality appraisal

The Cochrane Risk of Bias (ROB) tool (Higgins et al., 2011) was used by two independent reviewers (RB & KR); where any disagreements were discussed and resolved. Due to the nature of the interventions, whereby participants and personnel cannot be blinded to group allocation, the studies have not been downgraded for this and an assessment of blinding has been conducted in relation to blinding of those collecting and analysing the data. The results are presented in Robvis format in Table 1 (McGuinness & Higgins, 2021).

## Data extraction

Data were extracted in duplicate into excel tables that had been piloted. The data includes general information about the study, a description of the intervention and information about the control group, participant characteristics, health and wellbeing outcomes measured, data reported and, scales used. Efforts were made to contact authors where there was missing data.

## Data analysis

A meta-analysis was conducted to pool findings for each outcome using random effects models in RevMan 5.4 (Review Manager (RevMan) [Computer program]. Version 5.4. The Cochrane Collaboration, 2020). Standardised mean differences were calculated as different validated scales reported our outcomes of interest. Where heterogeneity precluded a meta-analysis, a narrative synthesis following the guidance in the Cochrane handbook was performed (McKenzie et al., 2021).

## Results

### Selection process

The PRISMA flow diagram (The PRISMA Group, 2009) provides a visual representation of the screening process and the number of studies included/excluded at each stage (Figure 1).

### Description of included studies

The key characteristics of the 20 studies are presented in Table 2. 11/20 were published in the last four years. Five of the studies were published in the USA (Brown et al., 2020;

Table 1. Risk of Bias table.

	Risk of bias							Overall
	D1	D2	D3	D4	D5	D6	D7	
Bay-Richer et al. (2012)*	-	-	-	-	-	-	-	-
Brown et al. (2019)	+	+	-	-	-	-	-	-
Demark-Wahnefried et al. (2018)	+	+	+	+	+	+	+	+
Detweiler et al. (2015)	-	-	-	-	-	-	-	-
Huang et al. (2018)*	+	-	-	-	-	-	-	-
Kam & Siu (2010)	+	+	+	+	+	+	+	+
Kim & Park (2018)	-	-	-	-	+	-	-	-
Kotozaki (2013a)	+	-	-	-	+	-	-	-
Kotozaki (2013b)	+	-	+	+	+	-	-	-
Kotozaki (2014a)	+	-	-	-	+	-	-	-
Kotozaki (2014b)	+	-	+	+	+	-	-	-
Makizako et al. (2019)	+	+	+	+	+	+	-	+
Ng et al. (2018)	+	+	+	+	+	+	+	+
Okvat (2011)	-	-	+	+	-	-	-	-
Odeh & Guy (2018)	-	-	-	-	-	-	-	-
Palsdottir et al. (2020)	+	+	+	+	+	+	+	+
Siu et al. (2020)	+	+	+	+	+	+	-	+
Stigsdotter et al. (2018)	+	+	+	+	+	+	+	+
Vujcic et al. (2017)	-	-	-	-	+	-	-	-
Vujcic et al. (2021)	-	-	-	-	+	-	-	-

D1: Random sequence generation  
D2: Allocation concealment  
D3: Blinding of participants and personnel  
D4: Blinding of outcome assessment  
D5: Incomplete outcome data  
D6: Selective reporting  
D7: Other sources of bias

Judgement  
- Unclear  
+ Low

\*Few details with which to assess risk of bias as published only in abstract form

Demark-Wahnefried et al., 2018; Detweiler et al., 2015; Odeh & Guy, 2018; Okvat, 2011) five were published in Japan (Kotozaki, 2013a; 2013b; 2014a; 2014b; Makizako et al., 2019) three in China (Huang et al., 2018; Kam & Siu, 2010; Siu et al., 2020) and the remaining were published in Sweden (Bay-Richter et al., 2012; Pálsdóttir et al., 2020) Serbia (Vujcic et al., 2017; 2021) Denmark (Stigsdotter et al., 2018) Singapore (Ng et al., 2018) and South Korea (Kim & Park, 2018).

Across the 20 published studies, the total number of participants included in the data analysis was 874. In individual studies, the sample size ranged from 20 (Brown et al., 2020) to 89 (Pálsdóttir et al., 2020). Most studies included a wide age range, e.g. 18–65 or 50–80, where overall the estimated mean of mean ages reported was 50.7 years. In 10/20 of the studies, participants had either diagnosed mental health conditions or mental health symptoms. Of the remaining 10 studies, participants had diagnoses of diabetes (Brown et al.,

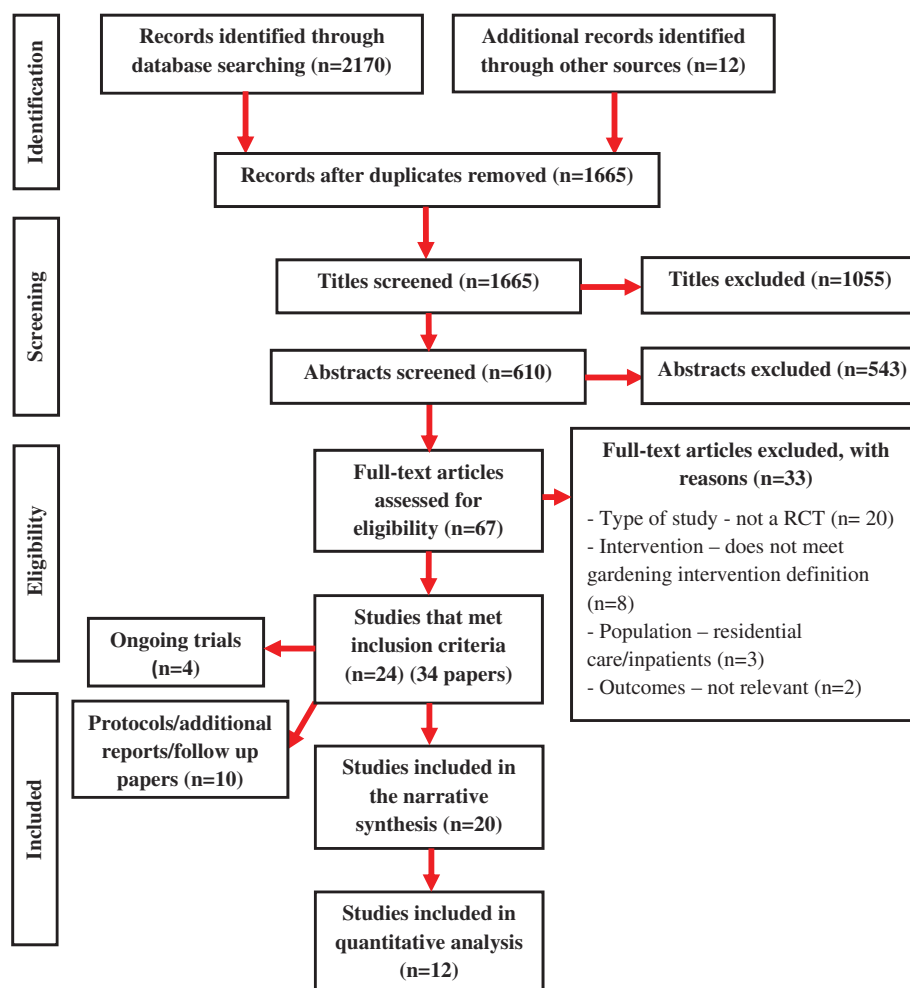


Figure 1. PRISMA flow diagram.

2020), was recovering from stroke (Pálsdóttir et al., 2020), cancer (Demark-Wahnefried et al., 2018), post-operative hand trauma (Huang et al., 2018) or suffered damage following an earthquake (Kotozaki, 2014a). In five studies participants had no reported health difficulties (Kim & Park, 2018; Kotozaki, 2013a; Ng et al., 2018; Odeh & Guy, 2018; Okvat, 2011).

Depression, anxiety, stress, quality of life, wellbeing and affect, were relevant outcomes assessed by the studies. Various validated scales were used (see Table 2, for outcome data, see Table 3). Four ongoing studies, with larger sample sizes and study completion, dates from December 2021 also met the inclusion criteria, their details are presented in Table 4.

### Methodological quality

The risk of bias appraisal (Table 1) indicated that seven studies had a low risk of bias and the remainder were at unclear risk of bias. Lack of reporting, whereby information necessary to determine risk rating was not included in the paper, was the predominant reason for rating studies as 'unclear' risk. Two studies were published only in abstract

form and due to lack of information with which to access the risk of bias, both were rated as 'unclear'.

### Depression

Eight studies (358 participants randomised) reported data on depression in a format suitable for meta-analysis (See Figure 2.1. Depression). Three of the eight studies selected patients with mental illness (Kam & Siu, 2010, Kotozaki, 2013b, Kotozaki, 2014b). There was substantial heterogeneity and so uncertainty in the pooled effect estimate, where four trials reported positive effects of the intervention on depression and the remaining four had little or no effect.

