

BMJ Open

BMJ Open is committed to open peer review. As part of this commitment we make the peer review history of every article we publish publicly available.

When an article is published we post the peer reviewers' comments and the authors' responses online. We also post the versions of the paper that were used during peer review. These are the versions that the peer review comments apply to.

The versions of the paper that follow are the versions that were submitted during the peer review process. They are not the versions of record or the final published versions. They should not be cited or distributed as the published version of this manuscript.

BMJ Open is an open access journal and the full, final, typeset and author-corrected version of record of the manuscript is available on our site with no access controls, subscription charges or pay-per-view fees (<http://bmjopen.bmj.com>).

If you have any questions on BMJ Open's open peer review process please email info.bmjopen@bmj.com

BMJ Open

What Is the Evidence for the Impact of Gardens and Gardening on Health and Wellbeing: A Systematic Scoping Review and Evidence-Based Logic Model to Guide Healthcare Strategy Decision Making on the use of Gardening Approaches as a Social Prescription. .

Journal:	<i>BMJ Open</i>
Manuscript ID	bmjopen-2020-036923
Article Type:	Original research
Date Submitted by the Author:	10-Jan-2020
Complete List of Authors:	Howarth, Michelle; University of Salford, ; University of Salford Brettle, Alison; University of Salford, School of Health and Society Hardman, Michael; University of Salford, School of Science, Engineering & Environment Maden, Michelle; University of Liverpool, Department of Health Services Research
Keywords:	SOCIAL MEDICINE, PUBLIC HEALTH, PRIMARY CARE

SCHOLARONE™
Manuscripts



I, the Submitting Author has the right to grant and does grant on behalf of all authors of the Work (as defined in the below author licence), an exclusive licence and/or a non-exclusive licence for contributions from authors who are: i) UK Crown employees; ii) where BMJ has agreed a CC-BY licence shall apply, and/or iii) in accordance with the terms applicable for US Federal Government officers or employees acting as part of their official duties; on a worldwide, perpetual, irrevocable, royalty-free basis to BMJ Publishing Group Ltd ("BMJ") its licensees and where the relevant Journal is co-owned by BMJ to the co-owners of the Journal, to publish the Work in this journal and any other BMJ products and to exploit all rights, as set out in our [licence](#).

The Submitting Author accepts and understands that any supply made under these terms is made by BMJ to the Submitting Author unless you are acting as an employee on behalf of your employer or a postgraduate student of an affiliated institution which is paying any applicable article publishing charge ("APC") for Open Access articles. Where the Submitting Author wishes to make the Work available on an Open Access basis (and intends to pay the relevant APC), the terms of reuse of such Open Access shall be governed by a Creative Commons licence – details of these licences and which [Creative Commons](#) licence will apply to this Work are set out in our licence referred to above.

Other than as permitted in any relevant BMJ Author's Self Archiving Policies, I confirm this Work has not been accepted for publication elsewhere, is not being considered for publication elsewhere and does not duplicate material already published. I confirm all authors consent to publication of this Work and authorise the granting of this licence.

1
2
3 **What Is the Evidence for the Impact of Gardens and Gardening on Health and Wellbeing: A**
4 **Systematic Scoping Review and Evidence-Based Logic Model to Guide Healthcare Strategy Decision**
5 **Making on the use of Gardening Approaches as a Social Prescription.**
6
7

8 **Author and Co-Authors.**
9

- 10
11 1. Dr Michelle Howarth: Senior Lecturer/ Deputy Director PGR - (training). School of Health &
12 Society. Room 1.65 Mary Seacole Building, Frederick Rd Campus Salford, M6 6PU T: +44(0)
13 0161 295 2873. m.l.howarth2@salford.ac.uk
14 2. Professor Alison Brettle: Research Centre Director / CARE. 1:90 Mary Seacole, University of
15 Salford, M6 6PU T: +44(0) 0161 295 0447. A.brettle@salford.ac.uk
16 3. Dr Michael Hardman: Senior Lecturer in Urban Geography Programme Leader UG Geography
17 & Environmental Management School of Science, Engineering & Environment G33, Peel
18 Building, University of Salford, Manchester M5 4WT. Tel: +44(0) 0161 295
19 2201. m.hardman@salford.ac.uk
20 4. Dr Michelle Maden: Postdoctoral Research Associate, Evidence Synthesis | Liverpool
21 Reviews & Implementation Group. University of Liverpool. Rm 2.19. Whelan
22 Building. Liverpool. L69 3GB. Tel: 0151 795 1088 . michelle.maden@liverpool.ac.uk
23
24
25
26

27 **Corresponding Author:** Dr Michelle Howarth: Senior Lecturer/ Deputy Director PGR -
28 (training). School of Health & Society. Room 1.65 Mary Seacole Building, Frederick Rd Campus
29 Salford, M6 6PU T: +44(0) 0161 295 2873 /
30 m.l.howarth2@salford.ac.uk
31
32

33 **Keywords:** Social Medicine, Public Health, Primary Care.
34

35 **Wordcount:** excluding title page, references, figures and tables is 3649
36
37
38
39
40
41
42
43
44
45
46
47
48
49
50
51
52
53
54
55
56
57
58
59
60

ABSTRACT

Objective: To systematically identify and describe studies that have evaluated the impact of gardens and gardening on health and wellbeing. A secondary objective was to use this evidence to build evidence-based logic models to guide health strategy decision making about gardens and gardening as a non-medical, social prescription.

Setting: Community-based.

Participants: Adults and children who use gardens

Interventions: Gardens including private spaces and those open to the public or part of hospitals, care homes, hospices or third sector organisations.

Primary Outcome Measures: Using systematic scoping review methods, electronic databases and grey literature were searched during in April 2017 – November 2019 to locate and identify gardening interventions. There were no restrictions on study design. All studies were independently screened by three reviewers. Data extraction was performed by one reviewer and verified by a second. Outcomes included mental health, wellbeing, nutrition and physiological measures.

Results: From the 8896 papers located, a total of 77 studies were included. Over 35 validated health and wellbeing outcome measures were reported and a range of functional biometrics. Interventions ranged from viewing gardens, taking part in gardening or undertaking therapeutic activities. The findings demonstrated links between gardens and improved mental wellbeing, increased physical activity and a reduction in social isolation enabling the development of 2 logic models.

Conclusions: Gardens and gardening can improve the health and wellbeing for people with a range of health and social needs. The benefits of gardens and gardening could be used as a 'social prescription' globally, for people with Long Terms Conditions (LTC). Our logic models provide an evidence-based illustration that can guide health strategy decision making about the referral of people with LTC to socially prescribed, non-medical interventions involving gardens and gardening.

ARTICLE SUMMARY: 'Strengths and limitations of this study',

- This is the first systematic scoping review to explicate the breadth and depth of evidence about the impact of gardens and gardening on a range of health and wellbeing outcomes
- Our findings confirm that gardens and gardening are an effective non-medical intervention that can be socially prescribed for people with LTC.
- Our paper provides evidence-based guidance via logic models to guide health strategy decision making about the referral of people with LTC to socially prescribed, non-medical interventions involving gardens and gardening

RATIONALE:

Long term conditions (LTC's) such as cardiovascular disease, chronic respiratory disorders and cancer remain a significant cause of death globally ¹. Contributing to these figures, mental ill-health is the largest single cause of disability worldwide representing 14% of the global population, with depression accounting for 4.3% (WHO 2013) ². Correspondingly, rising international levels of obesity have influenced an increase in type 2 diabetes and by 2025, the total number of people worldwide with diabetes due to obesity is likely be exacerbated by an estimated 1 billion people³. In the UK, the management of LTC's is challenged by unmet social needs which are attributed to increased attendance at GP surgeries ⁴. Patients with LTC's require multipurpose, complex interventions combining inter-professional and intra-agency responses. Hence, it is predicted that LTC's will outstrip universal health and social care service provision, forcing health care strategists to appraise the effectiveness of existing pathogenic interventions. However, the traditional medical management of people with LTC's does not tackle their social needs leading to repeat primary care appointments and unnecessary admissions to secondary care⁵. Consequently, there is a demand to explore alternative, non-medical, salutogenic (non-pathogenic) global approaches that could empower patients with LTC's to reduce their dependence on health and social care services ⁶.

Social prescribing is a non-medical method of care which *"links patients in primary care with sources of support within the community to help improve their health and well-being"* ⁷. This salutogenic process focuses on promoting wellbeing by referral to a range of non-medical approaches, from exercise on prescription, to arts-based activities and beyond. A popular approach within the social prescribing movement is the use of gardens and gardening as a nature-based activity to improve health and wellbeing. The use of nature as an intervention is increasingly being recognised worldwide as a means of improving social, emotional, mental and physiological outcomes and are of potential value for people with LTC's. In a recent meta-analysis by Soga et al. the impact of gardening and gardens on a range of physical and mental health outcomes was demonstrated to have positive health and wellbeing benefits ⁸. However, this meta-analysis only considered a limited range of methodologies, focusing on papers that compared health outcomes in control and treatment groups after participating in gardening. Typically, nature-based interventions comprise a broad spectrum of interventions, activities and outcomes that include plants, the natural environment and living creatures, and of interest here, is the recognition that gardening supports people with LTC's ⁹. To date, there have been no studies that have specifically explored the breadth of literature about the effectiveness of gardens and gardening that could help prevent the impact of rising levels of LTC's. However, the subjective and heterogeneous outcome measures that have been used to evaluate gardens and gardening, has created methodological challenges which has limited the conclusions of high-quality systematic reviews in this subject. There is a subsequent global dearth of data that can be pooled using a traditional systematic review method.

REVIEW AIM & OBJECTIVES

Our systematic scoping review aimed to identify and describe the evidence base on the impact of gardens and gardening on the physical, mental, health and well-being of populations. The objectives were to understand the benefits of gardens, provide a map of the literature, types of gardens and health outcomes and build evidence-based logic models to guide health care strategists decision to use of gardens and gardening as a non-medical, social prescription. We agreed the following review question *'What evidence is there on the physical, mental, health and well-being benefits of gardens?'*

1
2
3 **Scoping Protocol:** is a supplementary file for editors only
4

5 **METHODS**

6
7 To address the global gap in systematic reviews, we employed a systematic scoping review
8 methodology. Although different from systematic reviews, scoping reviews provide a robust means of
9 reviewing the breadth of evidence in a wide field and are useful in synthesising the increasing arsenal
10 of evidence¹⁰. We employed Arksey & O'Malley's validated framework to map the evidence¹¹. This
11 was particularly relevant as the scoping review aim was to explicate the impact of gardens and
12 gardening on diverse outcomes and populations rather than answer a specific and focussed question
13 by means of a traditional systematic review. The resultant map of the evidence was used to develop
14 evidence-based logic models to illustrate the key health and wellbeing outcomes as graphic tools to
15 support clinician and commissioner decision making. The initial scoping review framework¹¹ was
16 refined to provide an appropriate method based on the following steps^{12 13}. This involved: 1.
17 Identifying the research question, 2. Identifying relevant studies, 3. Study selection, 4. Charting the
18 data, 5. Collating, summarising and reporting the results. 6. Consultation. Stages 1-4 were conducted
19 iteratively. Stage 5 was undertaken following stages 1-4 and stage 6 (consultation) occurred
20 throughout the lifetime of the review between our research team and our external national
21 stakeholder.
22
23
24

25 **Search and selection of studies**

26
27 We undertook a comprehensive and iterative search to capture the range of perspectives relating to
28 gardens. We searched from 1990 onwards to capture evidence from the last 25 years¹¹. In April 2017,
29 we searched 15 electronic databases and 6 key journals capturing health, social, psychological and
30 environmental perspectives, grey literature sources and websites (including Google Scholar). We
31 repeated the search in September 2018 and November 2019 to capture additional literature
32 published. It is recommended that scoping reviews engage inter-professional teams as they bring a
33 breadth and depth of knowledge¹⁴. Correspondingly, our team was multi-disciplinary with subject and
34 methodological expertise comprising a nurse with experience in social prescribing and nature-based
35 approaches, a geographer with expertise in urban agriculture and sustainable cities, and two health
36 information specialists with additional expertise in systematic review methodology. Our external
37 stakeholder was a national body representing a wide range of gardening interests. We defined
38 gardens as being:
39
40
41

42 *"intimate private spaces attached to private households but they can also be large private or*
43 *formal gardens open to the public, or part of hospitals care homes or hospices. Gardens can*
44 *be cultivated for flowers or growing food, used as spaces for exercise, relaxation, solace and*
45 *recovery, as places to play, meet and volunteer"*¹⁵
46
47

48 We modified the protocol throughout the initial search and filtering process to ensure the project
49 remained manageable and faithful to the initial research question and definitions. We searched in a
50 wide and sensitive manner to encompass the diverse types of gardens that could be located within
51 green space or nature-based type of activities. A range of thesaurus and free text terms (adapted per
52 database) to describe the different types of gardens, and potential breadth of health outcomes were
53 used (see Appendix for example). To ensure robustness, our search followed the agreed protocol and
54 the results were stored on Endnote web reference management software function to manage and
55 track references throughout the scoping review process which was shared across the project team.
56 We recorded search strategies with details of the date the search was undertaken and the number of
57 results obtained and issues arising during the searching to provide a complete history of the search
58 process and provide transparency of the review process.
59
60

We agreed an initial set of inclusion and exclusion criteria following the scoping searches and set these out in the protocol. A study was included if it met the definition of gardens¹⁵, had a measurable outcome on health or well-being (e.g. physical or mental health or physiological or quality of life/well-being, improved nutrition) and was published in English after 1990. Ultimately, gardens comprise of numerous interacting components, outcomes and populations and may be described as complex interventions¹⁶. We therefore ensured that there were no restrictions on study design, biometric indicators or population groups. Systematic reviews are categorized as 'gold standard' evidence¹⁷ and were included as studies in their own right. We searched for non-experimental and quasi-experimental studies, which included non-equivalent control group pre-test post-test studies and single group non-controlled designs¹⁸ and studies that determined causality through non-randomisation. We excluded other green spaces such as forests or parks and studies on access to green spaces or living near green spaces. We excluded biological indicators of soil or plants, dissertations, theses, conference presentations, abstract or posters. We also excluded studies which used process indicators rather than health outcomes and studies which included gardening as part of other interventions where the effects could not be separated.

Three reviewers (AB, MHo, MHa) jointly screened 50 records by titles and abstracts to ensure calibration. Once this was achieved each record title was screened independently by 2 out of 3 members of the project team (AB, MHa, Mho), then each abstract was screened by 1 member of a team of 3 (AB, MHa, Mho), and full text screening was conducted by 1 member of a team of 3 (AB, MHa, Mho). Random checks on abstract and full text screening were conducted by a fourth member of the team (MM). Any discrepancies were resolved through double-checking and discussion.

Charting, collating and summarising the data

We used Microsoft Excel to create a data extraction template that could automatically populate evidence tables. Through team discussion we agreed elements to extract (column headings) based on study characteristics, green space characteristics, intervention characteristics, health condition, age group, outcome measures, findings and author conclusions. When reporting findings for experimental studies, effect sizes and confidence intervals were included as appropriate; for systematic reviews and other designs narrative findings were reported. One member of the project team (MM) extracted all the data up to 2017 and MH to 2019. We used the evidence tables to organise and synthesise the data to enable us to map the benefits of gardens in relation to different types of gardens, health outcomes (physical, mental and well-being) and health conditions.

Consultation with partners and patients

We engaged partners throughout this review process. We involved a national stakeholder organisation in developing the review protocol and presented and sought feedback on the results at an ESRC event of community leaders (including the national stakeholder organisation), third sector organisations, the general public and public health representatives with an interest in gardens and gardening.

Figure 1: PRISMA Diagram¹⁸: Searching & Sifting Process

RESULTS

Search results

From 8896 citations, we included 77 full text studies (figure 1).

Description of studies

A total of 77 studies were included in this review^{19–95}. Country of origin included the UK, USA, Brazil, South Korea, Taiwan, Japan and the Netherlands. All the studies described complex interventions, using heterogeneous methodologies, comprising 14 types of study designs. The scoping review highlights the methodological challenges associated in determining causality with complex interventions. There was an even split between experimental/quasi-experimental (29%) and non-experimental studies located (37%). Non-equivalent control group and single group pre-test, post-test was the most frequently used quasi-experimental study designs (20%). There were 8 RCTs (9%)^{22 25 29 37 49 53 59 91} and 13 (16%) systematic reviews^{20 26 36 38 54 58 69 77 80 84 89 92 93}. All, bar one⁵⁴ of the systematic reviews reported heterogeneous complex interventions. We present two evidence tables detailing higher level evidence from systematic review and RCT's (see tables 1 & 2); full evidence tables available from authors on request.

Table 1: Evidence Summary: RCT's

Author, Date and Country	Study Aims	Garden Type	Age	Outcomes Measured	Key Findings	Author Conclusions
Christian <i>et al</i> (2014) UK ²⁵	To evaluate the impact of a school gardening programme, the Royal Horticultural Society (RHS) Campaign for School Gardening, on children's fruit and vegetable intake	School gardening	8–11 years	Change in fruit and vegetable intake. Child level data - School food diary, home food diary - Child and Diet Evaluation Tool (CADET), knowledge and attitude questionnaire. School level – school gardening level questionnaire, gardening in schools – process measures email, information collected from RHS advisor on school gardening in intervention schools. Outcomes measured at baseline (May/June 2010) and Oct 2011-Jan 2012)	Trial 1: Higher mean change of 8 g (95% CI –19 to 36 g) for combined fruit and vegetable intake for teacher-led group than for RHS-led group –32 g (95% CI –60 to –3 g), difference not significant (intervention effect –43 g, 95% CI –88 to 1 g; p = 0.06). Trial 2: More fruit and vegetables consumed in teacher-led group (15 g (95% CI –36 to 148 g), difference not significant. Schools which improved their RHS gardening score by three levels, on average, an increase in intake of fruit and vegetables by 81 g (95% CI 0 to 163 g; p = 0.05) compared with children attending schools that had no change in gardening score.	There is little evidence that school gardening alone can improve children's fruit and vegetable intake. When gardening was implemented at the highest intensities the findings suggest it could improve children's fruit and vegetable intake by a portion per day.