Seven further studies reported the effects of gardening interventions on depression, but data were not in a format suitable for meta-analysis. Where available, data from these studies are reported in Table 3. In two studies data were not presented to calculate change from baseline to follow-up (Detweiler et al., 2015; Ng et al., 2018), and two had insufficient data as were reported only as abstracts (Bay-Richter et al., 2012; Huang et al., 2018), in one study the full paper did not present numerical data (Odeh & Guy, 2018) and in the remaining two studies, data were presented as either

**Table 2. Description of included studies.**

Study	Study population		Intervention	Control	Control	Intervention	Outcomes	Scales	Follow up	Number of sessions	Length of sessions	Frequency of sessions	Total length (Hours)	Location	Facilitator	Theory
	Intervention	Control														
Bay-Richter et al. (2012)	No information given No information given No information about diagnosis, recruited from an outpatient psychiatric hospital n = 8	No information given No information given n = 12	Garden rehabilitation programme in addition to treatment as usual.	Treatment as usual	Depression	Montgomery-Asperg Depression Rating Scale MADRS	8 weeks	No information	No information	No information	No information	No information	No information	No information	No information	None mentioned
Brown et al. (2020)	Mean age estimate = 49.5 80% female	Diabetes patients	Gardening on raised beds (Planning what to grow together, preparing, planting, and tending to vegetables) and semi-monthly gardening and food-related education sessions (n = 10).	Usual diabetes management	Mood Depression Quality of life	Profile of Mood States (POMS) Centre for Epidemiological studies depression Scale (CESD) World health organisation quality of life questionnaire (WHOQOL-BREF) Short-Form health survey-36 for health-related quality of life (SF-36) Perceived Stress Scale (PSS)	16 weeks	Participants tended to the raised beds at least once a week May – Sept	No info about how long they spent gardening- education sessions were 90 mins long	At least once a week. Two days a month of education sessions	Not possible to accurately determine total hours. 15 hours of education sessions	Outside tribal diabetes centre	Not specified	Community based participatory approach (CBPA) and Socio-ecological Model of health behaviour		
Demark-Wahnefried et al. (2018); Cases et al. (2016)	n = 22 Mean age = 70.4 (7.8)	n = 20 Mean age = 69.7 (8.5)	Growing vegetables year-round in a raised bed in own garden with support from 'master gardeners'. All supplies needed provided for as part of intervention. Master gardeners contacted participants bimonthly with alternating home visits and telephone/emails.	Waitlist control group	Quality of life Stress	Short-Form health survey-36 for health-related quality of life (SF-36) Perceived Stress Scale (PSS)	52 weeks	No information	No information	85% of participants reported gardening several times a week	No information	Own gardens	Master gardeners	Social ecological model and social cognitive theory		
Detweiler et al. (2015)	n = 13 mean age = 46.4 (11.9) 4.16% Female	n = 12 mean age = 46.4 (11.9) 4.16% Female	Gardening in raised beds, general gardening activities and education about gardening, preparing beds, planting seeds, harvesting.	Occupational therapy – Choice of crafts	Quality of life	Quality of Life Enjoyment and Satisfaction Questionnaire – Short Form (Q-LES-Q-SF) Centre for Epidemiological studies depression Scale (CESD)	3 weeks	15 sessions	60mins	Five days a week	15 hours	Courtyard garden of rehabilitation centre	No information	Horticultural therapy		
Huang et al. (2018)	n = 33 No information given No information given Postoperative hand trauma patients	n = 33 No information given No information given Postoperative hand trauma patients	Horticultural therapy for hand function rehabilitation in addition to usual exercise rehabilitation. Involved, potting, caring for plants, planting herbs.	Routine exercise rehabilitation – treatment as usual	Depression	Beck Depression Scale (CESD)	4 weeks	No information	No information	No information	No information	Rehabilitation hospital	No information	Horticultural therapy		
Kam and Su (2010)	n = 10 Mean age = 45.3 (10.38) 33% Female Schizophrenia spectrum disorder, bipolar disorder, major depression. Attending rehabilitation services	n = 12 Mean age = 43.3 (11.7) 25% Female	Sessions followed same structure, warm up, gardening activities and then group sharing and each had specific themes and objectives.	Both control and intervention continued usual workshop training for related skills.	Depression Anxiety Stress wellbeing	Depression, Anxiety and Stress scale (DASS21) Chinese personal wellbeing index (PWI-C)	Anxiety and 2 weeks	10 sessions	60 mins	10 consecutive days	10 hours	A rehabilitation farm with five themed gardens	A registered occupational therapist	Horticultural Therapy		
Kim and Park (2018)	n = 18 Mean age estimate = 50.5 100% Female No diagnosis	n = 18 Mean age estimate = 50.5 100% Female No diagnosis	A set programme of horticultural therapy was followed with specific aims and approaches for each session. Various group gardening activities and crafts with plants e.g. flower arranging.	Pre and post-test questionnaires only.	Depression Anxiety	Zung Self-rated depression scale (SDS) State-trait anxiety inventory (STAI)	6 weeks.	12 sessions	60 mins	Two days a week	12 hours	No information about the location	Two trained horticultural therapists	Horticultural Therapy		
Kotzaki (2013a)	n = 15 Mean age = 20.53 (2.45) 51% female No diagnosis	n = 15 Mean age = 21.60 (1.54) 51% female No diagnosis	Group gardening intervention involving interactive lectures and practical horticultural training. Participants were also asked to garden for 15mins each day at their homes with kits provided by study.	Two groups; Gardening intervention performed individually and control with home gardening kits only	Depression Quality of life Affect Mental health	Centre for Epidemiological studies depression Scale (CESD) WHO-QOL-26 POMS General Health Questionnaire (GHQ)	4 weeks	4 sessions	60 mins	once a week	4 hours	University lab	Horticultural therapist and Clinical psychologist	Horticultural therapy		

(continued)

Table 2. Continued.

Study	Study population		Intervention	Control	Intervention	Control	Outcomes	Scales	Follow up	Number of sessions	Length of sessions	Frequency of sessions	Total length (Hours)	Location	Facilitator	Theory
	Intervention	Control														
Kotzaki (2013b)	n = 20 Mean age = 65.15 (3.65) 100% female PTSD symptoms	n = 19 Mean age = 67.21 (5.18) 100% female PTSD symptoms	Group gardening intervention involving interactive lectures and practical horticultural training. Participants were also asked to garden for 15mins each day at their homes with kits provided by study.	Stress control psychoeducation group	Depression Quality of life PTSD	Geriatric depression scale (GDS-15) WHO-QOL-26 Clinician Administered PTSD Scale (CAPS)	8 weeks	8 sessions	60 mins	once a week	8 hours	University lab	Horticultural therapist and Clinical psychologist	Horticultural therapy		
Kotzaki (2014a)	n = 22 Mean age = 46.54 (8.40) 100% female	n = 23 No information given	Group gardening intervention. Participants were also asked to garden for 15mins each day at their homes.	Stress control psychoeducation weekly for 8 weeks	Depression Mental health	Centre for Epidemiological studies depression Scale (CESD) General Health Questionnaire (GHQ)	16 weeks	16 sessions	120 mins	once a week	32 hours	Community centre	No information	Horticultural therapy		
Kotzaki (2014b)	n = 27 Mean age = 42.48 (9.72)	n = 27 Mean age = 44.22 (7.8)	Group gardening intervention involving interactive lectures and practical horticultural training. Participants were also asked to garden for 15mins each day at their homes with kits provided by study	No information	Depression Mental health Quality of life Affect PTSD	Centre for Epidemiological studies depression Scale (CESD) General Health Questionnaire (GHQ) WHO-QOL-26 Positive and Negative Affect Scale (PANAS) Clinician Administered PTSD Scale (CAPS)	8 weeks	8 sessions	60 mins	once a week	8 hours	University lab	Horticultural therapist and Clinical psychologist	Horticultural therapy		
Makizako et al. (2019)	n = 20 Mean age = 73.1 (5.6) 46.7% Female	n = 23 (Exercise) & n = 24 (Control) Exercise = 73.1 (5.3) Control = 73.0 (5.9) 53.3% Female (Exercise) 51.7% Female (Control)	Growing crops in a group setting. Planting, cultivating, growing, and harvesting in a public garden.	Two control groups - exercise and cognition classes & traffic prevention class.	Depression Quality of life	Geriatric depression scale (GDS-15) Short-Form health survey-12 for health-related quality of life (SF-12)	24 weeks 52 weeks	20 sessions	60-90 mins	Once a week	25 hours	A Public Garden	Not specified	None mentioned		
Ng et al. (2018); Chan et al. (2016); Ng et al. (2019)	n = 26 Mean age = 67.21 (4.52) 79.3% Female Schizophrenia, bi-polar disorder	n = 27 Mean age = 67.00 (4.18) 76.7% Female	Horticultural therapy following a set session plan. Various gardening activities e.g. sowing, harvesting, garden maintenance. One week focused on indoor gardening and another on pressing flowers. Five of the weeks involved walks, locations included a nature reserve and botanical garden.	Waitlist control group	Depression Anxiety Wellbeing	Zung self-rating depression scale (SDS) Zung self-rating anxiety scale (SAS) Ryff's scale of psychological wellbeing	12 weeks, 24 weeks	15 sessions	60 mins	Once a week for first three months, then once a month for last three months	At selected parks/ gardens and a nature reserve	Not specified. The programme was designed by an 'experienced instructor'	Horticultural therapy			
Okvat (2011)	n = 12 (Gardening) n = 16 (Mindful Gardening) Mean age = 63.24 (5.60) Mean age = 62.18 (5.93) 88% Female in both groups No diagnosis	n = 11 Mean age = 64.94 (5.46) 75% Female	A range of gardening activities. 1.5h of gardening, planting, fertilising, composting, harvesting. Second hour allocated for socialising, chatting to gardeners, having breaks. Two intervention groups, Gardening and Mindful gardening (same activities undertaken but in a different way - being fully present. 1h gardening and remaining time for mindfulness guidance and breaks).	pre and post-test measures only.	Affect Quality of life	Positive and Negative Affect Scale (PANAS) Quality of Life Enjoyment and Satisfaction Questionnaire - Short Form (Q-LES-Q-SF)	9 weeks	9 sessions	150 mins	Once a week	22.5 hours	A community garden A garden Coordinator	Kaplan Attention Restoration Theory, Ecopsychology, Horticultural Therapy			

(continued)



Table 2. Continued.

Study	Study population		Intervention	Control	Intervention	Control	Outcomes	Scales	Follow up	Number of sessions	Length of sessions	Frequency of sessions	Total length (Hours)	Location	Facilitator	Theory
	Intervention	Control														
Odeh and Guy (2018)	n = 40 total		Horticultural therapy following a guidebook designed for the programme. All components were gardening related.		Art activity sessions twice weekly for 4 weeks	Mood Stress	Profile of Mood States (POMS) Perceived Stress Scale (PSS) Beck Depression Inventory (BDI – 2nd edition) State-trait anxiety inventory (STAI) Short-Form health survey-36 for health-related quality of life	4 weeks	8 sessions	60 mins	Twice a week	8 hours	Greenhouse of a garden	Horticultural therapist	Horticultural therapy	
	Mean age = 33 (SD 5.7)	Mean age = 32.8 (5.6)				Depression										
		100% female				Anxiety										
		No information given				Quality of life										
Pálsdóttir et al., 2020, 2015, 2016)	n = 48 Mean age = 67 (47–79) 53% Female	n = 42 Mean age = 66 (48–80) 66% Female Stroke	10-week structured programme of a range of gardening activities and guided exercise components in addition to usual stroke rehabilitation.	Control group continued their individualised programme of stroke rehabilitation.	Control group continued their usual day centre attendance – work-related tasks, craft, manufacturing and job coaching.	Anxiety Depression Quality of life	Hospital Anxiety and Depression Scale (HADS) EQ-5D 3L	32 weeks	20 sessions	210 mins	Twice a week	70 hours	Alnarp rehabilitation garden, 2-hectare garden	Occupational therapist, horticulturalist, psychotherapist, and physiotherapist	Horticultural Therapy	
Siu et al. (2020)	n = 37 Mean age = 50.8 (10.5) 46.7% Female Mental illness, 76.8% had diagnosis of schizophrenia	n = 36 Mean age = 49.7 (8.7) 53.3% Female	Each session followed the same structure and had a specific theme and objectives. Non gardening activities included cooking and mindful eating, diaphragmatic breathing technique and pressing flowers. Participants were encouraged to share experiences related gardening during reflection. Intervention group was released from normal programme to attend.	Control continued attendance – work-related tasks, craft, manufacturing and job coaching.	Control continued attendance – work-related tasks, craft, manufacturing and job coaching.	Anxiety Stress Wellbeing	Depression, Anxiety and Stress Scale (DASS21) Wanwick-Edinburgh Mental Wellbeing scale (C-WEMWBS)	8 weeks, 10 weeks	8 sessions	75 mins, 50 mins of which was gardening	Once a week	10 hours total intervention time, 6.66 hours of gardening	Not specified	Therapists	Horticultural Therapy + biopsychosocial and multidisciplinary perspective	
Stigsdóttir et al. (2018); Corazon et al. (2018); Nacadia Effect Study (NEST) (2013); Sidenius et al. (2017)	n = 39 Mean age = 47.9 (7.8) 79% female psychiatric diagnosis of adjustment disorder and reaction to severe stress	n = 37 Mean age = 44.9 (8.8) 73% female psychiatric diagnosis of adjustment disorder and reaction to severe stress	Nacadia Nature Based Therapy (NNBT). Sessions followed the same structure. All weeks had a theme in line with MBSR manual. Individuals could choose tasks undertaken. Most parts of intervention were carried out individually.	1:1 Cognitive Behavioural Therapy (CBT) programme for stress reduction. One hour sessions for 10 weeks	Control group received occupational therapy as well as conventional treatment in conditions without plants.	Wellbeing Burnout	Psychological general wellbeing index (PGWB) Shiron-Melamed Burnout Questionnaire (SMBO)	12 weeks, 24 weeks, 52 weeks	30 sessions	180 mins	Three days per week	90 hours	Therapy garden at the University of Copenhagen	Led by a clinical psychologist and a gardener	NNBT created with contributions from MBSR, CBT and attention restoration theory	
Vujčić et al. (2017)	n = 16 Mean age = 45.35 (10.16) 70% Female psychiatric diagnosis of an adjustment disorder and a reaction to severe stress, anxiety or depression disorders. 96% had diagnosis of depression.	n = 14 Mean age = 43.92 (10.16) 70% Female	Programme of Horticultural Therapy with specific aims and objectives. Introduction and preparation, then scheduled activities and group sharing. Activities included, potting, harvesting, walking through gardens, weeding. Also some art therapy and relaxation elements eg, meditation outside and drawing.	Control group received occupational therapy as well as conventional treatment in conditions without plants.	Control group received occupational therapy as well as conventional treatment in conditions without plants.	Depression Anxiety Stress	Depression, Anxiety and Stress Scale (DASS21)	4 weeks	12 sessions	60 mins	Three days per week	12 hours	Botanical Garden	No information about who led programme. Mentions it was created in collaboration with mental health therapists	Horticultural Therapy. Stress reduction theory and Attention Restoration Theory	
Vujčić et al. (2021)	n = 15 Psychiatric diagnosis of an adjustment disorder and a reaction to severe stress, anxiety or depression disorders. 96% had diagnosis of depression.	n = 12 70% female	Programme of Horticultural Therapy with specific aims and objectives. Introduction and preparation, then scheduled activities and group sharing. Activities included, potting, harvesting, walking through gardens, weeding. Also some art therapy and relaxation elements eg, meditation outside and drawing.	Control group received occupational therapy as well as conventional treatment in conditions without plants.	Control group received occupational therapy as well as conventional treatment in conditions without plants.	Severity of mental illness CGI – Impressions scale	Clinical Global Impressions scale	5 weeks	15 sessions	60mins	Three days per week	15 hours	Botanical Garden	No information	Horticultural therapy	

Table 3. Available data from included studies.

Study	Outcomes	Scales	Group	Baseline			Post intervention			P value	
				Mean	SD	N	Mean	SD	N		
Bay-Richter et al. (2012) Brown et al. (2020)	Depression	Montgomery Asperg Depression Rating Scale MADRS	Gardening Control	No information, published only as abstract							
	Mood	Profile of Mood States (POMS) – total mood disturbance	Gardening Control	Median 6.5 range –10 to 30 8 Median 9.5 range –6 to 46 9			Median change –2 Median change 9	Range –16 to 18 Range –1 to 30	8 9	Wilcoxon rank sum exact test	0.49
	Depression	Centre for Epidemiological studies depression Scale (CESD)	Gardening Control	Median 0 (range –6 to 2) 7 Median 6 (range 3 to 15) 9			Median change 0 Median change 0	Range –6 to 2 Range –4 to 18	5 9		0.38
	Quality of life	World health organisation quality of life questionnaire (WHOOOL-BRIEF) – psychological health-related quality of life (SF-36) – mental summary score	Gardening Control	Median 17 (range 14 to 19) 7 Median 16 (range 12 to 18) 11			Median change 0 Median change 0	Range –3.3 to 2 Range –4 to 4.5	7 11		0.77
Demark-Wahnefried et al. (2018); Cases et al. (2016)	Quality of life	Short-Form health survey-36 for health-related quality of life (SF-36) – mental summary score	Gardening Control	75.46 (2.86) 74.01 (4.76)		24 22	68.8 (4.42) 75.95 (4)		22 20		
		Short-Form health survey-36 for health-related quality of life (SF-36) – physical summary score	Gardening Control	72.45 (2.73) 66.14 (3.91)		24 22	67.69 (3.07) 74.67 (3.67)		22 20		
Detweiler et al. (2015)	Stress	Perceived Stress Scale (PSS)	Gardening Control	13.14 (1.33) 11.37 (1.91)		24 22	13.67 (1.52) 11.46 (1.9)		22 20		
	Quality of life	Quality of Life Enjoyment and Satisfaction Questionnaire – Short Form (Q-LES-Q-SF)	Gardening Control					Covariate-adjusted mean scores 71.05 Covariate-adjusted mean scores 61.22	n = 12 0.3 n = 10	F test 1.758	0.201
Huang et al. (2018)	Depression	Beck Depression Scale	Gardening Control			33		Covariate-adjusted mean scores 15.61 Covariate-adjusted mean scores 21.31	n = 12 0.37 n = 9	F test 2.521	0.13
Kam and Siu (2010)	Depression	Depression, Anxiety and Stress scale (DASS21)	Gardening Control	14.6 9.3	9.1 8.9	12 12	10.25 Change from baseline –9.20	3.16 3.68	10 12		<0.05
	Anxiety		Gardening Control	15 9.8	7.8 8.7	12 12	Change from baseline –1.17 Change from baseline 0.67	9.15 8.33	10 12		0.04
Kim and Park (2018)	Stress		Gardening Control	12.6 11.3	7.7 10.8	12 12	Change from baseline –0.6 Change from baseline –0.5	7.10 5.30	12 10		0.01
	wellbeing	Chinese personal wellbeing index (PWI-C)	Gardening Control	49.5 53.2	11.8 14.9	12 12	Change from baseline –0.6 Change from baseline 0.6	6.79 14.21	12 10		0.05
Kotozaki (2013a)	Depression	Zung Self-rated depression scale (SDS)	Gardening Control	44.7 43.2	8.6 6.6	18 18	Change from baseline 1.5 43.5	6.07 6.8	12 18	Paired t test	<0.001
	Anxiety	State-trait anxiety inventory (STAI)	Gardening Control	84.1 85.3	19.6 15.3	18 18	62.8 87.5	5.9 6.8	18 18		0.9
Kotozaki (2013b)	Depression	Centre for Epidemiological studies depression Scale (CESD)	Gardening Control	13.53 14	10.32 11.77	15 15	7.67 13.73	3.64 4.04	15 15	One-way analysis of covariance	<0.001
	Quality of life	WHO-QOL-26	Gardening Control	3.07 23.07	0.57 19	15 15	3.18 14.4	0.55 13.68	15 15		0.67
Kotozaki (2013c)	Affect	POMS	Gardening Control	24.4 6	22.03 3.34	15 15	21.73 3.2	19.87 2.81	15 15		<0.05
	Mental health	General Health Questionnaire (GHQ)	Gardening Control	4.73 3.25	2.79 3.37	15 20	5.47 1.85	5.79 2.06	15 20		
Kotozaki (2014a)	Depression	Geriatric depression scale (GDS-15)	Gardening Control	3.11 3.19	2.64 0.24	19 20	3.42 3.43	2.67 0.3	19 20		
	Quality of life	WHO-QOL-26	Gardening Control	3.07 23.5	0.39 6.03	19 20	2.98 6.6	0.36 5.25	19 20		
Kotozaki (2014b)	PTSD	Clinician Administered PTSD Scale (CAPS)	Gardening Control	21.84 7.59	4.83 4.62	19 22	10.63 4.41	8.9 4.34	19 22	One-way analysis of covariance	0.154
	Depression	Centre for Epidemiological studies depression Scale (CESD)	Gardening Control	6.52 6.52	6.71 4.6	23 22	8.96 2.14	7.88 3.52	23 22		0.086
Kotozaki (2014c)	Mental health	General Health Questionnaire (GHQ)	Gardening Control	6.52 13.4	6.71 7.1	23 27	4.87 11.8	6.76 7.4	23 27		0.934