1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21
22
23
24
25
26
27
28
29
30
31
32
33
34
35
36
37
38
39
40
41
42
43
44
45
46

<p>Detweiler et al (2015) USA ²⁹</p>	<p>To assess the effect of horticultural therapy on cortisol levels, depression, symptoms of posttraumatic stress disorder, alcohol cravings, and quality of life symptoms compared with a non-horticultural OT group.</p>	<p>Structured gardening programme</p>	<p>Mean age 46.4 years (SD=11.9)</p>	<p>Quality of Life[Quality of Life Enjoyment and Satisfaction Questionnaire– Short Form (Q-LES-Q-SF)] Alcohol craving [Alcohol Craving Questionnaire (ACQ-NOW)] PTSD [Posttraumatic Stress Disorder Checklist Civilian Version (PCLC)] Depression [Centre for Epidemiologic Studies Depression Scale (CES-D)] Outcomes assessed pre- and posttreatment. Salivary cortisol samples were taken at weeks 1, 2, and 3</p>	<p>24 participants completed protocol. Although a positive impact of HT was seen in a 12% reduction in salivary cortisol levels from week 1 to week 3, the difference was not statistically significant (ANOVA (F2,20 = 0.878), P = 0.43). Separate 1-way analyses of covariance (ANCOVAs) found no statistically significant differences in the self-administered tests. A positive trend was seen in improving quality of life and depressive symptoms in the HT group (Q-LES-Q-SF, P = .001 and CES-D, P < .001) compared with the OT group (Q-LES-Q-SF, P=.029 and CES-D, P = .050). HT group did not significantly improve in ACQ-NOW (P = .118), whereas the OT group did (P = .040). HT group did significantly improve in PCLC (P=.039), whereas the OT group did (P=.135).</p>	<p>HT may have a role in reducing stress and depression and quality of life more than the programmes in which the OT participated.</p>
<p>Jarott et al (2010) USA ⁴⁹</p>	<p>To compare a randomly assigned treatment group, who received horticultural therapy-based programming to a comparison group,</p>	<p>HT</p>	<p>Mean age of 80.09 years, SD= 8.05</p>	<p>Level of cognitive impairment [mini mental status exam] Affect [Apparent Affect Rating Scale] Engagement [Menorah Park Engagement Scale] Observations took place</p>	<p>No significant differences between groups were found on affect (pleasure (z = -1.544, P=.123), anxiety (z = -.086, P = .932), and interest (z = -1.26, P = .208). Levels of adaptive behaviour differed between the groups, with the</p>	<p>Horticultural therapy based activities successfully facilitate facilitates lower levels of self-engaging behaviours and engages groups of dementia sufferers who are often difficult to engage in activities that elicit high levels of adaptive behaviour.</p>

	who engaged in traditional activities programming, on engagement and affect			twice a week during weeks 1, 2, 5, and 6	treatment group demonstrating higher levels of active ($z = -2.90$, $P = .00$), passive ($z = -2.72$, $P = .01$), and other engagement ($z = -3.47$, $P = .00$) and the comparison group demonstrating higher levels of self-engagement ($z = -4.60$, $P = .00$).	
Van den Berg <i>et al</i> (2011) The Netherlands ⁹¹	To hypothesise and test the Stress-relieving effects of gardening	Gardening	Mean age 57.6 years (range 38–79)	Stress - Salivary cortisol levels and self-reported mood [Positive and Negative Affect Schedule (PANAS)] Saliva samples collected shortly after arrival at the experimental location, before/after the stressful task, halfway through and after experimental activity. PANAS assessed prior to/after stressor and after experimental activity	Study findings suggest that gardening has a positive impact on relief from acute stress. Both gardening and reading decreased cortisol levels during the recovery period, with significantly stronger decreases seen in the gardening group [(F (1, 11) = 24.15, $p < .001$ vs. F (1, 13) = 5.33, $p < .05$). Post-activity, cortisol levels were marginally lower in the gardening group than in the reading group [F (1, 27) = 3.21, $p = .08$]. A significant increase in positive mood was seen in the gardening group [F (1, 12) = 4.91, $p < .05$], but deteriorated by 4.3 percent in the reading group [$p = .53$]. Post-activity positive mood was significantly higher in the gardening group than in reading group [F (1, 28) = 4.93, $p < .05$].	Gardening can promote relief from acute stress. Gardens can be used as a valuable resource to prevent disease and promote health.

<p>Gatto <i>et al</i> (2017) USA ³⁷</p>	<p>To explore the effects of a novel 12-week gardening, nutrition and cooking intervention {'LA Sprouts'} on dietary intake, obesity parameters and metabolic disease risk among low-income, primarily Hispanic/Latino youth in Los Angeles.</p>	<p>structured gardening programme</p>	<p>3rd, 4th & 5th grade students (age range 8-11yrs)</p>	<p>Dietary intake measured via food frequency questionnaire, anthropometric measures {body mass index, waist circumference}, body fat, and fasting blood samples.</p>	<p>Study findings indicate that pupils participating in LA sprouts had significant reductions in body mass index z -scores as compared with the controls (-0.1 vs. -0.04, p=0.01). Waist circumference in the LA Sprouts group decreased more than the control (-1.2 vs. 0.1 cm: p<0.001). Dietary fibre increased with LA sprouts as compared with the controls (+3.4% vs. -16.5%; p=0.04) however there was no difference in the fruit intake between the LA Sprouts and control group.</p>	<p>The findings are positive and indicate that LA Sprouts can benefit pupils nutritional behaviours and impact on BMI and waist circumference, but larger, longitudinal studies are required.</p>
<p>Kam <i>et al</i> (2010) China ⁵³</p>	<p>To examine HT activity on reduced stress, improved quality of life and work performance for people with psychiatric disorders.</p>	<p>HT</p>	<p>Mean age of 44.3 (SD = 11.6).</p>	<p>Well-being and quality of life [Personal Wellbeing Index (PWI-C)] Mental state and behaviour [Depression Anxiety Stress Scale (DASS21)] General functioning [Work Behaviour Assessment (WBA)] PWI-C and DASS21 measured before and after intervention</p>	<p>A significant positive impact of the horticultural programme was seen in DASS-21 total (p=0.01), depression (p=0.04), anxiety (p=0.01) and stress (p=0.5) subscales. No significant differences were seen in change of WBA and its subscales (p ranges from 0.08-0.79) and PWI (p=0.84). Qualitative evidence suggested a positive impact on emotional, occupational, social and spiritual aspects.</p>	<p>Horticultural therapy is effective in reducing anxiety, depression and stress but no difference was seen on work behaviour or quality of life.</p>

<p>Bail et al (2018) UK²²</p>	<p>To assess a mentor home based vegetable garden as an intervention to cancer survivors to explicate health related outcomes</p>	<p>Gardening programme</p>	<p>adults – all ages, mean age of 60 years</p>	<p>Health-related outcomes (secondary outcomes of vegetable consumption, physical activity, performance and function, HRQOL, anthropometrics, and biomarkers) veg consumption, physical activity, HRQOL, Physical Performance, Anthropometrics, biomarkers such as toenail clippings to measure chronic stress levels.</p>	<p>100 % satisfaction with the programme. Statistically significant improvements with physical activities and vegetable consumption. Positive changes reported in the HRQOL scores. Non-significant trends noted in the BMI recordings. Overall, positive changes were reported across both groups, with a marked improvement in the intervention groups scores compared to the controls.</p>	<p>Home based mentoring gardening programme can significantly improve biometric outcomes and vegetable consumption.</p>
<p>Lai et al (2018) China⁶⁰</p>	<p>To explicate the impact of HT on frail older nursing home residents on psychological wellbeing</p>	<p>HT</p>	<p>Frail older adult and pre-frail</p>	<p>Happiness was measured using the subjective happiness scale; Frailty was measured using the 5 item Fried Frailty Index; Depressive symptoms were measured using the Geriatric Depression Scale; self-efficacy was measured using the 10 item General Self-Efficacy Scale; social engagement measured using the Social Engagement Scale; social networks were measured using Lubben Social Network Scale and wellbeing was measured</p>	<p>Significant improvement in the interaction time was observed in the happiness scale in the HT groups ($\beta = 1.457, P = .036$). No significant changes noted in any of the other outcomes. A later cluster analysis (follow up) indicated greater effects on subjective happiness for the HT group (mean difference =6.23, $P < .001$) as compared to the controls at baseline.</p>	<p>Frail and prefrail older people living in a nursing home can benefit from HT and can promote subjective happiness.</p>

1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21
22
23
24
25
26
27
28
29
30
31
32
33
34
35
36
37
38
39
40
41
42
43
44
45
46

				using the Personal Well-being Index.		
--	--	--	--	--------------------------------------	--	--

For peer review only

Table 2: Evidence Summary: Systematic Reviews:

Author, date and country	Aims	Type of Garden	Outcomes measured	Key findings	Authors Conclusions
Cipriani <i>et al</i> (2017) USA ²⁶	To conduct a systematic review on the benefits of horticultural therapy (HT) on persons with mental health conditions who are receiving services in either inpatient settings or outpatient community-based settings	HT	Outcome measures reported in included studies: Affect, agitation, behaviour/engagement, cognitive functioning, interpersonal relationship, physical well-being, psychiatric symptomatology, psychological/mental well-being, quality of life, self-esteem, sleep, social behaviour, stress and coping, volition, work behaviour. Tools reported in included studies: Affect Balance Scale, Test for Severe Impairment, Quality of Life Enjoyment and Satisfaction Questionnaire Short Form (Q-LES-Q-SF), Alcohol Craving Questionnaire, Posttraumatic Stress Disorder Checklist Civilian Version, Centre for Epidemiologic Studies Depression Scale (CES-D), cortisol levels, modified DCM [dementia care mapping] scale, homemade assessment for behaviour and a modified DCM, interviews, The Bradford Well-Being Profile, Mini Mental State Examination, Apparent Affect Rating Scale, Menorah Park Engagement Scale, Chinese version of Depression Anxiety Stress Scale 21, Work Behaviour Assessment, Chinese version Personal Well-being Index, sleep diary, Modified Cohen-Mansfield Agitation Inventory, Revised Hasegawa Dementia Scale, Cohen-Mansfield Agitation Inventory, Physical and Mental Impairment Functional Evaluation, Multi-focus Assessment Scale for the Frail Elderly, Participation Index (Caplovitz) and Participation Index (Phillips), Volitional Questionnaire, Relationship Change Scale, Self-Esteem Scale, Social Behaviour Scale, Symptom Checklist 90 Revision, Evaluation of Horticultural Activity.	14 studies were included in the review. Study designs include 5 RCT, 6 Cohort, 2 Before and After, 1 Cross-sectional. 11/14 studies found statistically significant findings in support of HT for at least one dependent variable. Studies were conducted in a variety of settings and mental health conditions. Limitations of the studies include, a lack of detail on the interventions in the included studies would limit reproducibility and a lack of information on the reliability and validity of outcome measures.	Moderate evidence exists that horticultural therapy can improve client factors and performance skills.

1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21
22
23
24
25
26
27
28
29
30
31
32
33
34
35
36
37
38
39
40
41
42
43
44
45
46

Genter <i>et al</i> (2015) UK ³⁸	To address the question of, does allotment gardening contribute to health and wellbeing?	Allotment	Health, wellbeing. No other outcomes were included in the search strategy.	10 studies were included published between 1999-2013, 7 qualitative studies, 3 quantitative studies. Overall, the review found that allotment gardening has a positive impact on health and wellbeing, provides a stress-relieving refuge and valued contact with nature, contributes to a healthier lifestyle, creates social opportunities and enables self-development. It was also found to reduce stress levels and increase positive mood. 3 qualitative papers found that allotment gardening is a suitable therapeutic group activity for people with mental health issues, while 4 papers recognised that individual and group allotment gardening supported healthy ageing.	Allotment gardening has a positive impact on health and wellbeing. Allotment gardening can be recommended as a form of occupational therapy and can help promote health and wellbeing.
--	--	-----------	--	---	--

For peer review only

<p>1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40 41 42 43 44 45 46</p> <p>Ohly et al (2016) UK⁸⁰</p>	<p>To review whether school gardens benefited health and wellbeing of pupils and understand factors that enabled or challenged the success.</p>	<p>School gardening</p>	<p>Studies were included if they reported quantitative or qualitative health and well-being outcomes. Outcomes reported include fruit and vegetable intake [Structured dietary assessment method, CADET, Lunchtime observations, parent questionnaire, 24 hr recall workbooks, parent survey, Garden Vegetables Frequency Questionnaire, Taste Test]; nutrients intake [CADET, 24 h urine samples; flame photometry, Block Food Screener, parent questionnaire, 24 hr recall workbooks]; physical [waist circumference, body mass index (BMI), and systolic and diastolic blood pressure, Urinary sodium, Total fat (%), GEMS Activity Questionnaire, Accelerometry, well-being [KIDSCREEN-10, Teacher Questionnaire, Quality of school life instrument, Youth Life Skills Inventory, Self-Report of Personality Scale for children and adolescents].</p>	<p>40 studies included (quantitative n=24, qualitative n=16, mixed method n=3). Included studies were from the UK, Australia, Portugal and USA. Quantitative evidence was of poor quality often relying on self-report. Evidence for changes in fruit and vegetable intake was limited; Two out of 13 non-randomised studies report a positive statistically significant impact of gardening on increasing intake of fruit and vegetables. Four out of 6 studies found statistically significant changes in nutrient intake, one of which found a decrease in dietary fibre in control group rather than an improvement in intervention group. One non-randomised controlled study reported a positive statistically significant impact for diastolic blood pressure in favour of the intervention group, but reviewers note that all blood pressure readings were within normal range. One cluster-RCT report that</p>	<p>There is limited quantitative evidence for the impacts of school gardens. Qualitative evidence suggests that participants of gardening programmes may experience or perceive a range of health/wellbeing outcomes. There are few studies that have used logic models to illustrate the impact of school gardens as complex interventions.</p>
---	---	-------------------------	---	---	--

1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21
22
23
24
25
26
27
28
29
30
31
32
33
34
35
36
37
38
39
40
41
42
43
44
45
46

				children in the intervention group were 'usually' less sedentary and spent more time engaged in 'moderate' physical activity than control group, but when measured objectively, there was no increase in 'light' physical activity or decrease in sedentary behaviour. Two out of 4 studies reported no difference in impact between a gardening intervention compared to a control group, data in the other 2 studies was found to be inadequate for assessment.	
Stern (2009) Australia ⁸⁹	To locate and synthesise best evidence about impact of physical activities on people with dementia.	Gardening	The Diagnostic Statistical Manual of Mental Disorders was used to classify the absence or presence of Dementia. Mental examination tools such as the mini-mental state examination and activities of daily living.	9/17 studies included in the systematic review looked at gardening as an intervention. Positive impacts of gardening were reported by 1 case-control study on a beneficial association with a reduction in the chance of developing Alzheimer's disease. Two cohort studies found that gardening was significantly associated with a reduced risk of dementia (RR = 0.53, 95% CI, 0.28–0.99; HR, 0.64, 95% CI, 0.50–0.83). Another cohort reported that exposure to gardening over	While the evidence is equivocal on whether participation in physical activities is protective against onset of dementia, gardening appears more beneficial than other types of activities. DATA extracted only for gardening

				at least 10-years may be associated with a reduced risk of developing Alzheimer's disease.	
Wang <i>et al</i> (2013) USA⁹²	Systemic review evidence for beneficial effects of gardening on older adults	Gardening	Range of outcomes measures, as authors sought to locate papers based on methodological approach rather than outcomes. Hence, outcomes were mixed and included Mini Mental State examination, Apparent Affect rating scales, nutrition Menorah Park Engagement Scale, Life Satisfaction Inventory, Stress tests, Perceived health and wellbeing scales, self-reported pain, SF36, Hand Function, Self-Rated Health and Happiness Scale, Pearlines ad Schoolers Mastery Scale, Sleep diaries, Modified Cohen-Mansfield Agitation Inventory and Revised Hasegave Dementia Scale.	22 articles were reviewed (adults. Through various research designs (quantitative and qualitative) and measurements utilized, the results reveal that gardening can be an activity that promotes overall health and quality of life, physical strength, fitness and flexibility, cognitive ability, and socialization. The implementation of various aspects of gardening as health-promoting activities transcend contexts of practice and disciplines and can be used in urban and rural communities as both individual and group activities	The authors conclude that the literature reported variable findings, and whilst most of these were positive, the majority were at an exploratory stage. The evidence base provides an intriguing foundation for further research. Gardening has positive effects on older adults and help improve engagement and activity participation for people with dementia.

1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21
22
23
24
25
26
27
28
29
30
31
32
33
34
35
36
37
38
39
40
41
42
43
44
45
46

<p>Whear <i>et al</i> (2014) UK ⁹³</p>	<p>To examine the impact of gardens and outdoor spaces on the mental and physical well-being of people with dementia who are resident in care homes and understand the views of people with dementia, their carers, and care home staff on the value of gardens and outdoor spaces.</p>	<p>Garden visiting</p>	<p>Included studies had to report on agitation, number of falls, aggression, physical activity, cognitive functioning, or quality of life (quantitative) or report on the views of people with dementia who were resident in care homes, care home staff, carers, and families on the use of gardens and outdoor spaces (qualitative). [Tools reported in included studies – Agitation: Cohen-Mansfield Agitation Inventory (CMAI); Emotional outcomes: Affect Rating Scale;</p>	<p>A total of 17 studies were included (9 quantitative, 7 qualitative, and 1 mixed methods). Quantitative designs included 6 pre-post studies, 2 RCTs, 1 prospective cohort, 1 crossover trial. Quantitative designs were of poor quality but suggest a beneficial effect associated with garden use on reduced levels of agitation. There was insufficient evidence from quantitative studies generalise the findings on other aspects of physical and mental wellbeing. Evidence on the impact of Horticulture Therapy was inconclusive.</p>	<p>Garden use provide promising impacts on levels of agitation in care home residents with dementia who spend time in a garden. Future research should focus on using comparative outcome measures.</p>
<p>Savoie-Roskos <i>et al</i> (2017) USA ⁸⁴</p>	<p>To identify the effectiveness of gardening interventions that have been implemented to increase fruit & vegetables consumption among children.</p>	<p>Gardening</p>	<p>Fruit and vegetable consumption among children aged 2 to 15 years before and after implementation of a gardening intervention in a school, community, or afterschool setting.</p>	<p>There were 14 papers located and included in the review. A total of 10 articles reported statistically significant increases in fruit or vegetable consumption for those who participated in the gardening intervention. The papers located varied in methodologies and many had small sample sizes and relied on the use of convenience samples, and self-reported measurements</p>	<p>The evidence suggests a modest but positive influence of gardens on F/V intake of children.</p>

				of F/V consumption. Whilst the effects are small, the evidence report a positive benefit on the consumption of F?V in the children who participated in the gardening.	
Annerstedt et al (2011) Sweden ²⁰	To systematically review the literature regarding effects of nature-assisted therapy (NAT), for patients with well-defined diseases, as a treatment option either alone, or together with other evidence-based treatment options.	Gardens	Studies were included if they reported systematic review and meta-analyses of RCT's; RCT's; non-randomised intervention studies, observational studies and qualitative studies. Nature based, nature assisted, gardening, horticulture, socio-horticulture, ecotherapy were included. A range of psychological, intellectual, social and physiological outcomes were included	38 papers (3 systematic reviews/meta-analysis, 6 RCTs, 12 non-randomised trials, 14 observational, 4 qualitative) published between 1980-May 2009 were included. The authors report 13 significant improvements for psychological goals, 6 for social goals, 4 for physical goals, and 2 for intellectual goals.	The authors conclude that the evidence base reports a small, but reliable resource that highlights the benefits of NAT as an approach to promote health. Future studies should be adequately powered with clearly defined definitions.
Kamioka et al (2014) Japan ⁵⁴	To summarize RCTs evidence on the effects of horticultural therapy.	HT	Inclusion criteria looked for all cure and rehabilitation effects in accordance with the International Classification of Diseases-10. Included studies reported on; Affect (the Apparent Affect Rating Scale) Engagement (Menorah Park Engagement Scale) Chinese version of Depression Anxiety Stress Scale 21 (DASS21) Work Behaviour Assessment (WBA) Chinese version Personal Wellbeing Index (PWI-C) Life Satisfaction Index-A Form, Revised UCLA Loneliness Scale The Lubben Social Network Scale Self-esteem scale Powerlessness Beck Depression Inventory (BDI) neurobehavioral cognitive status examination (NCSE), motor-free visual perception test (MVPT), and functional independence measure (FIM).	Four studies met all inclusion criteria. All studies showed significant effectiveness in one or more outcomes for mental health and behaviour. No studies report cost-effectiveness. Methodological quality of the RCTs was low.	People with mental and behavioural disorders such as dementia, schizophrenia, depression, and terminal-care for cancer, may benefit from HT, however the evidence supporting this is of low quality.