(continued)

Table 3. Continued.

Study	Outcomes	Scales	Group	Baseline			Post intervention			P value		
				Mean	SD	N	Mean	SD	N		Effect estimate	95% CI
Makizako et al. (2019); Makizako et al. (2015)	Mental health	Centre for Epidemiological studies depression Scale (CESD)	Control	14.6	6.9	27	12.5	5.2	27		One-way analysis of covariance	0.248
	Quality of life	General Health Questionnaire (GHQ)	Gardening	7.1	5.1	27	4.4	4.2	27			0.297
	Positive affect	WHO-QOL-26	Control	52.5	5.8	27	53.9	6.5	27			0.011
	Negative affect	Positive and Negative Affect Scale (PANAS)	Gardening	20.5	6.4	27	23.3	7.4	27			0.071
	PTSD	Positive and Negative Affect Scale (PANAS)	Control	23.6	7.8	27	21	7.2	27			<0.001
	Depression	Clinician Administered PTSD Scale (CAPS)	Gardening	18.9	7.7	27	15.1	6	27			0.744
	Quality of life	Geriatric depression scale (GDS-15)	Control	31.5	6.5	27	10	7.1	27			
		Short-Form health survey-12 for health-related quality of life (SF-12)	Gardening	31.3	6.5	27	16.1	9.3	27			
		Zung self-rating depression scale (SDS)	Control	6.4	2.5	28	5.1	3.1	28		Paired t test	
		Zung self-rating anxiety scale (SAS)	Gardening	50.8	7	30	51.9	7.7	26			
Ng et al. (2018); Chan et al. (2017); Ng et al. (2016); Ng et al. (2019)	Depression	Zung self-rating depression scale (SDS)	Gardening	44.69 (3.75)	3.61	15	39.53(5.70)	5.7	15		Repeated-measured analysis of variance (rANOVA) & paired t tests	0.68
	Anxiety	Zung self-rating anxiety scale (SAS)	Control	35.14 (2.24)	4.56	15	38.13(3.81)	3.81	15			0.81
	Wellbeing	Ryff's scale of psychological wellbeing	Gardening	28.14 (4.87)	6.42	10	36.64	4.32	10			0.34
	Positive Affect	Positive and Negative Affect Scale (PANAS)	Control	12.07 (4.75)	3.61	15	39.53(5.70)	5.7	15			
	Negative affect	Positive and Negative Affect Scale (PANAS)	Mindful gardening	36.41	4.56	15	38.13(3.81)	3.81	15			
	Quality of life	Quality of Life Enjoyment and Satisfaction Questionnaire – Short Form(Q-LES-Q-SF)	Control	37	5.3	15	36.64	4.32	10			
	Mood	Profile of Mood States (POMS)	Gardening	17.76	7.04	15	16.88(5.10)	5.1	15			
	Stress	Perceived Stress Scale (PSS)	Mindful gardening	18.29	4.76	10	17.33(5.46)	5.46	10			
	Depression	Beck Depression Inventory (BDI – 2nd edition)	Control	17.81	4.76	10	16.55	5.66	10			
	Anxiety	State-trait anxiety inventory (STAI)	Gardening	69.43(5.12)	5.12	15	65.95(8.23)	8.23	15			
Pálsdóttir et al., 2020, 2015, 2016)	Quality of life	Short-Form health survey-36 for health-related quality of life (SF-36)	Mindful gardening	61.44(8.60)	8.6	15	62.78(11.13)	11.13	15			
	Mood	Profile of Mood States (POMS)	Control	62.72(9.30)	9.3	10	62.77(8.38)	8.38	10			
	Stress	Perceived Stress Scale (PSS)	No numerical data in published paper									
	Depression	Beck Depression Inventory (BDI – 2nd edition)										
	Anxiety	State-trait anxiety inventory (STAI)										
	Quality of life	Short-Form health survey-36 for health-related quality of life (SF-36)										
	Depression	Hospital Anxiety and Depression Scale (HADS)	Gardening	5.37	0.55	41	4.33	0.54	37		Wilcoxon rank-sum test, 2-sided	0.31
	Anxiety	Hospital Anxiety and Depression Scale (HADS)	Control	5.86	0.47	41	4.68	0.72	36			0.42
	Quality of life	EQ-5D 3L	Gardening	7.63	0.66	41	6.27	0.66	37			0.94
		EQ-5D 3L	Control	7.94	0.57	41	7.39	0.6	36			0.29
Siu et al. (2020)	Anxiety	Depression, Anxiety and Stress Scale (DASS21)	Gardening	0.59	0.55	41	0.64	0.54	37		ANOVA	0.36
	Stress	Depression, Anxiety and Stress Scale (DASS21)	Control	0.71	0.47	41	0.79	0.72	36			0.01
	Wellbeing	Warwick-Edinburgh Mental Wellbeing scale (C-WEMWBS)	Gardening	0.73	0.66	41	0.71	0.66	37			<0.001
	Wellbeing	Psychological general wellbeing index (PGWBI)	Control	0.85	0.48	41	0.84	0.65	36			<0.05
	Burnout	Shiron-Melamed Burnout Questionnaire (SMBQ)	Gardening	3.18	0.66	41	3.3	0.73	37			<0.001
		Shiron-Melamed Burnout Questionnaire (SMBQ)	Control	3.18	0.71	41	2.95	0.7	36			<0.001
		Shiron-Melamed Burnout Questionnaire (SMBQ)	Gardening	46.59	15.38	39	61.44	15.51	39	$\eta^2 = 0.144$ ; $\omega^2 = 0.125$	Two way mixed design ANCOVA	<0.001
		Shiron-Melamed Burnout Questionnaire (SMBQ)	Control	49.24	16.64	37	59.62	18.87	37	$\eta^2 = 0.088$ ; $\omega^2 = 0.067$	Freidman's test	<0.001
		Shiron-Melamed Burnout Questionnaire (SMBQ)	Gardening									<0.001
		Shiron-Melamed Burnout Questionnaire (SMBQ)	Control									<0.001

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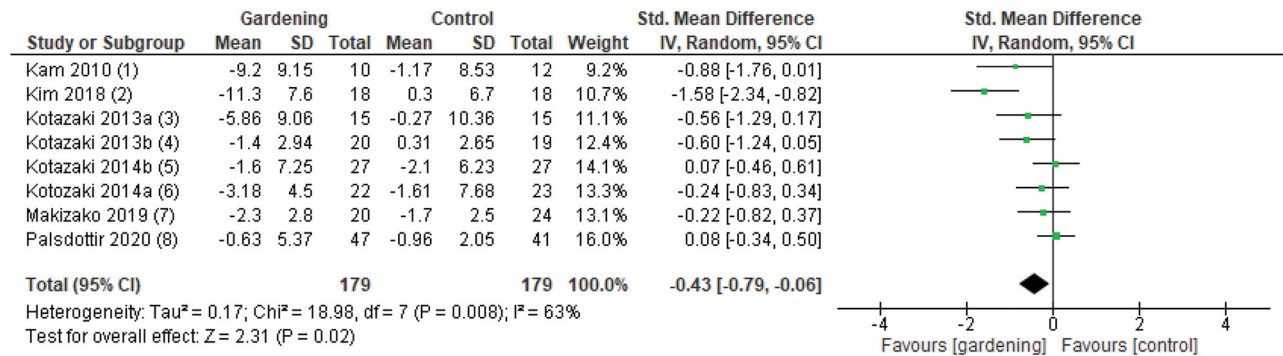
**Table 3.** Continued.

Study	Outcomes	Scales	Group	Baseline		Post intervention		Effect estimate	95% CI	Statistical test	P value
				Mean	SD	Mean	SD				
(2013); Sidenius et al. (2017)	Depression	Depression, Anxiety and Stress Scale (DASS21)	Gardening Control					Eta Squared = 0.037		Two factor analyses of variance	0.309
	Anxiety		Gardening Control					Eta Squared = 0.042			0.277
	Stress		Gardening Control					Eta Squared = 0.163			0.027
Vujcic et al. (2021)	Severity of mental illness	CGI – Clinical Global Impressions scale	Gardening Control	4.2 3.75	1.082 1.138	15 12	2.47 3.67	$\eta^2 = 0.313$		Two factor analyses of variance	0.002

**Table 4.** Description of ongoing trials.

Ongoing trials	Study population		Intervention	Control	Outcomes	Scales	Follow up	Location
	Intervention	Control						
Litt et al. (2018)	n = 156	n = 156	Community gardening	Waitlist	Wellbeing Anxiety Stress Depression	Warwick-Edinburgh Mental Wellbeing scale (C-WEMWBS) GAD-7 Perceived stress scale (PSS) Patient Health Questionnaire (PHQ-9)	9 months	Community garden
A Dose of Nature: An Interdisciplinary Study of Green Prescriptions (2019)	n = 240		Gardening activities	No intervention	Stress Wellbeing	Perceived stress scale (PSS) Warwick-Edinburgh Mental Wellbeing (C-WEMWBS)	3–6 months	Greenspace pockets around GP surgeries
Assessing the Effect of Environmental Activity on Depressive Symptoms (2020)	n = 40	n = 40	Six-week intervention involving twice weekly vegetable and flower growing for 90 mins duration.	Educational worksheet on behavioural activation and relaxation techniques.	Depression Quality of life	Beck depression inventory (BDI-II) Short-Form health survey-36 for health-related quality of life (SF-36)	10 weeks	Park
Harvest for Health in Older Cancer Survivors (2016)	n = 381		Gardening for 1 year in own gardens with support and supplies provided for by study	Waitlist	Quality of life	Short-Form health survey-36 for health-related quality of life (SF-36)	52 weeks	Own gardens

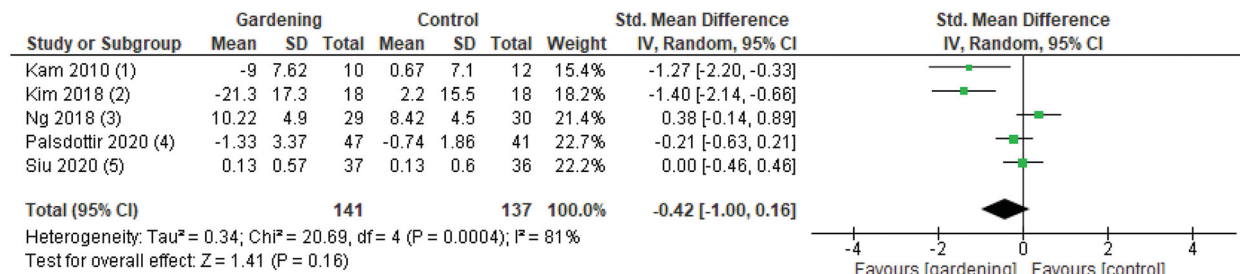
## 2. 1. Depression



### Footnotes

- (1) Active control, selected patients with mental illness. DASS21  
(2) Zung SDS  
(3) CES-D  
(4) Selected patients with PTSD. GDS  
(5) Selected patients with PTSD. CES-D  
(6) CES-D  
(7) GD5-15  
(8) HADS

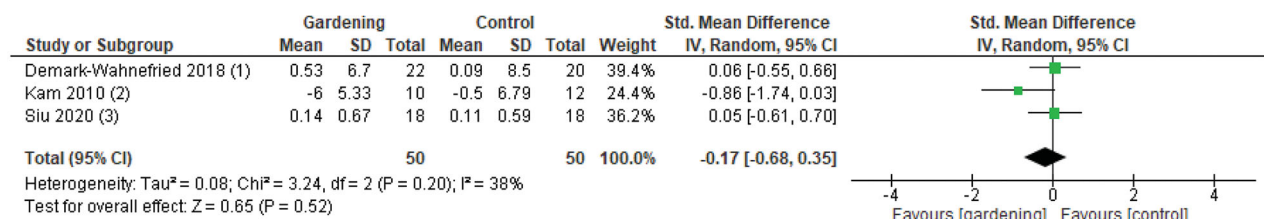
## 2. 2. Anxiety



### Footnotes

- (1) Active control, selected patients with mental illness. DASS21  
(2) STAI  
(3) Zung SAS  
(4) HADS  
(5) Selected patients with mental illness. DASS

## 2. 3. Stress



### Footnotes

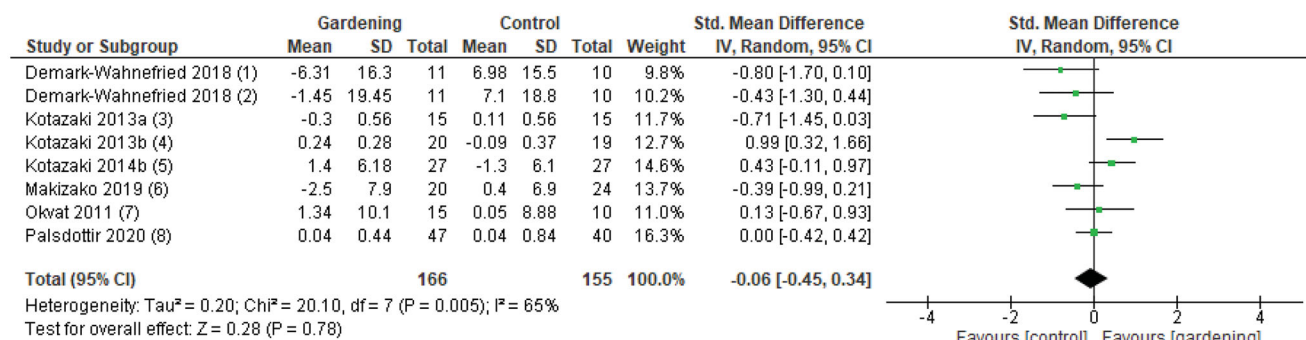
- (1) PSS  
(2) Active control, selected patients with mental illness. DASS21  
(3) Selected patients with mental illness. DASS

Figure 2. Forest Plots of health and wellbeing outcomes.

medians or comparison of variances (Brown et al., 2020; Vujcic et al., 2017). Four of the seven studies compared gardening interventions to inactive controls (Bay-Richter et al., 2012; Brown et al., 2020; Huang et al., 2018; Ng et al., 2018), and three to active comparators including occupational therapy (Detweiler et al., 2015; Vujcic et al., 2017) or

group art therapy (Odeh & Guy, 2018). Two studies selected patients with mental illness (Bay-Richter et al., 2012; Vujcic et al., 2017) and one selected veterans with substance abuse disorders (Detweiler et al., 2015), the remaining studies recruited healthy women (Odeh & Guy, 2018), native Americans with pre-diabetes or diabetes (Brown et al.,

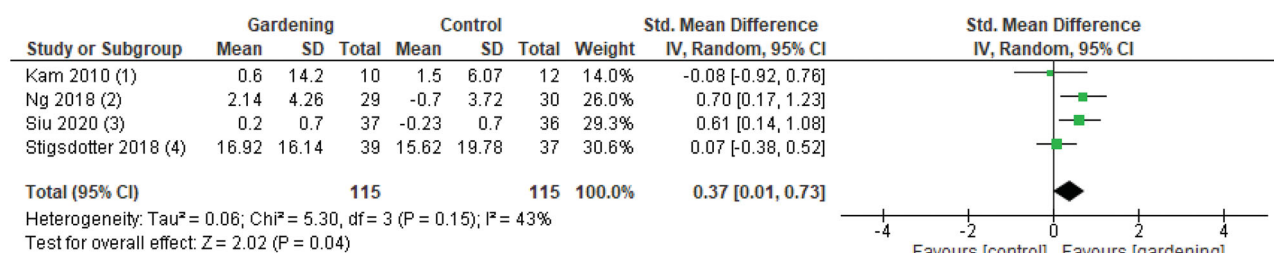
## 2. 4. Health-related quality of life



### Footnotes

- (1) SF-36 physical component summary (N numbers divided by two to prevent double counting of participants)
- (2) SF-36 mental component summary (N numbers divided by two to prevent double counting of participants)
- (3) WHO-QOL-26
- (4) Selected patients with PTSD. WHO-QOL-26 global score
- (5) Selected patients with PTSD. WHO-QOL-26 total score
- (6) SF-12 mental health score
- (7) Q-LES-Q-SF
- (8) EQ-5D 3L

## 2. 5. Wellbeing



### Footnotes

- (1) Active control, selected patients with mental illness. PWI
- (2) Rhfs Scales of Psychological Wellbeing
- (3) Selected patients with mental illness. WEMWBS
- (4) Active control, selected patients with stress related illness. PGWBI

Figure 2. (Continued).

2020), those with hand trauma undergoing rehabilitation (Huang et al., 2018), and older adults (Ng et al., 2018). Overall, findings were mixed with one study showing beneficial effects of gardening interventions on depression compared to control (Huang et al., 2018), another reporting improvements in depression with both gardening and the active comparator arts therapy, but with no analysis between groups (Odeh & Guy, 2018), and the remaining studies reporting little or no effect of gardening interventions on depression compared to control.

### Anxiety

Five studies (278 participants randomised) reported data on anxiety in a format suitable for meta-analysis (See Figure 2.2. Anxiety). Two of five studies selected patients with mental illness (Kam & Siu, 2010; Siu et al., 2020). There was considerable heterogeneity and so uncertainty in the pooled effect estimate, where two trials reported positive effects of the intervention on anxiety and the remaining three had little or no effect. Two further studies assessed the effect of

gardening interventions on anxiety but did not have data in a usable format for meta-analysis. One study (Odeh & Guy, 2018) where participants were healthy women found no statistically significant changes between pre and post-scores for either the gardening or art therapy group and did not analyse differences between groups. The remaining study (Vujcic et al., 2017) selected participants with mental illness and did not find significant interactions between pre and post-tests or groups (gardening and occupational therapy) for anxiety.