1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21
22
23
24
25
26
27
28
29
30
31
32
33
34
35
36
37
38
39
40
41
42
43
44
45
46

<p>Masset <i>et al</i> (2012) UK⁶⁹</p>	<p>To assess the effectiveness of agricultural interventions in improving the nutritional status of children in developing countries.</p>	<p>range for review including gardens</p>	<p>Dietary diversity, micronutrient intake, prevalence of under-nutrition, participation and household income. Studies were included if they were cross-sectional and longitudinal project-control comparisons and randomised field trials and studies that compared participants and non-participants over a single cross-section.</p>	<p>15 studies assessed the effectiveness of home gardens (1 RCT, others longitudinal comparison and cross-sectional studies). A positive impact of home gardens was found on increased consumption of fruit and vegetables. No evidence of impact was found on iron intake in children. Some evidence of impact was found on improved intake of vitamin A among children <5 years (Mean difference 2.4 µg/dL, 95%CI 1.67-3.16). Data for overall effects of garden interventions on children’s nutritional status not reported separately from other interventions. Methodological quality of included studies was poor.</p>	<p>The review authors concluded that there was limited evidence on the impact of agricultural interventions on the nutritional status of children. The authors were unable to answer the systematic review question with any confidence due to the methodological weaknesses of the studies.</p>
<p>Garcia <i>et al</i> (2017) Brazil³⁶</p>	<p>Systematic review to explore the impact of urban gardens on use of healthy food</p>	<p>Community gardening</p>	<p>Key nutrition related outcomes; Participation in urban gardens, food security, healthy food practices, increase in intake of fruit and vegetables, healthy diet and improved family nutrition. Impact on healthy food beliefs, healthy food access, reduction in food costs, greater interest in cooking and meal planning.</p>	<p>24 studies were located. The studies were heterogeneous and included methodological flaws. People who participated in community gardens had improved healthy diet intake, shared food and valued healthy food. People who participate in gardens have an increased fruit and vegetable intake, improved</p>	<p>Community gardens can have positive impact on food beliefs, knowledge and practices. Longer terms studies with more robust methodological frameworks are needed to verify the benefits of</p>

				access to health foods through harvest sharing and improved family diet.	community gardens on nutrition and diet.
Kunpeuk <i>et al</i> (2019) Thailand⁵⁸	Systematic review and meta analysis to explore association between community gardening, nutrition and physical health in adults	Community gardening	Diverse measurement units, but BMI only was pooled to enable meta analysis	19 articles were included in the review. 14 cross-sectional, 1 case-control and 4 quasi-experimental. Results suggest a modest positive impact of gardens on BMI reduction. A greater pooled effect size was reported for the subgroup analysis of the quasi-experimental and case-control studies.	Gardens reduced BMI and should be integrated into health policy.
Nicholas <i>et al</i> (2019) Singapore⁷⁷	To assess whether HT was beneficial for older people	HT	Psychosocial, QOL, SF36, Ryffs Scales of Psychological wellbeing. Subjective Happiness scale, Personal Wellbeing index, life satisfaction, dementia QOL	20 articles were included in the systematic review. 6 experimental studies of which 4 were RCTs. Other papers were quasi-experimental. Most studies reported significant effects of HT on a range of outcomes although there were mixed results on the effect of HT on function. Significant associations were reported on agitation, mood and engagement for people with dementia.	The evidence for HT is promising, but more robust evidence is required to draw firm conclusions.

Description of gardening interventions

The systematic scoping framework¹¹ enabled us to locate and include a broad range of evidence, likewise, using the predetermined¹⁵ definition of gardens enabled the capture of diverse types of gardens. Typical gardening interventions included 'allotment gardening' ($n=8$) and 'Community gardens' ($n=11$). The most common garden intervention reported was Horticultural Therapy (HT) ($n=17$) which integrates a structured gardening programme with qualified therapist input. The second most popular approach was 'structured gardening' ($n=17$) which provides a structured programme of activities but does not include a qualified therapist. Irrespective of garden 'type' all garden activities were characterized through a range of physical activities such as 'planting seeds', 'potting on', 'taking cuttings', 'pricking out', 'sweeping and maintaining the garden', 'using and cleaning tools', and other similar tasks.

Description of Outcome Types

We located a range of study methods which reported outcomes related to mental health (MH), physical impact (P), nutritional behaviour changes (N) and overall general wellbeing (WB). There were over 35 validated health and wellbeing outcome measures reported. Most papers examined the impact of gardens on MH (36%) General wellbeing represented 32% of the total outcomes reported. There was an even split between those papers reporting on specific physical outcomes (14%) and those reporting on nutrition as an outcome (18%). The heterogeneous outcomes may explain the paucity of meta-analyses (3.7%).

Development of the Logic Models

A secondary objective was to use this evidence to build evidence-based logic models to guide health strategy decision making about gardens and gardening as a non-medical, social prescription. Logic models illustrate causal relationships between service inputs, resultant activities, outputs and goals, emphasizing the contributory factors to successful programmes⁹⁶. The structure and organisation of logic models enable the results from scoping reviews and systematic reviews to delineate complex interventions, such as those without specific, controlled parameters thus enabling greater insight into the interactions between the intervention, in this case gardens & gardening, and the multiple outcomes⁹⁷. Logic models can represent causal processes and encapsulate complex interventions and illustrate heterogeneous outcomes⁹⁷. Hence, logic models provide an evidence-based tool that can support policy makers, health care strategists and/or primary health care clinician's decisions about commissioning non-medical approaches through social prescribing.

Logic Model: Evidence Evaluating the Impact of Gardens on Mental Health.

There were 29 (36%) studies that focused on the impact of gardening on mental health. We set parameters for mental wellbeing to include four main areas of interest: Psychological Wellbeing, Depression, Anxiety and Mental Status. In the latter, we resolved that mental status included pathological disorders such as dementia, schizophrenia, bi-polar and other chronic long-term conditions. Some categories overlapped, for example, papers with a focus on psychological wellbeing often captured outcomes relating to depression making the creation of distinct categories problematic. Commonly reported data collection methods included validated tools such as the Warwick-Edinburgh Mental Well-being Scale (WEMWBs)⁹⁸ or New Economic Foundation's Five Ways to Wellbeing⁹⁹ which offer observational subjective data as opposed to direct causality. Evidence from our review indicated a range of benefits that gardening had on diverse populations. Typically, gardening enabled greater social interaction with others⁸⁶ and improved physical activity⁹⁵, thus improving overall mental wellbeing²⁶, reducing depression⁷¹ and anxiety⁵³.

1
2
3 A significant percentage of papers focused on mental health (36%). The causal relationships illustrated
4 in our first logic model highlights the range of garden activities that contributed to an improvement in
5 mental health (see fig 2). These papers typically reported that gardens and gardening augmented
6 physical activities resulting in improved physiological outcomes such as reduced cortisol levels^{26 29 91}
7 and saliva amylase levels⁹¹. Additionally, the logic model graphic enables visual representation of how
8 mental health was improved through enhancing sociological outcomes leading to reduced
9 socialisation through improved social networks.
10
11

12 **INSERT Figure 2: Logic Model: Mental Health**

13 **Logic Model: Evidence Evaluating the Impact of Gardens on General Wellbeing.**

14
15 In determining a parameter for wellbeing, we used Dodge *et al*¹⁰⁰ who asserts that “*stable ‘well-*
16 *being’ is when individuals have the psychological, social and physical resources they need to meet a*
17 *particular psychological, social and/or physical challenge*”. Hence, a range of wellbeing indicators
18 were reported that relate to both mental and physical wellbeing outcomes. A total of 26 (32%) papers
19 reported general wellbeing and typically focussed on positive health^{21 72 95}, social health^{20 24 26 41 42 86},
20 subjective wellbeing^{48 89}, and/or quality of life^{29 32 71 75 93}. Typical LTC’s studied included chronic lung
21 disease²¹ diabetes, hypertension and kidney disease⁶⁴. Outcomes that measured impact of gardens
22 on nutrition were broad and included dietary changes, increase in fruit and vegetable intake. There
23 were 13 studies that explicated the impact of gardens and gardening on nutritional intake^{23 25 36 45 48 52}
24 ^{54 64 69 75 80 91 93}. Key outcomes used as predictors for nutritional impact included validated scales for
25 wellbeing, emotional health, mental health and physiological indicators. Overall, the findings report
26 that the gardening interventions have a positive impact (81%) on nutritional intake of fruit and
27 vegetables and a range of physiological outcomes and general wellbeing.
28
29

30
31 The second logic model (see fig 3) provides an illustration of how gardens can benefit general
32 wellbeing. The range of garden types located in the scoping review influenced activities that led to
33 improved wellbeing outputs for adults, children and older people. Several positive outcomes were
34 reported including social: involving skills, behaviours and networks; general mental wellbeing, such as
35 stress reduction^{29 89}, reduced anxiety and depression^{26 54 60}. As with the mental health logic model,
36 the graphic illustration enables visual representation of the overlap between the mental, physical,
37 social and emotional outcomes. Thus, papers that reported impact on general wellbeing also included
38 outcome measures that indicated increased physical activity resulting in reduced BMI³⁷ and healthier
39 blood glucose levels³⁷, and general wellbeing that benefited community growth⁶⁰, social interaction
40 ^{56 62} and quality of life^{38 60 71}.
41
42
43
44
45
46

47 **INSERT Figure 3: Logic Model: Wellbeing**

48
49 These evidence-based logic models report the diversity of gardens and gardening interventions and
50 subsequent benefits on a range of populations that may typically live with LTC’s. The resultant
51 outcomes reported provide confidence for clinicians considering gardens or gardening as a social
52 prescription for a range of populations.
53
54

55 **DISCUSSION**

56
57 The increasing interest in social prescribing as a non-medical approach, has gained international
58 attention¹⁰¹. Salutogenesis influences the question ‘what makes people healthy?’ rather than, ‘how
59 do we treat disease?’. Wellbeing is increasingly promoted through contemporary public health
60

1
2
3 strategies to help reduce LTC's¹⁰². The use of salutogenic approaches that are modelled through non-
4 traditional socially prescribed approaches are at the vanguard of global policies to help support people
5 with LTC's. Our findings indicate that diverse populations with LTC's could benefit from gardens and
6 gardening as a salutogenic, social prescription and is the first to use a robust systematic scoping review
7 framework to highlight these benefits.
8
9

10 Typically, gardening can help improve physiological outcomes associated with LTC's such as blood
11 glucose levels, cortisol levels, HRV, blood lipids and salivary stress cortisol. Similar findings were
12 identified by Nicklett et al⁷⁸ and Ohly et al⁸⁰ who reported positive physiological outcomes measures
13 on a range of biometrics including urinalysis, total fat, BMI and systolic/diastolic blood pressure as
14 outcomes. These findings, coupled with this review, demonstrate positive outcomes for a range of
15 population needs including those living with obesity, diabetes, cardiovascular disease and other LTC's.
16 The wellbeing of an individual is fundamental to health and is predicated on the social progression
17 and quality of life, typically influenced by positive physical and mental health. Similar to Bragg et al²³
18 our review identified that gardens and subsequent activities can help improve mental health. Bragg
19 and Atkins²³ suggest that growing food can help combat stress and reduce associated depression.
20 Likewise, Kam et al⁵³ report positive emotional and social improvements for those who participated
21 in a gardening programme. The benefits of gardening on mental health outcomes also extends to
22 other long terms conditions known to influence frequent attendance to A&E, front line health
23 providers or GP's¹⁰³.
24
25

26 The multiple benefits reported illustrate the breadth of the literature, and highlight the diverse
27 methodological approaches used to capture the impact of complex interventions. This was also
28 reported by Annerstadt's²⁰ systematic review which questioned the applicability of Cochrane
29 principles for systematic review for complex interventions such as gardens and gardening. This would
30 create challenges for any meta-analysis, and illustrates the challenges to adopting a standard
31 methodology with which to evaluate nature-based interventions. Nature-based interventions that are
32 socially prescribed are complex and favour natural experiments that enable observation of
33 communities and populations with allocation of control. Consequently, is it unrealistic to promote the
34 RCT as a 'gold standard' to assess gardens and gardening, as too many confounders exist leading to
35 methodological flaws. Equally, it would be impractical to use RCTs as they risk straightjacketing
36 innovation to facilitate a 'pathogenic rather than a 'salutogenic' methodological response. As a quasi-
37 experimental approach, pre-test, post-test designs provide a good opportunity to test out nature-
38 based activities in a range of contexts and populations and therefore are more likely to favour natural
39 experiments that enable observation of communities and populations with allocation of control. As
40 an assessment of effectiveness rather than efficiency, natural experiments may provide opportunity
41 for external validity and local meaningful generalisation¹⁰⁴. However, challenges associated with
42 refining nature-based interventions and controlling confounders may have influenced the dearth
43 noted in natural experiments within this review. The prevailing positivist paradigm needs to be
44 revisited within this context and greater consideration proffered for the use of natural experiments or
45 those that use mixed methods to demonstrate impact rather than causality. Hence, natural
46 experiments that include mixed methods are a potential solution to this methodological quagmire
47 that exists within contemporary evidence for complex nature- based interventions. We propose that
48 natural experiments could provide a methodological solution to support future analysis of gardens &
49 gardening on multiple health & wellbeing outcomes.
50
51
52
53
54
55

56 **Conclusions:**

57
58 A strength of our scoping review was the ability to locate, and understand the breadth of evidence
59 reporting the effects of gardens and gardening. The evidence base however, has been exposed to a
60

myriad of paradigmatic solutions to capture wellbeing outcomes, leaving researchers with a contemporary methodological quandary and health care decision makers with a practical dilemma regarding appropriate evidence on which to base their decisions. Irrespective of the heterogeneous methods used, our scoping review indicates that gardens and gardening have a positive dual benefit on a range of mental, social and psychological outcomes, thus, is of relevance to those considering gardens and gardening as a non-medical, social prescription. Our logic models summarise this evidence and act as a decision support aid to enable more confident referral to non-medical services that are typically part of a wider social prescription.

FUNDING:

This research received no specific grant from any funding agency in the public, commercial or not-for-profit sectors.

This research was done without patient involvement. Patients were not invited to comment on the study design and were not consulted to develop patient relevant outcomes or interpret the results. Patients were not invited to contribute to the writing or editing of this document for readability or accuracy. We consult the general public through an community engagement event with residents and local providers of gardening programmes.

References

1. World Health Organisation Global Health Observatory NCD Morality and Morbidity [Online] Available at: http://www.who.int/gho/ncd/mortality_morbidity/en/ 2017: [Accessed 14 September 2017]
2. World Health Organization. Mental health action plan 2013-2020. World Health Organization. 2013: <https://apps.who.int/iris/handle/10665/89966> .
3. World Obesity Federation. How Will the Assembly Meet its 2025 Targets? [Online] Available at: <http://www.worldobesity.org/news/wo-blog/october-2015/howwill-world-health-assembly-meet-its-2025-targets/> 2017: [Accessed on 16 September 2017]
4. Mcmanus, S., Bebbington, P., Jenkins, R. & Brugha T. (Eds.) Mental Health And Wellbeing In England: Adult Psychiatric Morbidity Survey 2014. 2016: [Online] Available at: <Http://Content.Digital.Nhs.Uk/Catalogue/Pub21748/Apms-2014-Full-Rpt.Pdf> [Accessed 7 August 2017]
5. Wakefield JRH, Sani, F, Dingle GA, Jetten. Social Isolation Predicts Frequent Attendance in Primary Care. *Annals of Behavioural Medicine*. 2018: 52:817–829
6. Henry H, Howarth ML. An overview of using an asset-based approach to nursing. *General Practice Nursing*. 2018: 4: (4) pp. 61-66.
7. Bickerdike L, Booth A, Wilson PM, Farley K, Wight K. Social prescribing: Less rhetoric and more reality. A systematic review of the evidence. *BMJ Open*. 2017: 7 (4): 1-17.
8. Soga M, Gaston KJ, Yamaura Y. Gardening is beneficial for health: A meta-analysis. *Preventative Medicine Reports*. 2017: 92-99.
9. Collins C C, O'Callaghan, AM. The Impact Of Horticultural Responsibility On Health Indicators And Quality Of Life In Assisted Living. *Horttechnology*. 2008: 18: 611–618
10. Munn, Z., Peters, M.D.J., Stern, C. *et al*. Systematic review or scoping review? Guidance for authors when choosing between a systematic or scoping review approach. *BMC Med Res Methodol*. 2018: 18, 143 doi:10.1186/s12874-018-0611-x
11. Arksey H, O'Malley L: Scoping studies: Towards a Methodological Framework. *Int J Soc Res Methodol*. 2005, 8: 19-32. 10.1080/1364557032000119616.
12. Midlands and Lancashire Commissioning Support Unit (nd) Using Logic Models [Online] Available At: <Https://Midlandsandlancashirecsu.Nhs.Uk/News-Insight/Press-Releases/236-Using-Logic-Models> [Accessed 1 September 2017]

13. Levac, D., Colquhoun, H. & O'Brien, K.K. Scoping studies: advancing the methodology. *Implementation Sci* 2010; 5, 69 doi:10.1186/1748-5908-5-69
14. Daudt, H.M., van Mossel, C. & Scott, S.J. Enhancing the scoping study methodology: a large, inter-professional team's experience with Arksey and O'Malley's framework. *BMC Med Res Methodol*. 2013; 13, 48 doi:10.1186/1471-2288-13-48
15. Buck D. Gardens and Health: Implications for Policy and Practice. 2016: Kings Fund: London.
16. Craig P, Diepe P, Macintyre S, Michie S, Nazareth I, Petticrew M. Medical Research Council (MRC) Developing and Evaluating Complex Interventions. 2006: MRC: London.
17. Muir Gray JA. Evidence-based Healthcare. How to make Health Policy and Management Decisions. 2001: 2nd Ed. Churchill-Livingstone.
18. [PLoS Medicine](#) (OPEN ACCESS) Moher D, Liberati A, Tetzlaff J, Altman DG, The PRISMA Group (2009). *Preferred Reporting Items for Systematic Reviews and Meta-Analyses: The PRISMA Statement*. [PLoS Med 6\(7\): e1000097. doi:10.1371/journal.pmed1000097](#)
19. Al-Delaimy WK, Webb M. Community Gardens as Environmental Health Interventions: Benefits Versus Potential Risks. *Curr Environ Health Rep*. 2017;4(2):252-65.
20. Annerstedt M, Währborg P. Nature-assisted therapy: Systematic review of controlled and observational studies. *Scandinavian Journal of Public Health*. 2011;39(4):371-88.
21. Austin EN, Johnston YAM, Morgan LL. Community gardening in a senior center: a therapeutic intervention to improve the health of older adults. *Therapeutic Recreation Journal*. 2006;40(1):48-57.
22. Bail JR, Frugé AD, Cases MG, De Los Santos JF, Locher JL, Smith KP, et al. A home-based mentored vegetable gardening intervention demonstrates feasibility and improvements in physical activity and performance among breast cancer survivors. *Cancer* (0008543X). 2018;124(16):3427-35.
23. Blair CK, Madan-Swain A, Locher JL, Desmond RA, de Los Santos J, Affuso O, et al. Harvest for health gardening intervention feasibility study in cancer survivors. *Acta Oncologica*. 2013;52(6):1110-8.
24. Bragg R, Atkins, G. A review of nature-based interventions for mental health care. 2016. Report No.: 204.
25. Christian MS, Evans CEL, Cade JE. Public Health Research. Does the Royal Horticultural Society Campaign for School Gardening increase intake of fruit and vegetables in children? Results from two randomised controlled trials. Southampton (UK): NIHR Journals Library
26. Cipriani J, Benz A, Holmgren A, Kinter D, McGarry J, Rufino G. A Systematic Review of the Effects of Horticultural Therapy on Persons with Mental Health Conditions. *Occupational Therapy in Mental Health*. 2017;33(1):47-69.
27. Clatworthy J, Hinds J, Camic PM. Gardening as a mental health intervention: A review. *Mental Health Review Journal*. 2013;18(4):214-25.
28. D'Andrea SJ, Batavia M, Sasson N. Effect of Horticultural Therapy on Preventing the Decline of Mental Abilities of Patients with Alzheimer's Type Dementia. *Journal of Therapeutic Horticulture*. 2007;18.
29. Detweiler MB, Self JA, Lane S, Spencer L, Lutgens B, Kim DY, et al. 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*. 2015;21(4):36-41.
30. Dewi NS, Komatsuzaki M, Yamakawa Y, Takahashi H, Shibnuma S, Yasue T, et al. Community Gardens as Health Promoters: Effects on Mental and Physical Stress Levels in Adults with and without Mental Disabilities. *Sustainability*. 2017;9(1).
31. Dunnett N, Qasim M. Perceived benefits to human well-being of urban gardens. *HortTechnology*. 2000;10(1):40-5.
32. Edwards CA, McDonnell C, Merl H. An evaluation of a therapeutic garden's influence on the quality of life of aged care residents with dementia. *Dementia-International Journal of Social Research and Practice*. 2013;12(4):494-510.
33. Eriksson T, Westerberg Y, Jonsson H. Experiences of women with stress-related ill health in a therapeutic gardening program. *Canadian Journal of Occupational Therapy*. 2011;78(5):273-81.
34. Farrier A, Baybutt M, Dooris M. Mental health and wellbeing benefits from a prisons horticultural programme. *International Journal of Prisoner Health*. 2019;15(1):91-104.
35. Ford Murphy P, Miyazaki Y, Detweiler MB, Kim KY. Longitudinal analysis of differential effects on agitation of a therapeutic wander garden for dementia patients based on ambulation ability. *Dementia*. 2010;9(3):355-73.