### Stress

Three studies (100 participants randomised) all of which had a low risk of bias, reported data on stress in a format suitable for meta-analysis (See Figure 2.3. Stress). Two of the studies selected patients with mental illness (Kam & Siu, 2010; Siu et al., 2020) though in the later, stress levels were low at baseline. Overall, the pooled effect estimate shows little or no effect of the intervention on stress (SMD -0.17 (95%CI to 0.68, 0.35)). Two further studies reported on

stress but not in a format suitable for meta-analysis (Odeh & Guy, 2018; Vujcic et al., 2017). Odeh and Guy (2018) found improvements in stress for both the gardening and art therapy conditions but did not analyse differences between groups. Vujcic et al. (2017) recruited participants with mental illness and found a significant interaction between tests (pre and post) and groups (gardening and occupational therapy) demonstrating a reduction in stress with gardening ( $P = 0.027$ ).

### **Health-related quality of life**

Seven studies (321 participants randomised) reported data on health-related quality of life in a format suitable for meta-analysis (See Figure 2.4. Health-related quality of life). There was substantial heterogeneity and so uncertainty in the pooled effect estimate, two trials, both with unclear risk of bias, reported positive effects of the intervention on quality of life, and the remaining five had little or no effect. Three further studies that did not have data in a usable format for meta-analysis also reported on this outcome (Brown et al., 2020; Detweiler et al., 2015; Odeh & Guy, 2018). None of these studies found significant differences in quality of life between comparison groups.

### **Wellbeing**

Four studies (230 participants randomised) all with a low risk of bias, reported data on wellbeing in a format suitable for meta-analysis (See Figure 2.5. Wellbeing). Three of the four studies selected patients with mental illness (Kam & Siu, 2010; Siu et al., 2020; Stigsdotter et al., 2018). Overall, the pooled effect estimate shows an increase in wellbeing with gardening interventions (SMD 0.37 (95%CI 0.01 to 0.73)).

### **Affect related outcomes**

Five studies included affect-related outcomes such as mood disturbance and positive and negative affect, data for which is presented in Table 3. Four of the studies included participants with no mental health conditions (Brown et al., 2020; Kotozaki, 2013a; Odeh & Guy, 2018; Okvat, 2011). Brown et al. (2020) reported a statistically significant difference between the groups for total mood disturbance while Odeh and Guy (2018) and Kotozaki (2013a) found no significant differences. Similarly, Okvat (2011) reported no significant differences between groups however, in this study, scores were already high for positive affect and low for negative affect at baseline. Kotozaki (2013b) included women with PTSD symptoms and found a significant improvement in positive affect but not for negative affect when compared to a stress control intervention.

### **Other relevant outcomes**

Burnout was assessed by Stigsdotter et al. (2018) significant reductions in burnout were observed for both the gardening

intervention group and CBT control group with no significant difference between them. The Global Impression scale was used by Vujcic et al. (2021) to assess the severity of mental illness in a study of people with diagnosed mental health conditions. Baseline scores of both groups reflected moderate illness. In the intervention group, scores decreased following the intervention reflecting 'minimal improvement' while no change was observed in the occupational therapy control group.

Kotozaki (2013a; 2014a; 2014b) assessed the mental health of participants using the General Health Questionnaire (GHQ). A significant decrease in GHQ scores (improvement in mental health) was observed among young adults without mental health conditions taking part in a group gardening intervention when compared to both those assigned to the individual gardening intervention as well as the control condition (Kotozaki, 2013a). No significant effect of the intervention on GHQ was observed in the two remaining studies (Kotozaki, 2014a; 2014b).

Two studies by Kotozaki (2013b; 2014b) assessed the effect of gardening interventions for women with PTSD using the Clinician Administered PDS scale, both found a statistically significant effect of the intervention on symptoms.

## **Discussion**

The results of this systematic review on the effects of gardening interventions on mental health and wellbeing are mixed. The current evidence indicates positive effects of group-based gardening interventions on depression and wellbeing, but these results need to be corroborated in larger sufficiently powered studies. No overall effects were seen on measures of anxiety, stress or quality of life when compared with active and inactive controls or those selected with mental illness, but numbers were small for both stress and anxiety. The most promising results were observed for wellbeing, showing significant improvements in the pooled effect estimate of four trials, all with a low risk of bias. Effects on wellbeing were largest for studies using inactive comparators, those using active comparators recruited participants with mental illness. Further studies are needed to corroborate these initial findings. The results of the four ongoing studies we identified and the conduct of additional high-quality studies will add to the evidence base and reduce uncertainty in the findings.

While the results are limited, the present review expands upon previous reviews by focussing exclusively on RCTs, reflecting advances in the quality of evidence in the field, as well as including a greater number of studies, several of which were published in recent years, which demonstrates an active research area. The results of this review also support and reaffirm those found in past reviews of gardening interventions for mental health, where positive effects were also found among various outcomes, including depression and anxiety (Cipriani et al., 2017; Clatworthy et al., 2013; Kamioka et al., 2014). However, methodological limitations and heterogeneity limited the conclusions that were able to be drawn from the results. The current review's focus on

RCTs and use of meta-analysis overcome many of the previously identified limitations, nonetheless, further high-quality trials are needed to make definitive conclusions about the effectiveness of these interventions for mental health. However, stronger conclusions have been made in other areas. For example, Spano et al. (2020b) found positive effects of gardening interventions for psychosocial outcomes such as trust and social networking, which may, in turn, lead to positive effects on participants mental health and wellbeing.

The positive findings in this present review regarding wellbeing also support the results of Soga et al. (2017) meta-analysis, where a significant positive effect of gardening on health was found. The authors' sub-group analysis identified a statistically significant difference in the effect sizes of wellbeing variables compared to physical health variables, with wellbeing variables observing a greater effect size. Soga et al. (2017) hypothesised that physical health outcomes may take longer to respond to change. While this present review did not include physical health outcomes, this may nonetheless help to explain why some outcomes, such as health-related quality of life, showed less improvement than others.

### **Strengths and limitations**

A limitation of the current review is the heterogeneity of the included studies, in particular the diversity of the gardening interventions; including their structure, duration, frequency and follow-up periods. Additionally, there were few studies reporting on each outcome except for depression and quality of life where there was substantial heterogeneity and so, uncertainty in the pooled effect estimates. For most studies, the sample sizes were small and so were subject to small study bias where larger effects are seen for smaller trials (Sterne et al., 2000). This needs to be taken into consideration when interpreting the findings.

One of the strengths of the review is its inclusion of only RCTs, many of which were published in recent years, which provides stronger evidence than was previously available, as well as a greater number of total studies than earlier reviews. We attempted to increase the precision of our findings by using meta-analysis where possible. For some outcomes, notably depression, several studies were not suitable for inclusion in the meta-analysis. This was due to a lack of reporting of data in a useable format, either missing baseline or follow-up data, lack of numerical reporting or use of alternative analyses. Where meta-analysis was possible, heterogeneity limited the interpretation of findings with pooled effect estimates reported only for stress, wellbeing, and quality of life where heterogeneity was either moderate or absent. We used Standardised Mean Difference as a measure of intervention effect as, whilst all scales measuring mental health and wellbeing were validated, several different scales were used for each outcome.

### **Recommendations for future research**

It is recommended that future research focus on larger, well-reported trials as this would help further the evidence

base, reduce uncertainty in the findings and make more definitive conclusions about the effectiveness of such interventions. Evidence is currently limited to predominantly small trials at unclear risk of bias. Trials of both healthy participants and people with poor mental health would be valuable to determine the effects on both groups. It is recommended that where trials include participants with mental health conditions, their baseline scores reflect this. In some of the included trials participants had low levels of symptoms at baseline (e.g. Ng et al., 2018; Pálsdóttir et al., 2020; Siu et al., 2020). This may have indicated sample bias and limited opportunity for improvement following the interventions.

### **Implications for practice and policy**

While promising effects were seen for wellbeing and possibly also depression, no definitive conclusions can be made about the effectiveness of such interventions currently. Consequently, no recommendations can be made about their use more widely. Nonetheless, there are already numerous such projects being offered by various charities and organisations, as such, it would be reasonable for future studies to evaluate these interventions to help further the evidence base. This would align with the UK Government's 25-Year Environment Plan, which highlights the need to understand how environmental therapies could be integrated into mental health services (Department for Environment Food & Rural Affairs, 2018). The research area is active as evidenced by the four ongoing studies we have identified. If in the future, the evidence finds group-based gardening interventions to be effective, they could help to contribute to reducing the burden of mental ill health in society either integrated within tiered mental health services or facilitated as social prescribing schemes.

### **Conclusion**

The findings of this review include mixed results for the effectiveness of group-based gardening interventions for mental health and wellbeing. Results for wellbeing and depression are promising, with further studies needed to corroborate these findings among both general population participants and those with identified poor mental health. More studies, with a focus on larger, well conducted and well-reported trials, are needed to confirm initial findings and to determine the effectiveness of these interventions on other health outcomes where results are less clear.

### **Acknowledgements**

The authors would like to thank Rowena Stewart for her help with devising the search strategy.

### **Disclosure statement**

The authors declare no conflicts of interest.



## Funding

The author(s) reported there is no funding associated with the work featured in this article.