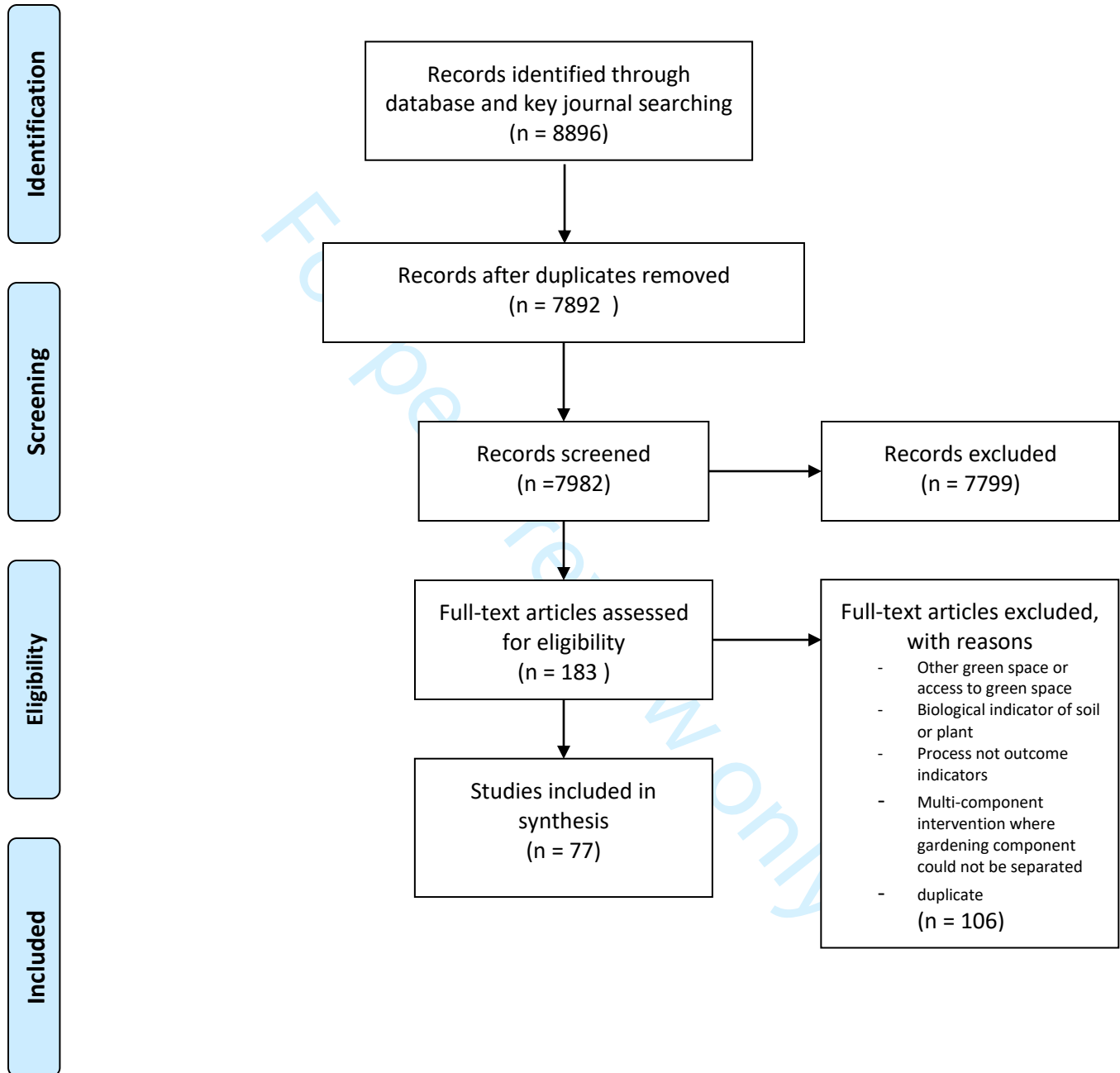
- 1
- 2
- 3 36. Garcia MT, Ribeiro SM, Germani ACCG, Bogus CM. The impact of urban gardens on adequate and
- 4 healthy food: a systematic review. *Public Health Nutrition*. 2018;21(2):416-25.
- 5 37. Gatto NM, Martinez LC, Spruijt-Metz D, Davis JN. LA sprouts randomized controlled nutrition, cooking
- 6 and gardening programme reduces obesity and metabolic risk in Hispanic/Latino youth. *Paediatric*
- 7 *Obesity*. 2017;12(1):28-37.
- 8 38. Genter C, Roberts A, Richardson J, Sheaff M. The contribution of allotment gardening to health and
- 9 wellbeing: A systematic review of the literature. *British Journal of Occupational Therapy*.
- 10 2015;78(10):593-605.
- 11 39. Gonzalez MT, Hartig T, Patil GG, Martinsen EW, Kirkevold M. Therapeutic horticulture in clinical
- 12 depression: a prospective study. *Research & Theory for Nursing Practice*. 2009;23(4):312-28.
- 13 40. Han A-R, Park S-A, Ahn B-E. Reduced stress and improved physical functional ability in elderly with
- 14 mental health problems following a horticultural therapy program. *Complementary Therapies in*
- 15 *Medicine*. 2018: 38:19-23.
- 16 41. Harris N, Minniss FR, Somerset S. Refugees connecting with a new country through community food
- 17 gardening. *International Journal of Environmental Research and Public Health*. 2014;11(9):9202-16.
- 18 42. Hartwig KA, Mason M. Community Gardens for Refugee and Immigrant Communities as a Means of
- 19 Health Promotion. *Journal of Community Health*. 2016;41(6):1153-9.
- 20 43. Hawkins JL, Thirlaway KJ, Backx K, Clayton DA. Allotment Gardening and Other Leisure Activities for
- 21 Stress Reduction and Healthy Aging. *Horttechnology*. 2011;21(5):577-85.
- 22 44. Hawkins JL, Smith A, Backx K, Clayton DA. Exercise intensities of gardening tasks within older adult
- 23 allotment gardeners in Wales. *Journal of Aging and Physical Activity*. 2015;23(2):161-8.
- 24 45. Heim S, Bauer KW, Stang J, Ireland M. Can a community-based intervention improve the home food
- 25 environment? Parental perspectives of the influence of the Delicious and Nutritious Garden. *Journal*
- 26 *of Nutrition Education and Behavior*. 2011;43(2):130-4.
- 27 46. Heliker D, Chadwick A, O'Connell T. The meaning of gardening and the effects on perceived well being
- 28 of a gardening project on diverse populations of elders. *Activities, Adaptation & Aging*. 2000;24(3):35-
- 29 56.
- 30 47. Hernandez RO. Effects of Therapeutic Gardens in Special Care Units for People with Dementia: Two
- 31 Case Studies. *Journal of Housing for the Elderly*. 2007;21(1-2):117-52.
- 32 48. Hewitt P, Watts C, Hussey J, Power K, Williams T. Does a structured gardening programme improve
- 33 well-being in young-onset dementia? A preliminary study. *British Journal of Occupational Therapy*.
- 34 2013;76(8):355-61.
- 35 49. Jarrott SE, Gigliotti CM. Comparing responses to horticultural-based and traditional activities in
- 36 dementia care programs. *American Journal of Alzheimer's Disease & Other Dementias*.
- 37 2010;25(8):657-65.
- 38 50. Jarrott SE, Kwack HR, Relf D. An observational assessment of a dementia-specific horticultural therapy
- 39 program. *Horttechnology*. 2002;12(3):403-10.
- 40 51. Jeong M-H, Lee I-S, Chung Y-M, Jeong S-J, Youn C-H, Cho H-G, et al. Effect of Horticultural Therapy on
- 41 Improvement of Mental Health and Social Adaptability of Schizoid of the Open Ward. *Korean Journal*
- 42 *of Horticultural Science and Technology*. 2004;22(4):499-503.
- 43 52. Joyce J, Warren A. A Case Study Exploring the Influence of a Gardening Therapy Group on Well-Being.
- 44 *Occupational Therapy in Mental Health*. 2016;32(2):203-15.
- 45 53. Kam MCY, Siu AMH. Evaluation of a horticultural activity programme for persons with psychiatric
- 46 illness. *Hong Kong Journal of Occupational Therapy*. 2010;20(2):80-6.
- 47 54. Kamioka H, Tsutani K, Yamada M, Park H, Okuizumi H, Honda T, et al. Effectiveness of horticultural
- 48 therapy: a systematic review of randomized controlled trials. *Complementary Therapies in Medicine*.
- 49 2014;22(5):930-43.
- 50 55. Kim MY, Kim GS, Mattson NS, Kim WS. Effects of Horticultural Occupational Therapy on the Physical
- 51 and Psychological Rehabilitation of Patients with Hemiplegia after Stroke. *Korean Journal of*
- 52 *Horticultural Science & Technology*. 2010;28(5):884-90.
- 53 56. Kohlleppl T, Bradley JC, Jacob S. A walk through the garden: Can a visit to a botanic garden reduce
- 54 stress? *HortTechnology*. 2002;12(3):489-92.
- 55 57. Korpela K, De Bloom J, Sianoja M, Pasanen T, Kinnunen U. Nature at home and at work: Naturally
- 56 good? Links between window views, indoor plants, outdoor activities and employee well-being over
- 57 one year. *Landscape & Urban Planning*. 2017;160:38-47.
- 58
- 59
- 60

58. Kunpeuk W, Spence W, Phulkerd S, Suphanchaimat R, Pitayarangsarit S. The impact of gardening on nutrition and physical health outcomes: a systematic review and meta-analysis. *Health Promotion International*. 2019.
59. Lai CKY, Kwan RYC, Lo SKL, Fung CYY, Lau JKH, Tse MMY. Effects of Horticulture on Frail and Prefrail Nursing Home Residents: A Randomized Controlled Trial. *Journal of the American Medical Directors Association*. 2018;19(8):696-702.
60. Lai CK-Y, Lau CK-Y, Kan WY, Lam WM, Fung CYY. The effect of horticultural therapy on the quality of life of palliative care patients. *Journal of Psychosocial Oncology*. 2017;35(3):278-91.
61. Ga L, Gupta A. Gardening increases vegetable consumption in school-aged children: A meta-analytical synthesis. *HortTechnology*. 2012;22:430-45.
62. Lanier J, Schumacher J, Calvert K. Cultivating Community Collaboration and Community Health Through Community Gardens. *Journal of Community Practice*. 2015;23(3-4):492-507.
63. Lee Y, Kim S. Effects of indoor gardening on sleep, agitation, and cognition in dementia patients - a pilot study. *International Journal of Geriatric Psychiatry*. 2008;23(5):485-9.
64. Leng CH, Wang J-D. Daily home gardening improved survival for older people with mobility limitations: an 11-year follow-up study in Taiwan. *Clinical interventions in Aging*. 2016;11:947-59.
65. Li WW, Hodgetts D, Ho E. Gardens, Transitions and Identity Reconstruction among Older Chinese Immigrants to New Zealand. *Journal of Health Psychology*. 2010;15(5):786-96.
66. Liu Y, Bo L, Sampson S, Roberts S, Zhang G, Wu W. Horticultural therapy for schizophrenia. Cochrane Database of Systematic Reviews. 2014(5):N.PAG-N.PAG.
67. Lu L-C, Lan S-H, Hsieh Y-P, Yen Y-Y, Chen J-C, Lan S-J. Horticultural Therapy in Patients With Dementia: A Systematic Review and Meta-Analysis. *American Journal of Alzheimer's Disease and other Dementias*. 2019:1533317519883498-.
68. Luk KY, Lai KY, Li CC, Cheung WH, Lam SM, Li HY, et al. The effect of horticultural activities on agitation in nursing home residents with dementia. *Int J Geriatr Psychiatry*. 2011;26(4):435-6.
69. Masset E, Haddad L, Cornelius A, Isaza-Castro J. Effectiveness of agricultural interventions that aim to improve nutritional status of children: systematic review. *BMJ (Clinical research ed)*. 2012;344:d8222.
70. Masuya J, Ota K. Efficacy of horticultural activity in elderly people with dementia: A pilot study on the influence on vitality and cognitive function. *International Journal of Nursing & Clinical Practices*. 2014.
71. Masuya J, Ota K, Mashida Y. 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*. 2014.
72. Matsunaga K, Park B-J, Kobayashi H, Miyazaki Y. Physiologically Relaxing Effect of a Hospital Rooftop Forest on Older Women Requiring Care. *Journal of the American Geriatrics Society*. 2011;59(11):2162-3.
73. McCaffrey R. The effect of healing gardens and art therapy on older adults with mild to moderate depression. *Holistic Nursing Practice*. 2007;21(2):79-84.
74. McCaffrey R, Hanson C, McCaffrey W. Garden walking for depression: a research report. *Holistic Nursing Practice*. 2010;24(5):252-9.
75. McCaffrey R, Liehr P. The Effect of Reflective Garden Walking on Adults with Increased Levels of Psychological Stress. *Journal of Holistic Nursing*. 2016;34(2):177-84.
76. Milligan C, Gatrell A, Bingley A. Cultivating health': therapeutic landscapes and older people in northern England. *Social Science & Medicine*. 2004;58(9):1781-93.
77. Nicholas SO, Giang AT, Yap PLK. The Effectiveness of Horticultural Therapy on Older Adults: A Systematic Review. *Journal of the American Medical Directors Association*. 2019;20(10):1351-.
78. Nicklett EJ, Anderson LA, Yen IH. Gardening Activities and Physical Health Among Older Adults: A Review of the Evidence. *Journal of Applied Gerontology*. 2016;35(6):678-90.
79. Oh Y-A, Park S-A, Ahn B-E. Assessment of the psychopathological effects of a horticultural therapy program in patients with schizophrenia. *Complementary Therapies in Medicine*. 2018;36:54-8.
80. Ohly H, Gentry S, Wigglesworth R. A systematic review of the health and well-being impacts of school gardening : synthesis of quantitative and qualitative evidence. *BMC Public Health*. 2016;16(286).
81. Park SA, Lee AY, Park HG, Son KC, Kim DS, Lee WL. Gardening Intervention as a Low- to Moderate-Intensity Physical Activity for Improving Blood Lipid Profiles, Blood Pressure, Inflammation, and Oxidative Stress in Women over the Age of 70: A Pilot Study. *Hortscience*. 2017;52(1):200-5.
82. Robinson-O'Brien R, Story M, Heim S. Impact of Garden-Based Youth Nutrition Intervention Programs: A Review. *Journal of the American Dietetic Association*. 2009;109(2):273-80.

- 1
 - 2
 - 3
 - 4
 - 5
 - 6
 - 7
 - 8
 - 9
 - 10
 - 11
 - 12
 - 13
 - 14
 - 15
 - 16
 - 17
 - 18
 - 19
 - 20
 - 21
 - 22
 - 23
 - 24
 - 25
 - 26
 - 27
 - 28
 - 29
 - 30
 - 31
 - 32
 - 33
 - 34
 - 35
 - 36
 - 37
 - 38
 - 39
 - 40
 - 41
 - 42
 - 43
 - 44
 - 45
 - 46
 - 47
 - 48
 - 49
 - 50
 - 51
 - 52
 - 53
 - 54
 - 55
 - 56
 - 57
 - 58
 - 59
 - 60
83. Rodiek S. Influence of an outdoor garden on mood and stress in older persons. *Journal of Therapeutic Horticulture*. 2002;13:13-21.
84. Savoie-Roskos MR, Wengreen H, Durward C. Increasing Fruit and Vegetable Intake among Children and Youth through Gardening-Based Interventions: A Systematic Review. *Journal of the Academy of Nutrition & Dietetics*. 2017;117(2):240-50.
85. Scott TL, Masser BM, Pachana NA. Exploring the health and wellbeing benefits of gardening for older adults. *Ageing & Society*. 2015;35(10):2176-200.
86. Sempik J, Rickhuss C, Beeston A. The effects of social and therapeutic horticulture on aspects of social behaviour. *British Journal of Occupational Therapy*. 2014;77(6):313-9.
87. M S, KJ G, Y Y. Gardening is beneficial for health: A meta-analysis. *Preventive Medicine Reports*. 2017;5:92-9.
88. Soga M, Cox DTC, Yamaura Y, Gaston KJ, Kurisu K, Hanaki K. Health Benefits of Urban Allotment Gardening: Improved Physical and Psychological Well-Being and Social Integration. *International Journal of Environmental Research and Public Health*. 2017;14(1).
89. Stern C, Munn Z. Physical Leisure Activities and their Role in Preventing Dementia: A Systematic Review. *Int J Evid Based Healthc*. 2010; 8(1):2-17. doi: 10.1111/j.1744-1609.2010.00150.x 7.:260-308.
90. Swank JM, Shin SM. Garden Counselling Groups and Self-Esteem: A Mixed Methods Study With Children With Emotional and Behavioral Problems. *Journal for Specialists in Group Work*. 2015;40(3):315-31.
91. Van Den Berg AE, Custers MHG. Gardening Promotes Neuroendocrine and Affective Restoration from Stress. *Journal of Health Psychology*. 2011;16(1):3-11.
92. Wang D, MacMillan T. The Benefits of Gardening for Older Adults: A Systematic Review of the Literature. *Activities, Adaptation and Aging*. 2013;37(2):153-81.
93. Whear R, Coon JT, Bethel A, Abbott R, Stein K, Garside R. What Is the Impact of Using Outdoor Spaces Such as Gardens on the Physical and Mental Well-Being of Those With Dementia? A Systematic Review of Quantitative and Qualitative Evidence. *Journal of the American Medical Directors Association*. 2014;15(10):697-705.
94. Wood CJ, Pretty J, Griffin M. A case-control study of the health and well-being benefits of allotment gardening. *Journal of Public Health*. 2016;38(3):e336-e44.
95. Zick CD, Smith KR, Kowaleski-Jones L, Uno C, Merrill BJ. Harvesting more than vegetables: The potential weight control benefits of community gardening. *American Journal of Public Health*. 2013;103(6):1110-5.
96. Mills T, Lawton R, Sheard L. Advancing complexity science in healthcare research: the logic of logic models. *BMC Med Res Methodol* 2019; 19, 55 doi:10.1186/s12874-019-0701-4
97. Rohwer ., Pfenhauer L, Burns J. et al. *Logic models help make sense of complexity in systematic reviews and health technology assessments*. *Journal of Clinical Epidemiology*. 2017; 83. pp. 37-47. ISSN 1878-5921
98. Tennant R, Hiller L, Fishwick R, Platt S, Joseph S, Weich S, Parkinson J, Secker J, Stewart-Brown S. The Warwick-Edinburgh Mental Well-being Scale (WEMWBS): Development and UK validation. *Health and Quality of Life Outcomes*. 2007; 5. 63. <https://doi.org/10.1186/1477-7525-5-63>
99. Aged J, Marks N, Cordon C, Thompson S. Five Ways to Wellbeing: A report presented to the Foresight Project on communicating the evidence base for improving people's well-being. 2008: London: New Economics Foundation.
100. Dodge R, Daly A, Huyton J, Sanders L. The challenge of defining wellbeing. *International Journal of Wellbeing*. 2012; 2(3), 222-235.
101. Howarth, ML, Lister, C. Social prescribing in cardiology: rediscovering the nature of and within us. *British Journal of Cardiac Nursing*. 2019; 14 (8) 1-9.
102. Cook PA, Howarth M, Wheeler CP. Biodiversity and Health in the Face of Climate Change: Implications for Public Health. In: Marselle M, Stadler J, Korn H, Irvine K, Bonn A. (eds) *Biodiversity and Health in the Face of Climate Change*. 2019: Springer Press.
103. Hajek A, Bock JO, König HH. Association of general psychological factors with frequent attendance in primary care: a population-based cross-sectional observational study. *BMC Family Practice*. 2017; 18 (1) 48.
104. Pettigrew M, Cummin S, Ferrell C, Findlay A, Higgins C, Hoy C, Kearns A, Sparks L. Natural Experiments: an underused tool for public health? *Public Health*. 2005; 119, 751-757.



Figure 1: PRISMA 2009 Flow Diagram

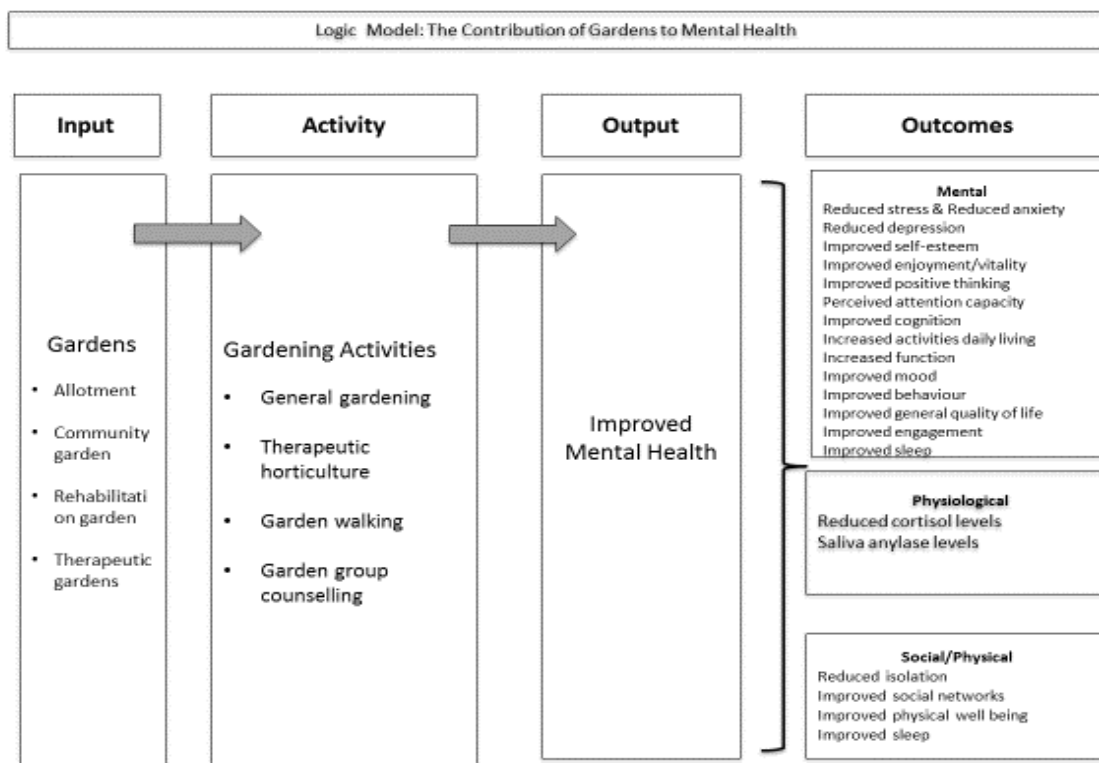


From: Moher D, Liberati A, Tetzlaff J, Altman DG, The PRISMA Group (2009). Preferred Reporting Items for Systematic Reviews and Meta-Analyses: The PRISMA Statement. PLoS Med 6(7): e1000097. doi:10.1371/journal.pmed1000097

For more information, visit www.prisma-statement.org.

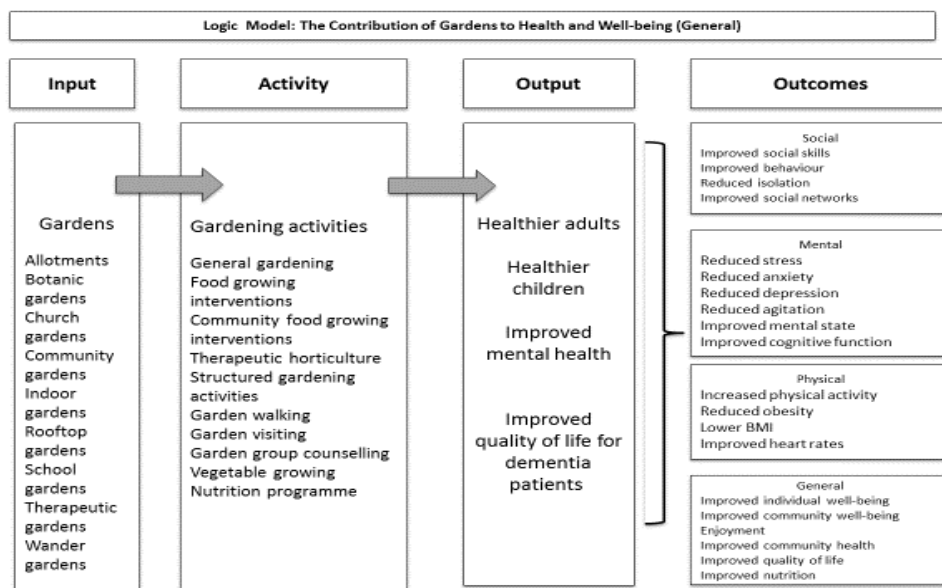
For peer review only - <http://bmjopen.bmj.com/site/about/guidelines.xhtml>

Figure 2: Logic Model: Mental Health



review only

Figure 3: Logic Model: Wellbeing.



Peer review only

Appendix 1

SAMPLE SEARCH STRATEGY**Medline**

Database: Ovid MEDLINE(R) 1946 to Present with Daily Update

Search Strategy:

-
- 1 Gardens/ (29)
 - 2 Gardening/ (745)
 - 3 Horticultural Therapy/ (32)
 - 4 Parks, Recreational/ (311)
 - 5 "Conservation of Natural Resources"/ (33544)
 - 6 Nature/ (755)
 - 7 garden*.mp. [mp=title, abstract, original title, name of substance word, subject heading word, keyword heading word, protocol supplementary concept word, rare disease supplementary concept word, unique identifier, synonyms] (8344)
 - 8 horticultur*.mp. [mp=title, abstract, original title, name of substance word, subject heading word, keyword heading word, protocol supplementary concept word, rare disease supplementary concept word, unique identifier, synonyms] (1641)
 - 9 green care.mp. [mp=title, abstract, original title, name of substance word, subject heading word, keyword heading word, protocol supplementary concept word, rare disease supplementary concept word, unique identifier, synonyms] (21)
 - 10 social prescrib*.mp. [mp=title, abstract, original title, name of substance word, subject heading word, keyword heading word, protocol supplementary concept word, rare disease supplementary concept word, unique identifier, synonyms] (17)
 - 11 (green space* or greenspace*).mp. [mp=title, abstract, original title, name of substance word, subject heading word, keyword heading word, protocol supplementary concept word, rare disease supplementary concept word, unique identifier, synonyms] (509)
 - 12 allotment*.mp. [mp=title, abstract, original title, name of substance word, subject heading word, keyword heading word, protocol supplementary concept word, rare disease supplementary concept word, unique identifier, synonyms] (448)
 - 13 ecotherap*.mp. [mp=title, abstract, original title, name of substance word, subject heading word, keyword heading word, protocol supplementary concept word, rare disease supplementary concept word, unique identifier, synonyms] (4)
 - 14 (plant* adj5 (garden* or shrub* or tree* or flower* or seed* or vegetable* or grass* or landscap* or lawn* or fruit* or cultivat*)).mp. [mp=title, abstract, original title, name of substance word, subject heading word, keyword heading word, protocol supplementary concept word, rare disease supplementary concept word, unique identifier, synonyms] (11776)
 - 15 or/1-14 (56079)
 - 16 Treatment Outcome/ (814853)
 - 17 "Outcome Assessment (Health Care)"/ (61518)

1
2
3
4 18 "Outcome and Process Assessment (Health Care)"/ (24767)
5 19 outcome assessment*.mp. [mp=title, abstract, original title, name of substance word, subject
6 heading word, keyword heading word, protocol supplementary concept word, rare disease
7 supplementary concept word, unique identifier, synonyms] (67872)
8
9 20 outcome measure*.mp. [mp=title, abstract, original title, name of substance word, subject
10 heading word, keyword heading word, protocol supplementary concept word, rare disease
11 supplementary concept word, unique identifier, synonyms] (169480)
12
13 21 exp Health Status/ (275273)
14
15 22 exp "Quality of Life"/ (154742)
16
17 23 Health Impact Assessment/ (388)
18
19 24 (well-being or wellbeing or "well being").mp. [mp=title, abstract, original title, name of substance
20 word, subject heading word, keyword heading word, protocol supplementary concept word, rare
21 disease supplementary concept word, unique identifier, synonyms] (55554)
22
23 25 (health* or wellness or mental health or mental* ill* or mental disorder* or quality of life or anxiet*
24 or anxious* or depress* or stress* or dementia or cardiovascular or myocardial infarction* or heart
25 attack* or stroke* or obesity or obese or overweight or learning disabilit* or learning disorder* or
26 outcome*).m_titl. (1454724)
27
28 26 exp Mental Health/ (29216)
29
30 27 exp Mental Disorders/ (1108313)
31
32 28 exp Depression/ (97090)
33
34 29 Anxiety/ (67031)
35
36 30 Stress, Psychological/ (104840)
37
38 31 exp Dementia/ (141332)
39
40 32 exp Cardiovascular Diseases/ (2171727)
41
42 33 Myocardial Infarction/ (159184)
43
44 34 exp Stroke/ (108360)
45
46 35 exp Obesity/ (176865)
47
48 36 exp Learning Disorders/ (22851)
49
50 37 or/16-36 (5055713)
51
52 38 exp Empirical Research/ (37340)
53
54 39 exp Research Design/ (398278)
55
56 40 exp Qualitative Research/ (33967)
57
58 41 exp epidemiologic studies/ (2076068)
59
60 42 or/38-41 (2437850)
43 15 and 37 and 42 (525)
44 15 and 37 (3842)
45 limit 44 to (meta analysis or "review" or systematic reviews) (497)
46 limit 44 to "reviews (maximizes sensitivity)" (1175)
47 43 or 45 or 46 (1476)

1
2
3
4 48 (review or synthesis or trial or meta-analysis or evaluation or cohort study or case control or
5 survey or qualitative or research).m_titl. (1399375)

6
7 49 15 and 37 and 48 (284)

8 50 47 or 49 (1594)

9 51 limit 50 to (english language and yr="1990 -Current") (1460)

10
11
12 Strategies for remaining databases available on request
13
14
15
16
17
18
19
20
21
22
23
24
25
26
27
28
29
30
31
32
33
34
35
36
37
38
39
40
41
42
43
44
45
46
47
48
49
50
51
52
53
54
55
56
57
58
59
60

Preferred Reporting Items for Systematic reviews and Meta-Analyses extension for Scoping Reviews (PRISMA-ScR) Checklist

SECTION	ITEM	PRISMA-ScR CHECKLIST ITEM	REPORTED ON PAGE #
TITLE			
Title	1	Identify the report as a scoping review.	1
ABSTRACT			
Structured summary	2	Provide a structured summary that includes (as applicable): background, objectives, eligibility criteria, sources of evidence, charting methods, results, and conclusions that relate to the review questions and objectives.	2
INTRODUCTION			
Rationale	3	Describe the rationale for the review in the context of what is already known. Explain why the review questions/objectives lend themselves to a scoping review approach.	3
Objectives	4	Provide an explicit statement of the questions and objectives being addressed with reference to their key elements (e.g., population or participants, concepts, and context) or other relevant key elements used to conceptualize the review questions and/or objectives.	3
METHODS			
Protocol and registration	5	Indicate whether a review protocol exists; state if and where it can be accessed (e.g., a Web address); and if available, provide registration information, including the registration number.	4
Eligibility criteria	6	Specify characteristics of the sources of evidence used as eligibility criteria (e.g., years considered, language, and publication status), and provide a rationale.	4,5
Information sources*	7	Describe all information sources in the search (e.g., databases with dates of coverage and contact with authors to identify additional sources), as well as the date the most recent search was executed.	5
Search	8	Present the full electronic search strategy for at least 1 database, including any limits used, such that it could be repeated.	appendix
Selection of sources of evidence†	9	State the process for selecting sources of evidence (i.e., screening and eligibility) included in the scoping review.	5
Data charting process‡	10	Describe the methods of charting data from the included sources of evidence (e.g., calibrated forms or forms that have been tested by the team before their use, and whether data charting was done independently or in duplicate) and any processes for obtaining and confirming data from investigators.	5
Data items	11	List and define all variables for which data were sought and any assumptions and simplifications made.	4
Critical appraisal of individual sources of evidence§	12	If done, provide a rationale for conducting a critical appraisal of included sources of evidence; describe the methods used and how this information was used in any data synthesis (if appropriate).	NA



SECTION	ITEM	PRISMA-ScR CHECKLIST ITEM	REPORTED ON PAGE #
Synthesis of results	13	Describe the methods of handling and summarizing the data that were charted.	7-21
RESULTS			
Selection of sources of evidence	14	Give numbers of sources of evidence screened, assessed for eligibility, and included in the review, with reasons for exclusions at each stage, ideally using a flow diagram.	5
Characteristics of sources of evidence	15	For each source of evidence, present characteristics for which data were charted and provide the citations.	6, 22, 23
Critical appraisal within sources of evidence	16	If done, present data on critical appraisal of included sources of evidence (see item 12).	NA
Results of individual sources of evidence	17	For each included source of evidence, present the relevant data that were charted that relate to the review questions and objectives.	7-21
Synthesis of results	18	Summarize and/or present the charting results as they relate to the review questions and objectives.	6, 22, 23
DISCUSSION			
Summary of evidence	19	Summarize the main results (including an overview of concepts, themes, and types of evidence available), link to the review questions and objectives, and consider the relevance to key groups.	23, 24 25
Limitations	20	Discuss the limitations of the scoping review process.	24
Conclusions	21	Provide a general interpretation of the results with respect to the review questions and objectives, as well as potential implications and/or next steps.	24
FUNDING			
Funding	22	Describe sources of funding for the included sources of evidence, as well as sources of funding for the scoping review. Describe the role of the funders of the scoping review.	825

JBI = Joanna Briggs Institute; PRISMA-ScR = Preferred Reporting Items for Systematic reviews and Meta-Analyses extension for Scoping Reviews.

* Where *sources of evidence* (see second footnote) are compiled from, such as bibliographic databases, social media platforms, and Web sites.

† A more inclusive/heterogeneous term used to account for the different types of evidence or data sources (e.g., quantitative and/or qualitative research, expert opinion, and policy documents) that may be eligible in a scoping review as opposed to only studies. This is not to be confused with *information sources* (see first footnote).

‡ The frameworks by Arksey and O'Malley (6) and Levac and colleagues (7) and the JBI guidance (4, 5) refer to the process of data extraction in a scoping review as data charting.

§ The process of systematically examining research evidence to assess its validity, results, and relevance before using it to inform a decision. This term is used for items 12 and 19 instead of "risk of bias" (which is more applicable to systematic reviews of interventions) to include and acknowledge the various sources of evidence that may be used in a scoping review (e.g., quantitative and/or qualitative research, expert opinion, and policy document).

From: Tricco AC, Lillie E, Zarin W, O'Brien KK, Colquhoun H, Levac D, et al. PRISMA Extension for Scoping Reviews (PRISMA-ScR): Checklist and Explanation. *Ann Intern Med.* 2018;169:467–473. doi: 10.7326/M18-0850.



St. Michael's

Inspired Care.
Inspiring Science.

For peer review only - <http://bmjopen.bmj.com/site/about/guidelines.xhtml>

BMJ Open

What Is the Evidence for the Impact of Gardens and Gardening on Health and Wellbeing: A Scoping Review and Evidence-Based Logic Model to Guide Healthcare Strategy Decision Making on the use of Gardening Approaches as a Social Prescription. .

Journal:	<i>BMJ Open</i>
Manuscript ID	bmjopen-2020-036923.R1
Article Type:	Original research
Date Submitted by the Author:	02-Apr-2020
Complete List of Authors:	Howarth, Michelle; University of Salford, ; University of Salford Brettle, Alison; University of Salford, School of Health and Society Hardman, Michael; University of Salford, School of Science, Engineering & Environment Maden, Michelle; University of Liverpool, Department of Health Services Research
Primary Subject Heading:	Public health
Secondary Subject Heading:	General practice / Family practice, Health services research, Patient-centred medicine
Keywords:	SOCIAL MEDICINE, PUBLIC HEALTH, PRIMARY CARE

SCHOLARONE™
Manuscripts



I, the Submitting Author has the right to grant and does grant on behalf of all authors of the Work (as defined in the below author licence), an exclusive licence and/or a non-exclusive licence for contributions from authors who are: i) UK Crown employees; ii) where BMJ has agreed a CC-BY licence shall apply, and/or iii) in accordance with the terms applicable for US Federal Government officers or employees acting as part of their official duties; on a worldwide, perpetual, irrevocable, royalty-free basis to BMJ Publishing Group Ltd ("BMJ") its licensees and where the relevant Journal is co-owned by BMJ to the co-owners of the Journal, to publish the Work in this journal and any other BMJ products and to exploit all rights, as set out in our [licence](#).

The Submitting Author accepts and understands that any supply made under these terms is made by BMJ to the Submitting Author unless you are acting as an employee on behalf of your employer or a postgraduate student of an affiliated institution which is paying any applicable article publishing charge ("APC") for Open Access articles. Where the Submitting Author wishes to make the Work available on an Open Access basis (and intends to pay the relevant APC), the terms of reuse of such Open Access shall be governed by a Creative Commons licence – details of these licences and which [Creative Commons](#) licence will apply to this Work are set out in our licence referred to above.

Other than as permitted in any relevant BMJ Author's Self Archiving Policies, I confirm this Work has not been accepted for publication elsewhere, is not being considered for publication elsewhere and does not duplicate material already published. I confirm all authors consent to publication of this Work and authorise the granting of this licence.

1
2
3 **What Is the Evidence for the Impact of Gardens and Gardening on Health and Wellbeing: A**
4 **Scoping Review and Evidence-Based Logic Model to Guide Healthcare Strategy Decision Making on**
5 **the use of Gardening Approaches as a Social Prescription.**
6
7

8 **ABSTRACT**
9

10 **Objective:** To systematically identify studies that have evaluated the impact of gardens and gardening
11 on health and wellbeing. A secondary objective was to use this evidence to build evidence-based logic
12 models to guide decision making about gardens and gardening as a social prescription.
13
14

15 **Design:** Scoping review of the impact of gardens and gardening on health and wellbeing. Gardens
16 include private spaces and those open to the public or part of hospitals, care homes, hospices or third
17 sector organisations.
18

19 **Data Sources:** A range of biomedical and health management journals were searched including
20 Medline, CINAHL, Psycinfo, Web of Knowledge, Cochrane, Joanna Briggs, Environment Complete and
21 a number of indicative websites were searched from 1990 – November 2019 to locate context specific
22 data and grey literature.
23
24

25 **Eligibility Criteria:** We included research studies (including systematic reviews) that assessed the
26 effect, value or impact of any garden that met the gardening definition.
27
28

29 **Data Extraction and Synthesis:** Three reviewers jointly screened 50 records by titles and abstracts to
30 ensure calibration. Each record title and abstract was screened independently by 2 out of 3 of the
31 project team and each abstract was independently screened. Random checks were conducted by a
32 fourth member of the team and discrepancies resolved through double-checking and discussion.
33
34

35 **Results:** From the 8896 papers located, a total of 77* studies were included. Interventions ranged from
36 viewing gardens, taking part in gardening or undertaking therapeutic activities. The findings
37 demonstrated links between gardens and improved mental wellbeing, increased physical activity and
38 a reduction in social isolation enabling the development of 2 logic models.
39

40 **Conclusions:** The benefits of gardens and gardening could be used as a 'social prescription' globally,
41 for people with Long Terms Conditions (LTC). Our logic models provide an evidence-based guide for
42 decision makers about referring people with LTC to socially prescribed gardens and gardening
43 solutions.
44
45

46
47
48 **Keywords:** Social Medicine, Public Health, Primary Care.
49

50 **Wordcount:** excluding abstract, title page, references, figures and tables is 3770.
51
52
53
54
55
56

57 **ARTICLE SUMMARY: 'Strengths and limitations of this study',**
58
59
60

- This is the first scoping review to explicate the breadth and depth of evidence about the impact of gardens and gardening on a range of health and wellbeing outcomes.
- Gardening as a construct lacks definition leading to associated challenges with the location and curation of papers.
- Lack of a 'standardised' garden or gardening approach has influenced a myriad of research designs, preventing meta-analysis.
- Our paper provides robust evidence-based guidance via logic models to guide health strategy decision making.