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## References

- A Dose of Nature: An Interdisciplinary Study of Green Prescriptions (2019). Identification number NCT04175561. <https://clinicaltrials.gov/ct2/show/NCT04175561?term=a+dose+of+nature&draw=2&rank=1>
- Annerstedt, M., & Währborg, P. (2011). Nature-assisted therapy: Systematic review of controlled and observational studies. *Scandinavian Journal of Public Health*, 39(4), 371–388. <https://doi.org/10.1177/1403494810396400>
- Assessing the Effect of Environmental Activity on Depressive Symptoms (2020). Identification number IRCT20181206041871N1. <https://trialsearch.who.int/?TrialID=IRCT20181206041871N1>
- Barton, H., & Grant, M. (2006). A health map for the local human habitat. *The Journal of the Royal Society for the Promotion of Health*, 126(6), 252–253. <https://doi.org/10.1177/1466424006070466>
- Bay-Richter, C., Träskman-Bendz, L., Grahn, P., & Brundin, L. (2012). Garden rehabilitation stabilises INF-gamma and IL-2 levels but does not relieve depressive-symptoms. *Neurology, Psychiatry and Brain Research*, 18(2), 37. <https://doi.org/10.1016/j.npbr.2012.02.002>
- Brown, B., Dybdal, L., Noonan, C., Pedersen, M. G., Parker, M., & Corcoran, M. (2020). Group gardening in a Native American Community: A collaborative approach. *Health Promotion Practice*, 21(4), 611–623. <https://doi.org/10.1177/1524839919830930>
- Buck, D. (2016). *Gardens and health implications for policy and practice*. The Kings Fund.
- Cases, M. G., Fruge, A. D., De Los Santos, J. F., Locher, J. L., Cantor, A. B., Smith, K. P., Glover, T. A., Cohen, H. J., Daniel, M., Morrow, C. D., Moellering, D. R., & Demark-Wahnefried, W. (2016). Detailed methods of two home-based vegetable gardening intervention trials to improve diet, physical activity, and quality of life in two different populations of cancer survivors. *Contemporary Clinical Trials*, 50, 201–212. <https://doi.org/10.1016/j.cct.2016.08.014>
- Centre for Reviews and Dissemination (2008). *Systematic reviews: CRD's guidance for undertaking systematic reviews in health care*. University of York.
- Chan, H. Y., Ho, R. C., Mahendran, R., Ng, K. S., Tam, W. W., Rawtaer, I., Tan, C. H., Larbi, A., Feng, L., Sia, A., Ng, M., Gan, G. L., & Kua, E. H. (2017). Effects of horticultural therapy on elderly health: Protocol of a randomized controlled trial. *BMC Geriatrics*, 17(1), 192. <https://doi.org/10.1186/s12877-017-0588-z>
- Cipriani, J., Benz, A., Holmgren, A., Kinter, D., McGarry, J., & 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. <https://doi.org/10.1080/0164212X.2016.1231602>
- Clatworthy, J., Hinds, J., & Camic, P. (2013). Gardening as a mental health intervention: A review. *Mental Health Review Journal*, 18(4), 214–225. <https://doi.org/10.1108/MHRJ-02-2013-0007>
- Corazon, S. S., Stigsdotter, U. K., Jensen, A. G., & Nilsson, K. (2010). Development of the nature-based therapy concept for patients with stress-related illness at the Danish healing forest garden Nadadia. *Journal of Therapeutic Horticulture*, 20, 34–51.
- Corazon, S. S., Nyed, P. K., Sidenius, U., Poulsen, D. V., & Stigsdotter, U. K. (2018). A long-term follow-up of the efficacy of nature-based therapy for adults suffering from stress-related illnesses on levels of healthcare consumption and sick-leave absence: A randomized controlled trial. *International Journal of Environmental Research and Public Health*, 15(1), 137–147. <https://doi.org/10.3390/ijerph15010137>
- Dean, J., Van Dooren, K., & Weinstein, P. (2011). Does biodiversity improve mental health in urban settings? *Medical Hypotheses*, 76(6), 877–880. <https://doi.org/10.1016/j.mehy.2011.02.040>
- Demark-Wahnefried, W., Cases, M. G., Cantor, A. B., Fruge, A. D., Smith, K. P., Locher, J., Cohen, H. J., Tsuruta, Y., Daniel, M., Kala, R., & De Los Santos, J. F. (2018). A pilot randomized controlled trial of a home vegetable gardening intervention among older cancer survivors shows feasibility, satisfaction, and promise in improving vegetable and fruit consumption, reassurance of worth, and the trajectory of central adiposity. *Journal of the Academy of Nutrition and Dietetics*, 118(4), 689–704. <https://doi.org/10.1016/j.jand.2017.11.001>
- Department for Environment Food & Rural Affairs. (2018). *A green future: Our 25-year plan to improve the environment*. UK Government.
- Detweiler, M. B., Self, J. A., Lane, S., Spencer, L., Lutgens, B., Kim, D.-Y., Halling, M. H., Rudder, T. F., & Lehmann, L. (2015). Horticultural therapy: A pilot study on modulating cortisol levels and indices of substance craving, posttraumatic stress disorder, depression, and quality of life in veterans. *Alternative Therapies in Health and Medicine*, 21(4), 36–41.
- Harris, H. (2017). The social dimensions of therapeutic horticulture. *Health & Social Care in the Community*, 25(4), 1328–1336. <https://doi.org/10.1111/hsc.12433>
- Hartig, T. (2004). Restorative environments. In Spielberger, C., (Ed). *Encyclopedia of applied psychology*. Academic Press. pp. 273–279. <https://doi.org/10.1016/B0-12-657410-3/00821-7>
- Hartig, T., Mitchell, R., De Vries, S., & Frumkin, H. (2014). Nature and health. *Annual Review of Public Health*, 35(1), 207–228. <https://doi.org/10.1146/annurev-publhealth-032013-182443>
- Harvest for Health in Older Cancer Survivors (2016). Identification number NCT02985411. <https://clinicaltrials.gov/ct2/show/NCT02985411>
- Higgins, J. P. T., Altman, D. G., Gøtzsche, P. C., Jüni, P., Moher, D., Oxman, A. D., Savovic, J., Schulz, K. F., Weeks, L., & Sterne, J. A. C. (2011). The Cochrane Collaboration's tool for assessing risk of bias in randomised trials. *BMJ*, 343(7829), d5928. <https://doi.org/10.1136/bmj.d5928>
- Howarth, M., Brettell, A., Hardman, M., & Maden, M. (2020). What is the evidence for the impact of gardens and gardening on health and well-being: A scoping review and evidence-based logic model to guide healthcare strategy decision making on the use of gardening approaches as a social prescription. *BMJ Open*, 10(7), e036923. <https://doi.org/10.1136/bmjopen-2020-036923>
- Huang, W. Z., Liu, L., Wang, Z. J., Mai, G. H., Cui, A. Y., & Yan, W. (2018). Effect of horticultural therapy on psychological factors of patients with hand functional rehabilitation. *Basic & Clinical Pharmacology and Toxicology*, 122(2), 50.
- Kam, M. C. Y., & Siu, A. M. H. (2010). Evaluation of a horticultural activity programme for persons with psychiatric illness. *Hong Kong Journal of Occupational Therapy*, 20(2), 80–86. [https://doi.org/10.1016/S1569-1861\(11\)70007-9](https://doi.org/10.1016/S1569-1861(11)70007-9)
- Kamioka, H., Tsutani, K., Yamada, M., Park, H., Okuizumi, H., Honda, T., Okada, S., Park, S.-J., Kitayuguchi, J., Abe, T., Handa, S., & Mutoh, Y. (2014). Effectiveness of horticultural therapy: A systematic review of randomized controlled trials. *Complementary Therapies in Medicine*, 22(5), 930–943. <https://doi.org/10.1016/j.ctim.2014.08.009>
- Kaplan, R., & Kaplan, S. (1989). *The experience of nature: A psychological perspective*. Cambridge University Press.
- Kaplan, S. (1995). The restorative benefits of nature: Toward an integrative framework. *Journal of Environmental Psychology*, 15(3), 169–182. [https://doi.org/10.1016/0272-4944\(95\)90001-2](https://doi.org/10.1016/0272-4944(95)90001-2)
- Kim, K. H., & Park, S. A. (2018). Horticultural therapy program for middle-aged women's depression, anxiety, and self-identify. *Complementary Therapies in Medicine*, 39, 154–159. <https://doi.org/10.1016/j.ctim.2018.06.008>

- Kotozaki, Y. (2013a). Comparison of the effects of individual and group horticulture interventions. *Health Care: Current Reviews*, 02(02). <https://doi.org/10.4172/hccr.1000120>
- Kotozaki, Y. (2013b). The Psychological changes of horticultural therapy intervention for elderly women of earthquake related areas. *Journal of Trauma & Treatment*, 3(1).
- Kotozaki, Y. (2014a). Horticultural therapy as a measure for recovery support of regional community in the disaster area: A preliminary experiment for forty five women who living certain region in the coastal area of Miyagi Prefecture. *International Journal of Emergency Mental Health and Human Resilience*, 16(2), 112–116.
- Kotozaki, Y. (2014b). The psychological effect of horticultural therapy intervention of earthquake related stress in women of earthquake related areas. *Journal of Translational Medicine & Epidemiology*, 2(1)
- Litt, J. S., Alaimo, K., Buchenau, M., Villalobos, A., Glueck, D. H., Crume, T., Fahnestock, L., Hamman, R. F., Hebert, J. R., Hurley, T. G., Leiferman, J., & Li, K. (2018). Rationale and design for the community activation for prevention study (CAPs): A randomized controlled trial of community gardening. *Contemporary Clinical Trials*, 68, 72–78. <https://doi.org/10.1016/j.cct.2018.03.005>
- Makizako, H., Tsutsumimoto, K., Doi, T., Hotta, R., Nakakubo, S., Liu-Ambrose, T., & Shimada, H. (2015). Effects of exercise and horticultural intervention on the brain and mental health in older adults with depressive symptoms and memory problems: Study protocol for a randomized controlled trial [UMIN000018547]. *Trials*, 16(1), 499. <https://doi.org/10.1186/s13063-015-1032-3>
- Makizako, H., Tsutsumimoto, K., Doi, T., Makino, K., Nakakubo, S., Liu-Ambrose, T., & Shimada, H. (2019). Exercise and horticultural programs for older adults with depressive symptoms and memory problems: A randomized controlled trial. *Journal of Clinical Medicine*, 9(1), 99–112. <https://doi.org/10.3390/jcm9010099>
- McGuinness, L. A., & Higgins, J. P. T. (2021). Risk-of-bias Visualization (Robvis): An R package and Shiny web app for visualizing risk-of-bias assessments. *Research Synthesis Methods*, 12(1), 55–61. <https://doi.org/10.1002/jrsm.1411>
- McKenzie, J. E., Brennan, S. E. (2021). Chapter 12: Synthesizing and presenting findings using other methods. In: Higgins, J. P. T., Thomas, J., Chandler, J., Cumpston, M., Li, T., Page, M. J., Welch, V. A., (editors). *Cochrane handbook for systematic reviews of interventions version 6.2 (updated February 2021)*. Cochrane.
- Nacadia Effect Study (NEST) (2013). Identification number NCT01849718. <https://clinicaltrials.gov/ct2/show/NCT01849718>
- Ng, K. S. T., Chan, H. Y., Sia, A., Mahendran, R., Tan, H. C., Feng, L., Ng, M. K.-W., Tan, C. T. Y., Larbi, A., Ho, R. C.-M., & Kua, E. H. (2016). The effects of horticultural therapy on the psychological well-being and associated biomarkers of elderly in Singapore. *Alzheimers and Dementia*, 12(7), 1180. <https://doi.org/10.1016/j.jalz.2016.07.117>
- Ng, K., Sia, A., Ng, M., Tan, C., Chan, H., Tan, C., Rawtaer, I., Feng, L., Mahendran, R., Larbi, A., Kua, E. H., & Ho, R. (2018). Effects of horticultural therapy on Asian older adults: A randomized controlled trial. *International Journal of Environmental Research and Public Health*, 15(8), 1705–1719. <https://doi.org/10.3390/ijerph15081705>
- Ng, K. S. T., Sia, A., Ng, M. K.-W., Kua, E., & Ho, R. C.-M. (2019). Horticultural therapy improves IL-6 and social connectedness differentially. *Alzheimers and Dementia*, 15(7), P1211–P1211. <https://doi.org/10.1016/j.jalz.2019.06.3649>
- Nicholas, S. O., Giang, A. T., & Yap, P. L. K. (2019). The effectiveness of horticultural therapy on older adults: A systematic review. *Journal of the American Medical Directors Association*, 20(10), 1351.e1–1351.e11. <https://doi.org/10.1016/j.jamda.2019.06.021>
- Odeh, R., & Guy, C. (2018). Gardening and art study: Assessing biometric changes for healthy women in a randomized. *Controlled Intervention. Proceedings of the Florida State Horticultural Society*, 131, 224–227.
- Okvat, H. (2011). *A pilot study of the benefits of traditional and mindful community gardening for urban older adults' subjective well-being* [Doctoral dissertation, Arizona State University] ASU Digital Repository. <https://repository.asu.edu/>
- Pálsdóttir, A. M., Andersson, G., Grahn, P., Norrving, B., Kyrö-Wissler, S., Petersson, I. F., & Pessah-Rasmussen, H. (2015). A randomized controlled trial of nature-based post-stroke fatigue rehabilitation ("the nature stroke study" (NASTRU)): study design and progress report Paper presented at the ESO, Glasgow.
- Pálsdóttir, A. M., Stigmar, K., Grahn, P., Norrving, B., & Pessah-Rasmussen, H. (2016). The Nature Stroke Study (NASTRU), Nature-based rehabilitation of post stroke fatigue- A randomised controlled trial. Paper presented at the 2nd European Stroke Organisation Conference 2016.
- Pálsdóttir, A., Stigmar, K., Norrving, B., Grahn, P., Petersson, I., Åström, M., & Pessah-Rasmussen, H. (2020). The nature stroke study; NASTRU: A randomized controlled trial of nature-based post-stroke fatigue rehabilitation. *Journal of Rehabilitation Medicine*, 52(2), jrm00020. <https://doi.org/10.2340/16501977-2652>
- Review Manager (RevMan) [Computer program]. (2020). Version 5.4, The Cochrane Collaboration,
- Sempik, J. (2010). Green care and mental health: Gardening and farming as health and social care. *Mental Health and Social Inclusion*, 14(3), 15–22. <https://doi.org/10.5042/mhsi.2010.0440>
- Sempik, J., Hine, R., & Wilcox, D. (2010). (Eds) *Green care: a conceptual framework: a report of the working group on the health benefits of green care*, COST Action 866, Green Care in Agriculture, Loughborough: Loughborough University, Centre for Child and Family Research. From: [https://www.researchgate.net/publication/254841074\\_Green\\_Care\\_a\\_Conceptual\\_Framework\\_A\\_Report\\_of\\_the\\_Working\\_Group\\_on\\_the\\_Health\\_Benefits\\_of\\_Green\\_Care](https://www.researchgate.net/publication/254841074_Green_Care_a_Conceptual_Framework_A_Report_of_the_Working_Group_on_the_Health_Benefits_of_Green_Care)
- Sidenius, U., Karlsson Nyed, P., Linn Lygum, V., & Stigsdotter, U. K. (2017). A diagnostic post-occupancy evaluation of the Nacadia(R) therapy garden. *International Journal of Environmental Research and Public Health*, 14(8), 882. <https://doi.org/10.3390/ijerph14080882>
- Siu, A. M. H., Kam, M., & Mok, I. (2020). Horticultural therapy program for people with mental illness: A mixed-method evaluation. *International Journal of Environmental Research and Public Health*, 17(3), 711–710. <https://doi.org/10.3390/ijerph17030711>
- Soga, M., Gaston, K. J., & Yamaura, Y. (2017). Gardening is beneficial for health: A meta-analysis. *Preventive Medicine Reports*, 5, 92–99. <https://doi.org/10.1016/j.pmedr.2016.11.007>
- Sterne, J. A., Gavaghan, D., & Egger, M. (2000). Publication and related bias in meta-analysis: Power of statistical tests and prevalence in the literature. *Journal of Clinical Epidemiology*, 53(11), 1119–1129. [https://doi.org/10.1016/S0895-4356\(00\)00242-0](https://doi.org/10.1016/S0895-4356(00)00242-0)
- Spano, G., Giannico, V., Elia, M., Bosco, A., Laforteza, R., & Sanesi, G. (2020a). Human health-environment interaction science: An emerging research paradigm. *The Science of the Total Environment*, 704, 135358. <https://doi.org/10.1016/j.scitotenv.2019.135358>
- Spano, G., D'Este, M., Giannico, V., Carrus, G., Elia, M., Laforteza, R., Panno, A., & Sanesi, G. (2020b). Are community gardening and horticultural interventions beneficial for psychosocial wellbeing? A meta-analysis. *International Journal of Environmental Research and Public Health*, 17(10), 3584. <https://doi.org/10.3390/ijerph17103584>
- Stigsdotter, U. K., Corazon, S. S., Sidenius, U., Karlsson Nyed, P., Larsen, H. B., & Fjorback, L. O. (2018). Efficacy of nature-based therapy for individuals with stress-related illnesses: Randomised controlled trial. *The British Journal of Psychiatry: The Journal of Mental Science*, 213(1), 404–411. <https://doi.org/10.1192/bjp.2018.2>
- The PRISMA Group. (2009). Preferred reporting items for systematic reviews and meta-analyses: The PRISMA statement. *PLOS Med*, 6(7), e1000097. <https://doi.org/10.1371/journal.pmed.1000097>
- Thompson, R. (2018). Gardening for health: A regular dose of gardening. *Clinical Medicine*, 18(3), 201–205. <https://doi.org/10.7861/clinmedicine.18-3-201>
- Thomson, L. J., Camic, P. M., & Chatterjee, H. J. (2015). *Social prescribing: A review of community referral schemes*. University College London.
- Ulrich, R. (1984). View through a window may influence recovery from surgery. *Science*, 224(4647), 420–421. <https://doi.org/10.1126/science.6143402>

- Ulrich, R. S., Simons, R. F., Losito, B. D., Fiorito, E., Miles, M. A., & Zelson, M. (1991). Stress recovery during exposure to natural and urban environments. *Journal of Environmental Psychology*, 11(3), 201–230. [https://doi.org/10.1016/S0272-4944\(05\)80184-7](https://doi.org/10.1016/S0272-4944(05)80184-7)
- Vujcic, M., Tomicevic-Dubljevic, J., Grbic, M., Lecic-Tosevski, D., Vukovic, O., & Toskovic, O. (2017). Nature based solution for improving mental health and well-being in urban areas. *Environmental Research*, 158, 385–392. <https://doi.org/10.1016/j.envres.2017.06.030>
- Vujcic, M., Tomicevic-Dubljevic, J., Tosevski, D. L., Vukovic, O., & Toskovic, O. (2021). Development of evidence-based rehabilitation practice in botanical garden for people with mental health disorders. *Health Environments Research & Design Journal*, 14(4), 242–257. <https://doi.org/10.1177/19375867211007941>
- Wang, D., & MacMillan, T. (2013). The benefits of gardening for older adults: A systematic review of the literature. *Activities, Adaptation & Aging*, 37(2), 153–181. <https://doi.org/10.1080/01924788.2013.784942>
- Wilson, E. O. (1984). *Biophilia*. Harvard University Press.
- Yeo, N. L., Elliott, L. R., Bethel, A., White, M. P., Dean, S. G., & Garside, R. (2020). Indoor nature interventions for health and well-being of older adults in residential settings: A systematic review. *The Gerontologist*, 60(3), e184–e199. <https://doi.org/10.1093/geront/gnz019>