RATIONALE:

Long term conditions (LTC's), also referred to as chronic diseases, such as cardiovascular disease, chronic respiratory disorders and cancer remain a significant cause of death globally¹. Contributing to these figures, mental ill-health is the largest single cause of disability worldwide representing 14% of the global population, with depression accounting for 4.3% (WHO 2013)². Socio-economic factors such as education and employment also influence health and wellbeing and health inequalities, and can often lead to increased risk of chronic conditions³.

In the UK, the management of LTC's are challenged by unmet social needs which are attributed to increased attendance at GP surgeries⁴. Patients with LTC's require multipurpose, complex interventions combining inter-professional and intra-agency responses. Hence, it is predicted that LTC's will outstrip universal health and social care service provision, forcing health care strategists to appraise the effectiveness of existing pathogenic interventions. However, the traditional medical management of people with LTC's does not tackle their social needs leading to repeat primary care appointments and unnecessary admissions to secondary care⁵. Consequently, there is a demand to explore alternative, non-medical, salutogenic (non-pathogenic) global approaches that could empower patients with LTC's to reduce their dependence on health and social care services⁶.

Social prescribing is a non-medical method of care which *"links patients in primary care with sources of support within the community to help improve their health and well-being"*⁷. This salutogenic process focuses on promoting wellbeing by referral to a range of non-medical approaches, from exercise on prescription, to arts-based activities and beyond⁶. The complex relationship between health communities and its citizens is largely influenced by wider social determinants⁸. Place-based community organisations which invest in the community are able to respond to and support the wider social determinants of health⁹.

A popular social prescribing approach offered by place-based organisations is the use of gardens and gardening as a nature-based activity to improve health and wellbeing. The use of nature as an intervention is increasingly being recognised worldwide as a means of improving social, emotional, mental and physiological outcomes and are of potential value for people with LTC's. In a recent meta-analysis by Soga et al., the impact of gardening and gardens on a range of physical and mental health outcomes was demonstrated to have positive health and wellbeing benefits¹⁰. However, this meta-analysis only considered a limited range of methodologies, focusing on papers that compared health outcomes in control and treatment groups after participating in gardening. Typically, nature-based interventions comprise a broad spectrum of interventions, activities and outcomes that include plants, the natural environment and living creatures, and of interest here, is the recognition that gardening supports people with LTC's¹¹. People with chronic conditions can engage in nature through being in gardens and through gardening activities such as allotment gardening¹², guerrilla gardening¹³ and

community gardening¹⁴. Gardens are used to cultivate flowers, take exercise, connect with others and grow food. In this article, we adopt this broad definition of gardening and evaluate the full range of interventions within our scoping review. In doing so, we produced two evidence-based logic models that demonstrate the benefit of different forms of gardening across the globe.

To date, there have been no studies that have specifically explored the breadth of literature about the effectiveness of gardens and gardening that could help prevent the impact of rising levels of chronic disease.

REVIEW AIM & OBJECTIVES

Our scoping review aimed to identify and describe the evidence base on the impact of gardens and gardening on the physical, mental, health and well-being of populations. The objectives were to understand the benefits of gardens, provide a map of the literature, types of gardens and health outcomes and build evidence-based logic models to guide decision making about the use of gardens and gardening as a non-medical, social prescription. We agreed the following review question '*What evidence is there on the physical, mental, health and well-being benefits of gardens?*'

METHODS

To address the global gap in evidence, we employed a scoping review methodology. Scoping reviews provide a systematic and robust means of reviewing the breadth of evidence in a wide field and are useful in synthesising the increasing arsenal of evidence, in contrast to a more traditional systematic review that focuses on answering a particular question¹⁵. We employed Arksey & O'Malley's validated framework to map the evidence¹⁶. This was particularly relevant as the scoping review aim was to explicate the impact of gardens and gardening on diverse outcomes and populations. The resultant map of the evidence was used to develop evidence-based logic models to illustrate the key health and wellbeing outcomes as graphic tools to support clinician and commissioner decision making¹⁷. The initial scoping review framework was refined to provide an appropriate method based on the following steps^{18,19}. This involved: 1. Identifying the research question, 2. Identifying relevant studies, 3. Study selection, 4. Charting the data, 5. Collating, summarising and reporting the results. 6. Consultation. Stages 1-4 were conducted iteratively. Stage 5 was undertaken following stages 1-4 and stage 6 (consultation) occurred throughout the lifetime of the review between our research team and our external national stakeholder. Tables 1 & 2 detail the databases and journals searched.

Table 1: Databases Searched.

Database name
Medline
Cinahl
Psychinfo
Web of Knowledge/Science
Scopus
HMIC
Science Direct
Social Care Online
ASSIA
Cochrane Database of Promoting Health Effectiveness Reviews
Joanna Briggs Systematic Reviews
Greenfile

Environment complete
 AMED
 Social Policy and Practice

Table 2: Journals Searched.

Journals Searched
<ul style="list-style-type: none"> • International Journal of Agricultural Sustainability, • Journal of Environmental Planning and Management • Health and the Natural Outdoors • Journal of Environmental Psychology • Psychological Science, • Environment and Behaviour • Environmental Health Perspectives, • Landscape and Urban Planning, • Urban Forestry and Urban Greening • Journal of Social Issues • International Journal of Environment and Health • International Journal of Environmental Health Research • International Journal of Environmental Research and Public Health, • Journal of Public Health • Public Health • Environmental Science and Technology • Journal of Epidemiology and Community Health • Health and Place, • Int. J. Environ.Res. Public Health, • Environmental Sciences

Search and selection of studies

We undertook a comprehensive and iterative search to capture the range of perspectives relating to gardens. We searched from 1990 onwards to capture evidence from the last 25 years, as recommended by Arksey and O'Malley¹⁶. In April 2017, we searched 15 electronic databases and 6 key journals capturing health, social, psychological and environmental perspectives, grey literature sources and websites (including Google Scholar). We repeated the search in September 2018 and November 2019 to capture additional literature published. It is recommended that scoping reviews engage inter-professional teams as they bring a breadth and depth of knowledge¹⁷. Correspondingly, our team was inter-disciplinary with subject and methodological expertise comprising a nurse with experience in social prescribing and nature-based approaches, a geographer with expertise in urban agriculture and sustainable cities, and two health information specialists with additional expertise in systematic review methodology. Our external stakeholder was a national body representing a wide range of gardening interests. We defined gardens as being:

“intimate private spaces attached to private households but they can also be large private or formal gardens open to the public, or part of hospitals care homes or hospices.”²⁰

We modified the protocol throughout the initial search and filtering process to ensure the project remained manageable and faithful to the initial research question and definitions. We searched in a wide and sensitive manner to encompass the diverse types of gardens that could be located within

1
2
3 green space or nature-based type of activities. A range of thesaurus and free text terms (adapted per
4 database) to describe the different types of gardens, and potential breadth of health outcomes were
5 used (see Appendix for example). To ensure robustness, our search followed the agreed protocol and
6 the results were stored on Endnote web reference management software function to manage and
7 track references throughout the scoping review process which was shared across the project team.
8 We recorded search strategies with details of the date the search was undertaken and the number of
9 results obtained and issues arising during the searching to provide a complete history of the search
10 process and provide transparency of the review process.
11

12
13 We agreed an initial set of inclusion and exclusion criteria following the scoping searches and set these
14 out in the protocol. A study was included if it met the definition of gardens²⁰, had a measurable
15 outcome on health or well-being and was published in English after 1990. Ultimately, gardens
16 comprise of numerous interacting components, outcomes and populations and may be described as
17 complex interventions²¹. We therefore ensured that there were no restrictions on study design,
18 biometric indicators or population groups. Systematic reviews summarise the results of studies
19 answering a focused question and within the evidence-based health care policy context, they are
20 acknowledged as 'gold standard' evidence;²² no systematic reviews covered the breadth of our review
21 question, so they were included as studies in their own right. We searched for non-experimental and
22 quasi-experimental studies, which included non-equivalent control group pre-test post-test studies
23 and single group non-controlled designs¹⁸ and studies that determined causality through non-
24 randomization. We excluded other green spaces such as forests or parks and studies on access to
25 green spaces or living near green spaces. We excluded biological indicators of soil or plants,
26 dissertations, theses, conference presentations, abstract or posters. We also excluded studies which
27 used process indicators rather than health outcomes and studies which included gardening as part of
28 other interventions where the effects could not be separated.
29
30
31
32

33 Three reviewers (AB, MHo, MHa) jointly screened 50 records by titles and abstracts to ensure
34 calibration. Once this was achieved each record title was screened independently by 2 out of 3
35 members of the project team (AB, MHa, Mho), then each abstract was screened by 1 member of a
36 team of 3 (AB, MHa, Mho), and full text screening was conducted by 1 member of a team of 3 (AB,
37 MHa, Mho). Random checks on abstract and full text screening were conducted by a fourth member
38 of the team (MM). Any discrepancies were resolved through double-checking and discussion.
39
40

41 **Charting, collating and summarising the data**

42
43 We used Microsoft Excel to create a data extraction template that could automatically populate
44 evidence tables. Through team discussion we agreed elements to extract (column headings) based on
45 study characteristics, green space characteristics, intervention characteristics, health condition, age
46 group, outcome measures, findings and author conclusions. When reporting findings for experimental
47 studies, effect sizes and confidence intervals were included as appropriate; for systematic reviews and
48 other designs narrative findings were reported. One member of the project team (MM) extracted all
49 the data up to 2017 and MH to 2019. We used the evidence tables to organise and synthesise the
50 data to enable us to map the benefits of gardens in relation to different types of gardens, health
51 outcomes (physical, mental and well-being) and health conditions.
52
53

54 **Consultation with partners and patients**

55
56 We engaged partners throughout this review process. We involved a national stakeholder
57 organisation in developing the review protocol and presented and sought feedback on the results at
58 an Economic Social Research Council (ESRC) funded event of community leaders (including the
59
60

national stakeholder organisation), third sector organisations, the general public and public health representatives with an interest in gardens and gardening.

Figure 1: PRISMA Diagram²³: Searching & Sifting Process

Patient and Public Involvement.

This research was done without patient involvement. Patients were not invited to comment on the study design and were not consulted to develop patient relevant outcomes or interpret the results. Patients were not invited to contribute to the writing or editing of this document for readability or accuracy. However we consulted the general public through a community engagement event with residents and local providers of gardening programmes.

RESULTS

Search results

From 8896 citations, we included 77 full text studies* (figure 1²³).

Description of studies

A total of 77 studies were included in this review^{24-101*}. Country of origin included the UK, USA, Brazil, South Korea, Taiwan, Japan and the Netherlands. All the studies described complex interventions, using heterogeneous methodologies, comprising 14 types of study designs. The scoping review highlights the methodological challenges associated in determining causality with complex interventions. There was an even split between experimental/quasi-experimental (29%) and non-experimental studies located (37%). Non-equivalent control group and single group pre-test, post-test was the most frequently used quasi-experimental study designs (20%). There were 8 RCTs (9%)^{24-31*} and 13 (16%) systematic reviews^{32-44*}. All, bar one⁴³ of the systematic reviews reported heterogeneous complex interventions. We present two evidence tables detailing higher level evidence from systematic review and RCT's (see tables 3 & 4); full evidence tables available from authors on request.

Table 3: Evidence Summary: RCT's.

Author, Date and Country	Study Aims	Garden Type	Age	Outcomes Measured	Key Findings	Author Conclusions
Christian <i>et al</i> (2014) UK ²⁴	To evaluate the impact of a school gardening programme, the Royal Horticultural Society (RHS) Campaign for School Gardening, on children's fruit and vegetable intake.	School gardening.	8–11 years.	Change in fruit and vegetable intake. Child level data - School food diary, home food diary - Child and Diet Evaluation Tool (CADET), knowledge and attitude questionnaire. School level – school gardening level questionnaire, gardening in schools – process measures email, information collected from RHS advisor on school gardening in intervention schools. Outcomes measured at baseline (May/June 2010) and Oct 2011-Jan 2012).	Trial 1: Higher mean change of 8 g (95% CI –19 to 36 g) for combined fruit and vegetable intake for teacher-led group than for RHS-led group –32 g (95% CI –60 to –3 g), difference not significant (intervention effect –43 g, 95% CI –88 to 1 g; p = 0.06). Trial 2: More fruit and vegetables consumed in teacher-led group (15 g (95% CI –36 to 148 g), difference not significant. Schools which improved their RHS gardening score by three levels, on average, an increase in intake of fruit and vegetables by 81 g (95% CI 0 to 163 g; p = 0.05) compared with children attending schools that had no change in gardening score.	There is little evidence that school gardening alone can improve children's fruit and vegetable intake. When gardening was implemented at the highest intensities the findings suggest it could improve children's fruit and vegetable intake by a portion per day.

1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21
22
23
24
25
26
27
28
29
30
31
32
33
34
35
36
37
38
39
40
41
42
43
44
45
46

<p>Detweiler <i>et al</i> (2015) USA ²⁵</p>	<p>To assess the effect of horticultural therapy on cortisol levels, depression, symptoms of posttraumatic stress disorder, alcohol cravings, and quality of life symptoms compared with a non-horticultural OT group.</p>	<p>Structured gardening programme.</p>	<p>Mean age 46.4 years (SD=11.9).</p>	<p>Quality of Life[Quality of Life Enjoyment and Satisfaction Questionnaire– Short Form (Q-LES-Q-SF)] Alcohol craving [Alcohol Craving Questionnaire (ACQ-NOW)] PTSD [Posttraumatic Stress Disorder Checklist Civilian Version (PCLC)] Depression [Centre for Epidemiologic Studies Depression Scale (CES-D)] Outcomes assessed pre- and posttreatment. Salivary cortisol samples were taken at weeks 1, 2,and 3.</p>	<p>24 participants completed protocol. Although a positive impact of HT was seen in a 12% reduction in salivary cortisol levels from week 1 to week 3, the difference was not statistically significant (ANOVA (F2,20 = 0.878), P = 0.43). Separate 1-way analyses of covariance (ANCOVAs) found no statistically significant differences in the self-administered tests. A positive trend was seen in improving quality of life and depressive symptoms in the HT group (Q-LES-Q-SF, P = .001 and CES-D, P < .001) compared with the OT group (Q-LES-Q-SF, P=.029 and CES-D, P = .050). HT group did not significantly improve in ACQ-NOW (P = .118), whereas the OT group did (P = .040). HT group did significantly improve in PCLC (P=.039), whereas the OT group did (P=.135).</p>	<p>HT may have a role in reducing stress and depression and quality of life more than the programmes in which the OT participated.</p>
---	--	--	---------------------------------------	---	--	--

<p>Jarott <i>et al</i> (2010) USA ²⁶</p>	<p>To compare a randomly assigned treatment group, who received horticultural therapy-based programming to a comparison group, who engaged in traditional activities programming, on engagement and affect.</p>	<p>HT**</p>	<p>Mean age of 80.09 years, SD= 8.05.</p>	<p>Level of cognitive impairment [mini mental status exam] Affect [Apparent Affect Rating Scale] Engagement [Menorah Park Engagement Scale] Observations took place twice a week during weeks 1, 2, 5, and 6.</p>	<p>No significant differences between groups were found on affect (pleasure ($z = -1.544$, $P = .123$), anxiety ($z = -.086$, $P = .932$), and interest ($z = -1.26$, $P = .208$). Levels of adaptive behaviour differed between the groups, with the treatment group demonstrating higher levels of active ($z = -2.90$, $P = .00$), passive ($z = -2.72$, $P = .01$), and other engagement ($z = -3.47$, $P = .00$) and the comparison group demonstrating higher levels of self-engagement ($z = -4.60$, $P = .00$).</p>	<p>Horticultural therapy based activities successfully facilitate facilitates lower levels of self-engaging behaviours and engages groups of dementia sufferers who are often difficult to engage in activities that elicit high levels of adaptive behaviour.</p>
<p>Van den Berg <i>et al</i> (2011) The Netherlands ²⁷</p>	<p>To hypothesise and test the Stress-relieving effects of gardening.</p>	<p>Gardening.</p>	<p>Mean age 57.6 years (range 38–79)</p>	<p>Stress - Salivary cortisol levels and self-reported mood [Positive and Negative Affect Schedule (PANAS)] Saliva samples collected shortly after arrival at the experimental location, before/after the stressful task, halfway through and after experimental activity. PANAS assessed prior to/after stressor and</p>	<p>Study findings suggest that gardening has a positive impact on relief from acute stress. Both gardening and reading decreased cortisol levels during the recovery period, with significantly stronger decreases seen in the gardening group [($F(1, 11) = 24.15$, $p < .001$ vs. $F(1, 13) = 5.33$, $p < .05$). Post-activity, cortisol levels were marginally lower in the gardening group than in the reading group [$F(1, 27) = 3.21$, $p = .08$]. A significant increase in positive</p>	<p>Gardening can promote relief from acute stress. Gardens can be used as a valuable resource to prevent disease and promote health.</p>

1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21
22
23
24
25
26
27
28
29
30
31
32
33
34
35
36
37
38
39
40
41
42
43
44
45
46

				after experimental activity.	mood was seen in the gardening group [F (1, 12) = 4.91, p < .05], but deteriorated by 4.3 percent in the reading group [p = .53]. Post-activity positive mood was significantly higher in the gardening group than in reading group [F (1, 28) = 4.93, p < .05].	
Gatto et al (2017) USA ²⁸	To explore the effects of a novel 12-week gardening, nutrition and cooking intervention {'LA Sprouts'} on dietary intake, obesity parameters and metabolic disease risk among low-income, primarily Hispanic/Latino youth in Los Angeles.	structured gardening programme.	3rd, 4th & 5th grade students (age range 8-11yrs).	Dietary intake measured via food frequency questionnaire, anthropometric measures {body mass index, waist circumference}, body fat, and fasting blood samples.	Study findings indicate that pupils participating in LA sprouts had significant reductions in body mass index z -scores as compared with the controls (-0.1 vs. -0.04, p=0.01). Waist circumference in the LA Sprouts group decreased more than the control (-1.2 vs. 0.1 cm: p<0.001). Dietary fibre increased with LA sprouts as compared with the controls (+3.4% vs. -16.5%; p=0.04) however there was no difference in the fruit intake between the LA Sprouts and control group.	The findings are positive and indicate that LA Sprouts can benefit pupils nutritional behaviours and impact on BMI and waist circumference, but larger, longitudinal studies are required.

<p>Kam <i>et al</i> (2010) China²⁹</p>	<p>To examine HT activity on reduced stress, improved quality of life and work performance for people with psychiatric disorders.</p>	<p>HT**</p>	<p>Mean age of 44.3 (SD = 11.6).</p>	<p>Well-being and quality of life [Personal Wellbeing Index (PWI-C)] Mental state and behaviour [Depression Anxiety Stress Scale (DASS21)] General functioning [Work Behaviour Assessment (WBA)] PWI-C and DASS21 measured before and after intervention.</p>	<p>A significant positive impact of the horticultural programme was seen in DASS-21 total (p=0.01), depression (p=0.04), anxiety (p=0.01) and stress (p=0.5) subscales. No significant differences were seen in change of WBA and its subscales (p ranges from 0.08-0.79) and PWI (p=0.84). Qualitative evidence suggested a positive impact on emotional, occupational, social and spiritual aspects.</p>	<p>Horticultural therapy is effective in reducing anxiety, depression and stress but no difference was seen on work behaviour or quality of life.</p>
<p>Bail <i>et al</i> (2018) UK³⁰</p>	<p>To assess a mentor home based vegetable garden as an intervention to cancer survivors to explicate health related outcomes.</p>	<p>Gardening programme.</p>	<p>adults – all ages, mean age of 60 years.</p>	<p>Health-related outcomes (secondary outcomes of vegetable consumption, physical activity, performance and function, HRQOL, anthropometrics, and biomarkers) veg consumption, physical activity, HRQOL, Physical Performance, Anthropometrics, biomarkers such as toenail clippings to measure chronic stress levels.</p>	<p>100 % satisfaction with the programme. Statistically significant improvements with physical activities and vegetable consumption. Positive changes reported in the HRQOL scores. Non-significant trends noted in the BMI recordings. Overall, positive changes were reported across both groups, with a marked improvement in the intervention groups scores compared to the controls.</p>	<p>Home based mentoring gardening programme can significantly improve biometric outcomes and vegetable consumption.</p>

1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21
22
23
24
25
26
27
28
29
30
31
32
33
34
35
36
37
38
39
40
41
42
43
44
45
46

<p>Lai et al (2018) China ³¹</p>	<p>To explicate the impact of HT on frail older nursing home residents on psychological wellbeing.</p>	<p>HT**</p>	<p>Frail older adult and pre-frail.</p>	<p>Happiness was measured using the subjective happiness scale; Frailty was measured using the 5 item Fried Frailty Index; Depressive symptoms were measured using the Geriatric Depression Scale; self-efficacy was measured using the 10 item General Self-Efficacy Scale; social engagement measured using the Social Engagement Scale; social networks were measured using Lubbens Social Network Scale and wellbeing was measured using the Personal Well-being Index.</p>	<p>Significant improvement in the interaction time was observed in the happiness scale in the HT groups ($\beta = 1.457, P = .036$). No significant changes noted in any of the other outcomes. A later cluster analysis (follow up) indicated greater effects on subjective happiness for the HT group (mean difference =6.23, $P < .001$) as compared to the controls at baseline.</p>	<p>Frail and prefrail older people living in a nursing home can benefit from HT and can promote subjective happiness.</p>
---	--	-------------	---	---	---	---

HT** = Horticultural Therapy

For peer review only

Table 4: Evidence Summary: Systematic Reviews.

Author, date and country	Aims	Type of Garden	Outcomes measured	Key findings	Authors Conclusions
Cipriani <i>et al</i> (2017) USA ³²	To conduct a systematic review on the benefits of horticultural therapy (HT) on persons with mental health conditions who are receiving services in either inpatient settings or outpatient community-based settings.	HT**	Outcome measures reported in included studies: Affect, agitation, behaviour/engagement, cognitive functioning, interpersonal relationship, physical well-being, psychiatric symptomatology, psychological/mental well-being, quality of life, self-esteem, sleep, social behaviour, stress and coping, volition, work behaviour. Tools reported in included studies: Affect Balance Scale, Test for Severe Impairment, Quality of Life Enjoyment and Satisfaction Questionnaire Short Form (Q-LES-Q-SF), Alcohol Craving Questionnaire, Posttraumatic Stress Disorder Checklist Civilian Version, Centre for Epidemiologic Studies Depression Scale (CES-D), cortisol levels, modified DCM [dementia care mapping] scale, homemade assessment for behaviour and a modified DCM, interviews, The Bradford Well-Being Profile, Mini Mental State Examination, Apparent Affect Rating Scale, Menorah Park Engagement Scale, Chinese version of Depression Anxiety Stress Scale 21, Work Behaviour Assessment, Chinese version Personal Well-being Index, sleep diary, Modified Cohen-Mansfield Agitation Inventory, Revised Hasegawa Dementia Scale, Cohen-Mansfield Agitation Inventory, Physical and Mental Impairment Functional Evaluation, Multi-focus Assessment Scale for the Frail Elderly, Participation Index (Caplovitz) and Participation Index (Phillips), Volitional Questionnaire, Relationship Change Scale, Self-Esteem Scale, Social Behaviour Scale, Symptom	14 studies were included in the review. Study designs include 5 RCT, 6 Cohort, 2 Before and After, 1 Cross-sectional. 11/14 studies found statistically significant findings in support of HT for at least one dependent variable. Studies were conducted in a variety of settings and mental health conditions. Limitations of the studies include, a lack of detail on the interventions in the included studies would limit reproducibility and a lack of information on the reliability and validity of outcome measures.	Moderate evidence exists that horticultural therapy can improve client factors and performance skills.

1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21
22
23
24
25
26
27
28
29
30
31
32
33
34
35
36
37
38
39
40
41
42
43
44
45
46

			Checklist 90 Revision, Evaluation of Horticultural Activity.		
Genter <i>et al</i> (2015) UK ³³	To address the question of, does allotment gardening contribute to health and wellbeing?	Allotment.	Health, wellbeing. No other outcomes were included in the search strategy.	10 studies were included published between 1999-2013, 7 qualitative studies, 3 quantitative studies. Overall, the review found that allotment gardening has a positive impact on health and wellbeing, provides a stress-relieving refuge and valued contact with nature, contributes to a healthier lifestyle, creates social opportunities and enables self-development. It was also found to reduce stress levels and increase positive mood. 3 qualitative papers found that allotment gardening is a suitable therapeutic group activity for people with mental health issues, while 4 papers	Allotment gardening has a positive impact on health and wellbeing. Allotment gardening can be recommended as a form of occupational therapy and can help promote health and wellbeing.

For peer review only

				<p>recognised that individual and group allotment gardening supported healthy ageing.</p>	
<p>Ohly et al (2016) UK ³⁴</p>	<p>To review whether school gardens benefited health and wellbeing of pupils and understand factors that enabled or challenged the success.</p>	<p>School gardening.</p>	<p>Studies were included if they reported quantitative or qualitative health and well-being outcomes. Outcomes reported include fruit and vegetable intake [Structured dietary assessment method, CADET, Lunchtime observations, parent questionnaire, 24 hr recall workbooks, parent survey, Garden Vegetables Frequency Questionnaire, Taste Test]; nutrients intake [CADET, 24 h urine samples; flame photometry, Block Food Screener, parent questionnaire, 24 hr recall workbooks]; physical [waist circumference, body mass index (BMI), and systolic and diastolic blood pressure, Urinary sodium, Total fat (%), GEMS Activity Questionnaire, Accelerometry, well-being [KIDSCREEN-10, Teacher Questionnaire, Quality of school life instrument, Youth Life Skills Inventory, Self-Report of Personality Scale for children and adolescents].</p>	<p>40 studies included (quantitative n=24, qualitative n=16, mixed method n=3). Included studies were from the UK, Australia, Portugal and USA. Quantitative evidence was of poor quality often relying on self-report. Evidence for changes in fruit and vegetable intake was limited; Two out of 13 non-randomised studies report a positive statistically significant impact of gardening on increasing intake of fruit and vegetables. Four out of 6 studies found statistically significant changes in nutrient intake, one of which found a decrease in dietary fibre in control group rather than an</p>	<p>There is limited quantitative evidence for the impacts of school gardens. Qualitative evidence suggests that participants of gardening programmes may experience or perceive a range of health/wellbeing outcomes. There are few studies that have used logic models to illustrate the impact of school gardens as complex interventions.</p>

1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21
22
23
24
25
26
27
28
29
30
31
32
33
34
35
36
37
38
39
40
41
42
43
44
45
46

1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21
22
23
24
25
26
27
28
29
30
31
32
33
34
35
36
37
38
39
40
41
42
43
44
45
46

For peer review only

				<p>improvement in intervention group. One non-randomised controlled study reported a positive statistically significant impact for diastolic blood pressure in favour of the intervention group, but reviewers note that all blood pressure readings were within normal range. One cluster-RCT report that children in the intervention group were 'usually' less sedentary and spent more time engaged in 'moderate' physical activity than control group, but when measured objectively, there was no increase in 'light' physical activity or decrease in sedentary behaviour. Two out of 4 studies reported no difference in impact between a gardening intervention compared to a control group, data in the other 2 studies was found to be inadequate for assessment.</p>	
--	--	--	--	--	--

<p>Stern (2009) Australia ³⁵</p>	<p>To locate and synthesise best evidence about impact of physical activities on people with dementia.</p>	<p>Gardening .</p>	<p>The Diagnostic Statistical Manual of Mental Disorders was used to classify the absence or presence of Dementia. Mental examination tools such as the mini-mental state examination and activities of daily living.</p>	<p>9/17 studies included in the systematic review looked at gardening as an intervention. Positive impacts of gardening were reported by 1 case-control study on a beneficial association with a reduction in the chance of developing Alzheimer's disease. Two cohort studies found that gardening was significantly associated with a reduced risk of dementia (RR = 0.53, 95% CI, 0.28–0.99; HR, 0.64, 95% CI, 0.50–0.83). Another cohort reported that exposure to gardening over at least 10-years may be associated with a reduced risk of developing Alzheimer's disease.</p>	<p>While the evidence is equivocal on whether participation in physical activities is protective against onset of dementia, gardening appears more beneficial than other types of activities. DATA extracted only for gardening.</p>
<p>Wang et al (2013) USA ³⁶</p>	<p>Systemic review evidence for beneficial effects of gardening on older adults.</p>	<p>Gardening.</p>	<p>Range of outcomes measures, as authors sought to locate papers based on methodological approach rather than outcomes. Hence, outcomes were mixed and included Mini Mental State examination, Apparent Affect rating scales, nutrition Menorah Park Engagement Scale, Life Satisfaction Inventory, Stress tests, Perceived health and wellbeing scales, self-reported pain, SF36, Hand Function, Self-Rated Health and Happiness Scale, Pearlines ad Schoolers Mastery Scale, Sleep diaries, Modified Cohen-Mansfield</p>	<p>22 articles were reviewed (adults. Through various research designs (quantitative and qualitative) and measurements utilized, the results reveal that gardening can be an activity that promotes overall health and quality of life, physical strength, fitness and</p>	<p>The authors conclude that the literature reported variable findings, and whilst most of these were positive, the majority were at an exploratory stage. The evidence base provides an intriguing foundation</p>

1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21
22
23
24
25
26
27
28
29
30
31
32
33
34
35
36
37
38
39
40
41
42
43
44
45
46

			Agitation Inventory and Revised Hasegave Dementia Scale.	flexibility, cognitive ability, and socialization. The implementation of various aspects of gardening as health-promoting activities transcend contexts of practice and disciplines and can be used in urban and rural communities as both individual and group activities.	for further research. Gardening has positive effects on older adults and help improve engagement and activity participation for people with dementia.
Whear et al (2014) UK ³⁷	To examine the impact of gardens and outdoor spaces on the mental and physical well-being of people with dementia who are resident in care homes and understand the views of people with dementia, their carers, and care home staff on the value of gardens and outdoor spaces.	Garden visiting.	Included studies had to report on agitation, number of falls, aggression, physical activity, cognitive functioning, or quality of life (quantitative) or report on the views of people with dementia who were resident in care homes, care home staff, carers, and families on the use of gardens and outdoor spaces (qualitative). [Tools reported in included studies – Agitation: Cohen-Mansfield Agitation Inventory (CMAI); Emotional outcomes: Affect Rating Scale;	A total of 17 studies were included (9 quantitative, 7 qualitative, and 1 mixed methods). Quantitative designs included 6 pre-post studies, 2 RCTs, 1 prospective cohort, 1 crossover trial. Quantitative designs were of poor quality but suggest a beneficial effect associated with garden use on reduced levels of agitation. There was insufficient evidence from quantitative studies generalise the findings on other aspects of physical and mental wellbeing. Evidence on the impact of Horticulture Therapy was inconclusive.	Garden use provide promising impacts on levels of agitation in care home residents with dementia who spend time in a garden. Future research should focus on using comparative outcome measures.

<p>Savoie-Roskos et al (2017) USA³⁸</p>	<p>To identify the effectiveness of gardening interventions that have been implemented to increase fruit & vegetables consumption among children.</p>	<p>Gardening.</p>	<p>Fruit and vegetable consumption among children aged 2 to 15 years before and after implementation of a gardening intervention in a school, community, or afterschool setting.</p>	<p>There were 14 papers located and included in the review. A total of 10 articles reported statistically significant increases in fruit or vegetable consumption for those who participated in the gardening intervention. The papers located varied in methodologies and many had small sample sizes and relied on the use of convenience samples, and self-reported measurements of F/V consumption. Whilst the effects are small, the evidence report a positive benefit on the consumption of F/V in the children who participated in the gardening.</p>	<p>The evidence suggests a modest but positive influence of gardens on F/V intake of children.</p>
<p>Annerstedt et al (2011) Sweden³⁹</p>	<p>To systematically review the literature regarding effects of nature-assisted therapy (NAT), for patients with well-defined diseases, as a treatment option either alone, or together with other</p>	<p>Gardens.</p>	<p>Studies were included if they reported systematic review and meta-analyses of RCT's; RCT's; non-randomised intervention studies, observational studies and qualitative studies. Nature based, nature assisted, gardening, horticulture, socio-horticulture, ecotherapy were included. A range of psychological, intellectual, social and physiological outcomes were included.</p>	<p>38 papers (3 systematic reviews/meta-analysis, 6 RCTs, 12 non-randomised trials, 14 observational, 4 qualitative) published between 1980-May 2009 were included. The authors report 13 significant improvements for psychological goals, 6 for social goals, 4 for physical</p>	<p>The authors conclude that the evidence base reports a small, but reliable resource that highlights the benefits of NAT as an approach to promote health. Future studies should be adequately powered</p>

1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21
22
23
24
25
26
27
28
29
30
31
32
33
34
35
36
37
38
39
40
41
42
43
44
45
46

	evidence-based treatment options.			goals, and 2 for intellectual goals.	with clearly defined definitions.
Kamioka <i>et al</i> (2014) Japan⁴⁰	To summarize RCTs evidence on the effects of horticultural therapy.	HT**	Inclusion criteria looked for all cure and rehabilitation effects in accordance with the International Classification of Diseases-10. Included studies reported on; Affect (the Apparent Affect Rating Scale) Engagement (Menorah Park Engagement Scale) Chinese version of Depression Anxiety Stress Scale 21 (DASS21) Work Behaviour Assessment (WBA) Chinese version Personal Wellbeing Index (PWI-C) Life Satisfaction Index-A Form, Revised UCLA Loneliness Scale The Lubben Social Network Scale Self-esteem scale Powerlessness Beck Depression Inventory (BDI) neurobehavioral cognitive status examination (NCSE), motor-free visual perception test (MVPT), and functional independence measure (FIM).	Four studies met all inclusion criteria. All studies showed significant effectiveness in one or more outcomes for mental health and behaviour. No studies report cost-effectiveness. Methodological quality of the RCTs was low.	People with mental and behavioural disorders such as dementia, schizophrenia, depression, and terminal-care for cancer, may benefit from HT, however the evidence supporting this is of low quality.

<p>Masset <i>et al</i> (2012) UK⁴¹</p>	<p>To assess the effectiveness of agricultural interventions in improving the nutritional status of children in developing countries.</p>	<p>range for review including gardens.</p>	<p>Dietary diversity, micronutrient intake, prevalence of under-nutrition, participation and household income. Studies were included if they were cross-sectional and longitudinal project-control comparisons and randomised field trials and studies that compared participants and non-participants over a single cross-section.</p>	<p>15 studies assessed the effectiveness of home gardens (1 RCT, others longitudinal comparison and cross-sectional studies). A positive impact of home gardens was found on increased consumption of fruit and vegetables. No evidence of impact was found on iron intake in children. Some evidence of impact was found on improved intake of vitamin A among children <5 years (Mean difference 2.4 µg/dL, 95%CI 1.67-3.16). Data for overall effects of garden interventions on children's nutritional status not reported separately from other interventions. Methodological quality of included studies was poor.</p>	<p>The review authors concluded that there was limited evidence on the impact of agricultural interventions on the nutritional status of children. The authors were unable to answer the systematic review question with any confidence due to the methodological weaknesses of the studies.</p>
<p>Garcia <i>et al</i> (2017) Brazil⁴²</p>	<p>Systematic review to explore the impact of urban gardens on use of healthy food.</p>	<p>Community gardening.</p>	<p>Key nutrition related outcomes; Participation in urban gardens, food security, healthy food practices, increase in intake of fruit and vegetables, healthy diet and improved family nutrition. Impact on healthy food beliefs, healthy food access, reduction in food costs, greater interest in cooking and meal planning.</p>	<p>24 studies were located. The studies were heterogeneous and included methodological flaws. People who participated in community gardens had improved healthy diet intake, shared food and valued healthy food. People</p>	<p>Community gardens can have positive impact on food beliefs, knowledge and practices. Longer terms studies with more robust methodological frameworks are</p>

1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21
22
23
24
25
26
27
28
29
30
31
32
33
34
35
36
37
38
39
40
41
42
43
44
45
46

				who participate in gardens have an increased fruit and vegetable intake, improved access to health foods through harvest sharing and improved family diet.	needed to verify the benefits of community gardens on nutrition and diet.
Kunpeuk <i>et al</i> (2019) Thailand⁴³	Systematic review and meta-analysis to explore association between community gardening, nutrition and physical health in adults.	Community gardening.	Diverse measurement units, but BMI only was pooled to enable meta-analysis.	19 articles were included in the review. 14 cross-sectional, 1 case-control and 4 quasi-experimental. Results suggest a modest positive impact of gardens on BMI reduction. A greater pooled effect size was reported for the subgroup analysis of the quasi-experimental and case-control studies.	Gardens reduced BMI and should be integrated into health policy.
Nicholas <i>et al</i> (2019) Singapore⁴⁴	To assess whether HT was beneficial for older people.	HT**	Psychosocial, QOL, SF36, Ryffs Scales of Psychological wellbeing. Subjective Happiness scale, Personal Wellbeing index, life satisfaction, dementia QOL.	20 articles were included in the systematic review. 6 experimental studies of which 4 were RCTs. Other papers were quasi-experimental. Most studies reported significant effects of HT on a range of outcomes although there were mixed results on the effect of HT on function. Significant associations were reported on agitation, mood	The evidence for HT is promising, but more robust evidence is required to draw firm conclusions.

1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21
22
23
24
25
26
27
28
29
30
31
32
33
34
35
36
37
38
39
40
41
42
43
44
45
46

				and engagement for people with dementia.	
--	--	--	--	--	--

*HT** = Horticultural Therapy*

For peer review only

Description of gardening interventions

The scoping framework¹⁶ enabled us to locate and include a broad range of evidence, likewise, using the predetermined²⁰ definition of gardens enabled the capture of diverse types of gardens. Typical gardening interventions included 'allotment gardening' ($n=7$)^{33, 45-50} and 'Community gardens' ($n=9$)^{42, 51-58}. The most common garden intervention reported was Horticultural Therapy (HT) ($n=13$)^{32, 40, 59-67} which integrates a structured gardening programme with qualified therapist input. The second most popular approach was 'structured gardening' ($n=12$)^{25, 28, 29, 68-76} which provides a structured programme of activities but does not include a qualified therapist. Irrespective of garden 'type' all garden activities were characterized through a range of physical activities such as 'planting seeds', 'potting on', 'taking cuttings', 'pricking out', 'sweeping and maintaining the garden', 'using and cleaning tools', and other similar tasks.

Description of Outcome Types

We located a range of study methods which reported outcomes related to mental health (MH)^{32, 35 36 47 49-53, 55 59, 67-75, 77-80} physical impact (P)^{25 29 33 38 56 62 76 80 89}, nutritional behaviour changes (N)^{37 40 41} and overall general wellbeing (WB)^{26 32 39 50 54 57 58 60 61 63 83-88, 93-101}. There were over 35 validated health and wellbeing outcome measures reported. Most papers examined the impact of gardens on MH (36%) General wellbeing represented 32% of the total outcomes reported. There was an even split between those papers reporting on specific physical outcomes (14%)⁸⁹ and those reporting on nutrition as an outcome (18%). The heterogeneous outcomes may explain the paucity of meta-analyses (3.7%).

Development of the Logic Models

A secondary objective was to use this evidence to build evidence-based logic models to guide health strategy decision making about gardens and gardening as a non-medical, social prescription. Logic models illustrate causal relationships between service inputs, resultant activities, outputs and goals, emphasizing the contributory factors to successful programmes⁹⁰. The structure and organisation of logic models enable the results from scoping reviews and systematic reviews to delineate complex interventions, such as those without specific, controlled parameters thus enabling greater insight into the interactions between the intervention, in this case gardens & gardening, and the multiple outcomes¹⁰². Logic models can represent causal processes and encapsulate complex interventions and illustrate heterogeneous outcomes¹⁰². Hence, logic models provide an evidence-based tool that can support policy makers, health care strategists and/or primary health care clinician's decisions about commissioning non-medical approaches through social prescribing.

Logic Model: Evidence Evaluating the Impact of Gardens on Mental Health.

There were 29 (36%) studies that focused on the impact of gardening on mental health. We set parameters for mental wellbeing to include four main areas of interest: Psychological Wellbeing, Depression, Anxiety and Mental Status. In the latter, we resolved that mental status included pathological disorders such as dementia, schizophrenia, bi-polar and other chronic long-term conditions. Some categories overlapped, for example, papers with a focus on psychological wellbeing often captured outcomes relating to depression making the creation of distinct categories problematic. Commonly reported data collection methods included validated tools such as the Warwick-Edinburgh Mental Well-being Scale (WEMWBs)¹⁰³ or New Economic Foundation's Five Ways to Wellbeing¹⁰⁴ which offer observational subjective data as opposed to direct causality. Evidence from our review indicated a range of benefits that gardening had on diverse populations. Typically, gardening enabled greater social interaction with others^{87*} and improved physical activity^{37*}, thus improving overall mental wellbeing^{32*}, reducing depression^{83*} and anxiety^{29*}.

1
2
3 A significant percentage of papers (36%) focused on mental health, and of these, the majority (57%)
4 used experimental or quasi-experimental designs. The causal relationships illustrated in our first logic
5 model highlights the range of garden activities that contributed to an improvement in mental health
6 (see fig 2). These papers typically reported that gardens and gardening augmented physical activities
7 resulting in improved physiological outcomes such as reduced cortisol levels^{32 25 89*} and saliva amylase
8 levels^{27*}. Additionally, the logic model graphic enables visual representation of how mental health was
9 improved through enhancing sociological outcomes leading to reduced socialisation through
10 improved social networks.
11
12

13 **INSERT Figure 2: Logic Model: Mental Health**

14 **Logic Model: Evidence Evaluating the Impact of Gardens on General Wellbeing.**

15
16
17 In determining a parameter for wellbeing, we used Dodge *et al*¹⁰⁵ who asserts that “‘stable ‘well-
18 being’ is when individuals have the psychological, social and physical resources they need to meet a
19 particular psychological, social and/or physical challenge”. Hence, a range of wellbeing indicators
20 were reported that relate to both mental and physical wellbeing outcomes. A total of 26 (32%) papers
21 reported general wellbeing and typically focussed on positive health^{30 101 52*}, social health^{84 62 65 38*},
22 subjective wellbeing^{77 35*}, and/or quality of life^{25 78 83 61 37*}. Typical LTC’s studied included chronic lung
23 disease^{56*} diabetes, hypertension and kidney disease^{97*}. Outcomes that measured impact of gardens
24 on nutrition were broad and included dietary changes, increase in fruit and vegetable intake. There
25 were 3 studies that explicated the impact of gardens and gardening on nutritional intake^{37 40 41*}. Key
26 outcomes used as predictors for nutritional impact included validated scales for wellbeing, emotional
27 health, mental health and physiological indicators. Overall, the findings report that the gardening
28 interventions have a positive impact (81%) on nutritional intake of fruit and vegetables and a range of
29 physiological outcomes and general wellbeing.
30
31
32

33
34 The second logic model (see fig 3) provides an illustration of how gardens can benefit general
35 wellbeing. The range of garden types located in the scoping review influenced activities that led to
36 improved wellbeing outputs for adults, children and older people. Several positive outcomes were
37 reported including social: involving skills, behaviours and networks; general mental wellbeing, such as
38 stress reduction^{25 35*}, reduced anxiety and depression^{32 40 63*}. As with the mental health logic model,
39 the graphic illustration enables visual representation of the overlap between the mental, physical,
40 social and emotional outcomes. Thus, papers that reported impact on general wellbeing also included
41 outcome measures that indicated increased physical activity resulting in reduced BMI^{28*} and healthier
42 blood glucose levels^{42*}, and general wellbeing that benefited community growth^{63*}, social interaction
43 ^{95 55} and quality of life^{33 63 83*}.
44
45
46
47

48 **INSERT Figure 3: Logic Model: Wellbeing**

49
50 These evidence-based logic models report the diversity of gardens and gardening interventions and
51 subsequent benefits on a range of populations that may typically live with LTC’s. The resultant
52 outcomes reported provide confidence for clinicians considering gardens or gardening as a social
53 prescription for a range of populations.
54
55

56 **DISCUSSION**

57
58 The increasing interest in social prescribing as a non-medical approach, has gained international
59 attention¹⁰⁶. Salutogenesis influences the question ‘what makes people healthy?’ rather than, ‘how
60

1
2
3 do we treat disease?'. Wellbeing is increasingly promoted through contemporary public health
4 strategies to help reduce LTC's ¹⁰⁷. Although research explicating the impact of gardens and gardening
5 may be inhibited by the broad construct, the paradox here, suggests that it is the range offered that
6 instigates the salutogenic response, ultimately impacting on the wider social determinants of health
7 and benefitting diverse populations. Our findings indicate that diverse populations with LTC's could
8 enjoy health and wellbeing gains from gardens and gardening as a salutogenic, social prescription and
9 is the first to use a robust scoping review using a systematic approach to highlight these advantages.
10
11

12 Typically, gardening can help improve physiological outcomes associated with LTC's such as blood
13 glucose levels, cortisol levels, HRV, blood lipids and salivary stress cortisol. Similar findings were
14 identified by Nicklett et al ^{76*} and Ohly et al ^{34*} who reported positive physiological outcomes measures
15 on a range of biometrics including urinalysis, total fat, BMI and systolic/diastolic blood pressure as
16 outcomes. These findings, coupled with this review, demonstrate positive outcomes for a range of
17 population needs including those living with obesity, diabetes, cardiovascular disease and other LTC's.
18 The wellbeing of an individual is fundamental to health and is predicated on the social progression
19 and quality of life, typically influenced by positive physical and mental health. Similar to Bragg et al
20 ^{84*} our review identified that gardens and subsequent activities can help improve mental health. Bragg
21 and Atkins ^{84*} suggest that growing food can help combat stress and reduce associated depression.
22 Likewise, Kam et al ^{58*} report positive emotional and social improvements for those who participated
23 in a gardening programme. The benefits of gardening on mental health outcomes also extends to
24 other long terms conditions known to influence frequent attendance to A&E, front line health
25 providers or GP's ¹⁰⁸.
26
27
28

29 Our scoping review has implications for researchers seeking to explicate the impact of nature-based
30 solutions on populations. There is a predilection for the use of quasi-experimental pre-test, post-test
31 designs as they appear to provide a good opportunity to test out nature-based solutions in a range of
32 contexts and populations. This suggests that research favours natural experiments that enable
33 observation of communities and populations with allocation of control. As an assessment of
34 effectiveness rather than efficiency, natural experiments may also provide opportunity for external
35 validity and local meaningful generalisation ¹⁰⁹. However, challenges associated with refining nature-
36 based interventions and controlling confounders may have influenced the dearth noted in natural
37 experiments within this review. The prevailing positivist paradigm needs to be revisited within this
38 context and greater consideration proffered for the use of natural experiments or those that use
39 mixed methods to demonstrate impact rather than causality. Hence, natural experiments that include
40 mixed methods are a potential solution to this methodological quagmire that exists within
41 contemporary evidence for complex nature- based interventions.
42
43
44

45 The multiple benefits reported in this scoping review illustrate the breadth of the literature, and
46 highlight the advantages of gardens and gardening on diverse populations. This has wider implications
47 for health care practitioners and can offer non-clinical solutions that build on traditional asset-based
48 community approaches. Our findings suggest that socially prescribed referrals to gardens and
49 gardening have the potential to change people's behaviours and activate wellbeing. In addressing the
50 wider determinants of health, social prescriptions using nature-based solutions could help improve
51 mental, physical and physiological outcomes, ultimately influencing a potential to minimise
52 inappropriate GP consultations and A&E attendance and improve resilience. As a social prescription,
53 nature-based solutions, such as gardening, provide clinicians with an evidence-based opportunity to
54 promote wellbeing through non-medical methods.
55
56
57
58
59
60

Conclusions:

A strength of our scoping review was its rigorous and systematic approach to locate and understand the breadth of evidence reporting the effects of gardens and gardening on people with LTC's. The scoping review has exposed a myriad of paradigmatic solutions that have been used to capture wellbeing outcomes. Irrespective of the heterogeneous methods used, our scoping review indicates that gardens and gardening could have a positive dual benefit on a range of mental, social and psychological outcomes, thus, may be of relevance to those considering gardens and gardening as a non-medical, social prescription. Our logic models could be used as a decision support aid to enable more confident referral to nature-based solutions as part of a wider social prescription.

CONTRIBUTORSHIP STATEMENT: Mho, AB, MHa, MM made substantial contributions to the conception or design of the work and drafted the work and provide final approval of the version to be published. All authors are accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved.

COMPETING INTERESTS: There are no competing interests.

FUNDING: This research received no specific grant from any funding agency in the public, commercial or not-for-profit sectors.

DATA SHARING STATEMENT

There are no data in this work. The search protocol is available on request.

References

1. World Health Organisation Global Health Observatory NCD Morbidity and Mortality [Online] Available at: http://www.who.int/gho/ncd/mortality_morbidity/en/ 2017: [Accessed 14 September 2017]
2. World Health Organization. *Mental health action plan 2013-2020*. World Health Organization. 2013: <https://apps.who.int/iris/handle/10665/89966> .
3. Koh, Howard K,M.D., M.P.H., Bantham, Amy,M.S., M.P.P., Geller, Alan C,R.N., M.P.H., Rukavina, M. A., M.B.A., Emmons, K. M., Ph.D., Yatsko, P., M.A., & Restuccia, R., M.P.A. (2020). Anchor institutions: Best practices to address social needs and social determinants of health. *American Journal of Public Health*, 110(3), 309-316. doi:<http://dx.doi.org/10.2105/AJPH.2019.305472>
4. Mcmanus, S., Bebbington, P., Jenkins, R. & Brugha T. (Eds.) *Mental Health And Wellbeing In England: Adult Psychiatric Morbidity Survey 2014*. 2016: [Online] Available at: [Http://Content.Digital.Nhs.Uk/Catalogue/ Pub21748/Apms-2014-Full-Rpt.Pdf](Http://Content.Digital.Nhs.Uk/Catalogue/Pub21748/Apms-2014-Full-Rpt.Pdf) [Accessed 7 August 2017]
5. Wakefield JRH, Sani, F, Dingle GA, Jetten. Social Isolation Predicts Frequent Attendance in Primary Care. *Annals of Behavioural Medicine*. 2018: 52:817–829
6. Henry H, Howarth ML. An overview of using an asset-based approach to nursing. *General Practice Nursing*. 2018: 4: (4) pp. 61-66.
7. Bickerdike L, Booth A, Wilson PM, Farley K, Wight K. Social prescribing: Less rhetoric and more reality. A systematic review of the evidence. *BMJ Open*. 2017: 7 (4): 1-17
8. Croft, B. Self-direction and the Social Determinants of Health. *Community Ment Health J*(2020). <https://doi.org/10.1007/s10597-020-00597-5>
9. Howard
10. Soga M, Gaston KJ, Yamaura Y. Gardening is beneficial for health: A meta-analysis. *Preventative Medicine Reports*. 2017: 92-99.
11. Collins C C, O’Callaghan, AM. The Impact Of Horticultural Responsibility On Health Indicators And Quality Of Life In Assisted Living. *Horttechnology*. 2008: 18: 611–618
12. Wiskerke J. S. C. and Viljoen, A. (2012) ‘Sustainable Urban Food Provisioning: Challenges for Scientists, Policymakers, Planners and Designers’, in: Viljoen, A. and Wiskerke J. S. C. (Eds.) *Sustainable Food Planning: Evolving Theory and Practice*, Wageningen: Wageningen Academic Publishers.
13. Hardman, M. and Larkham, P.J. (2014) *Informal Urban Agriculture*, Berlin: Springer.
14. Holland, L. (2004) Diversity and Connections in Community Gardens: A Contribution to Local Sustainability, *Local Environment: The International Journal of Justice and Sustainability*, 9 (3): 285 – 305.
15. Munn, Z., Peters, M.D.J., Stern, C. *et al*. Systematic review or scoping review? Guidance for authors when choosing between a systematic or scoping review approach. *BMC Med Res Methodol*. 2018: 18, 143 doi:10.1186/s12874-018-0611-x
16. Arksey H, O’Malley L: Scoping studies: Towards a Methodological Framework. *Int J Soc Res Methodol*. 2005, 8: 19-32. 10.1080/1364557032000119616.
17. Midlands and Lancashire Commissioning Support Unit (nd) Using Logic Models [Online] Available At: <Https://Midlandsandlancashirecsu.Nhs.Uk/News-Insight/Press-Releases/236-Using-Logic-Models> [Accessed 1 September 2017]
18. Levac, D., Colquhoun, H. & O’Brien, K.K. Scoping studies: advancing the methodology. *Implementation Sci* 2010: 5, 69 doi:10.1186/1748-5908-5-69
19. Daudt, H.M., van Mossel, C. & Scott, S.J. Enhancing the scoping study methodology: a large, inter-professional team’s experience with Arksey and O’Malley’s framework. *BMC Med Res Methodol*. 2013: 13, 48 doi:10.1186/1471-2288-13-48
20. Buck D. *Gardens and Health: Implications for Policy and Practice*. 2016: Kings Fund: London.
21. Craig P, Diepe P, Macintyre S, Michie S, Nazareth I, Petticrew M. *Medical Research Council (MRC) Developing and Evaluating Complex Interventions*. 2006: MRC: London.
22. Muir Gray JA. *Evidence-based Healthcare. How to make Health Policy and Management Decisions*. 2001: 2nd Ed. Churchill-Livingstone.

- 1
 - 2
 - 3
 - 4
 - 5
 - 6
 - 7
 - 8
 - 9
 - 10
 - 11
 - 12
 - 13
 - 14
 - 15
 - 16
 - 17
 - 18
 - 19
 - 20
 - 21
 - 22
 - 23
 - 24
 - 25
 - 26
 - 27
 - 28
 - 29
 - 30
 - 31
 - 32
 - 33
 - 34
 - 35
 - 36
 - 37
 - 38
 - 39
 - 40
 - 41
 - 42
 - 43
 - 44
 - 45
 - 46
 - 47
 - 48
 - 49
 - 50
 - 51
 - 52
 - 53
 - 54
 - 55
 - 56
 - 57
 - 58
 - 59
 - 60
23. *PLoS Medicine* (OPEN ACCESS) Moher D, Liberati A, Tetzlaff J, Altman DG, The PRISMA Group (2009). *Preferred Reporting Items for Systematic Reviews and Meta-Analyses: The PRISMA Statement*. *PLoS Med* 6(7): e1000097. doi:10.1371/journal.pmed1000097
24. Christian MS, Evans CEL, Cade JE. Public Health Research. Does the Royal Horticultural Society Campaign for School Gardening increase intake of fruit and vegetables in children? Results from two randomised controlled trials. Southampton (UK): NIHR Journals Library*.
25. Detweiler MB, Self JA, Lane S, Spencer L, Lutgens B, Kim DY, et al. 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*. 2015;21(4):36-41.*
26. Jarrott SE, Gigliotti CM. Comparing responses to horticultural-based and traditional activities in dementia care programs. *American Journal of Alzheimer's Disease & Other Dementias*. 2010;25(8):657-65.*
27. Van Den Berg AE, Custers MHG. Gardening Promotes Neuroendocrine and Affective Restoration from Stress. *Journal of Health Psychology*. 2011;16(1):3-11.*
28. Gatto NM, Martinez LC, Spruijt-Metz D, Davis JN. LA sprouts randomized controlled nutrition, cooking and gardening programme reduces obesity and metabolic risk in Hispanic/Latino youth. *Paediatric Obesity*. 2017;12(1):28-37.*
29. Kam MCY, Siu AMH. Evaluation of a horticultural activity programme for persons with psychiatric illness. *Hong Kong Journal of Occupational Therapy*. 2010;20(2):80-6.*
30. Bail JR, Frugé AD, Cases MG, De Los Santos JF, Locher JL, Smith KP, et al. A home-based mentored vegetable gardening intervention demonstrates feasibility and improvements in physical activity and performance among breast cancer survivors. *Cancer* (0008543X). 2018;124(16):3427-35*.
31. Lai CKY, Kwan RYC, Lo SKL, Fung CYY, Lau JKH, Tse MMY. Effects of Horticulture on Frail and Prefrail Nursing Home Residents: A Randomized Controlled Trial. *Journal of the American Medical Directors Association*. 2018;19(8):696-702.*
32. Cipriani J, Benz A, Holmgren A, Kinter D, McGarry J, Rufino G. A Systematic Review of the Effects of Horticultural Therapy on Persons with Mental Health Conditions. *Occupational Therapy in Mental Health*. 2017;33(1):47-69.*
33. Genter C, Roberts A, Richardson J, Sheaff M. The contribution of allotment gardening to health and wellbeing: A systematic review of the literature. *British Journal of Occupational Therapy*. 2015;78(10):593-605.*
34. Ohly H, Gentry S, Wigglesworth R. A systematic review of the health and well-being impacts of school gardening : synthesis of quantitative and qualitative evidence. *BMC Public Health*. 2016;16(286).*
35. Stern C, Munn Z. Physical Leisure Activities and their Role in Preventing Dementia: A Systematic Review. *Int J Evid Based Healthc*. 2010; 8(1):2-17. doi: 10.1111/j.1744-1609.2010.00150.x 7.:260-308.*
36. Wang D, MacMillan T. The Benefits of Gardening for Older Adults: A Systematic Review of the Literature. *Activities, Adaptation and Aging*. 2013;37(2):153-81.*
37. Whear R, Coon JT, Bethel A, Abbott R, Stein K, Garside R. What Is the Impact of Using Outdoor Spaces Such as Gardens on the Physical and Mental Well-Being of Those With Dementia? A Systematic Review of Quantitative and Qualitative Evidence. *Journal of the American Medical Directors Association*. 2014;15(10):697-705.*
38. Savoie-Roskos MR, Wengreen H, Durward C. Increasing Fruit and Vegetable Intake among Children and Youth through Gardening-Based Interventions: A Systematic Review. *Journal of the Academy of Nutrition & Dietetics*. 2017;117(2):240-50.*
39. Annerstedt M, Währborg P. Nature-assisted therapy: Systematic review of controlled and observational studies. *Scandinavian Journal of Public Health*. 2011;39(4):371-88*.
40. Kamioka H, Tsutani K, Yamada M, Park H, Okuizumi H, Honda T, et al. Effectiveness of horticultural therapy: a systematic review of randomized controlled trials. *Complementary Therapies in Medicine*. 2014;22(5):930-43.*
41. Masset E, Haddad L, Cornelius A, Isaza-Castro J. Effectiveness of agricultural interventions that aim to improve nutritional status of children: systematic review. *BMJ* (Clinical research ed). 2012;344:d8222.*

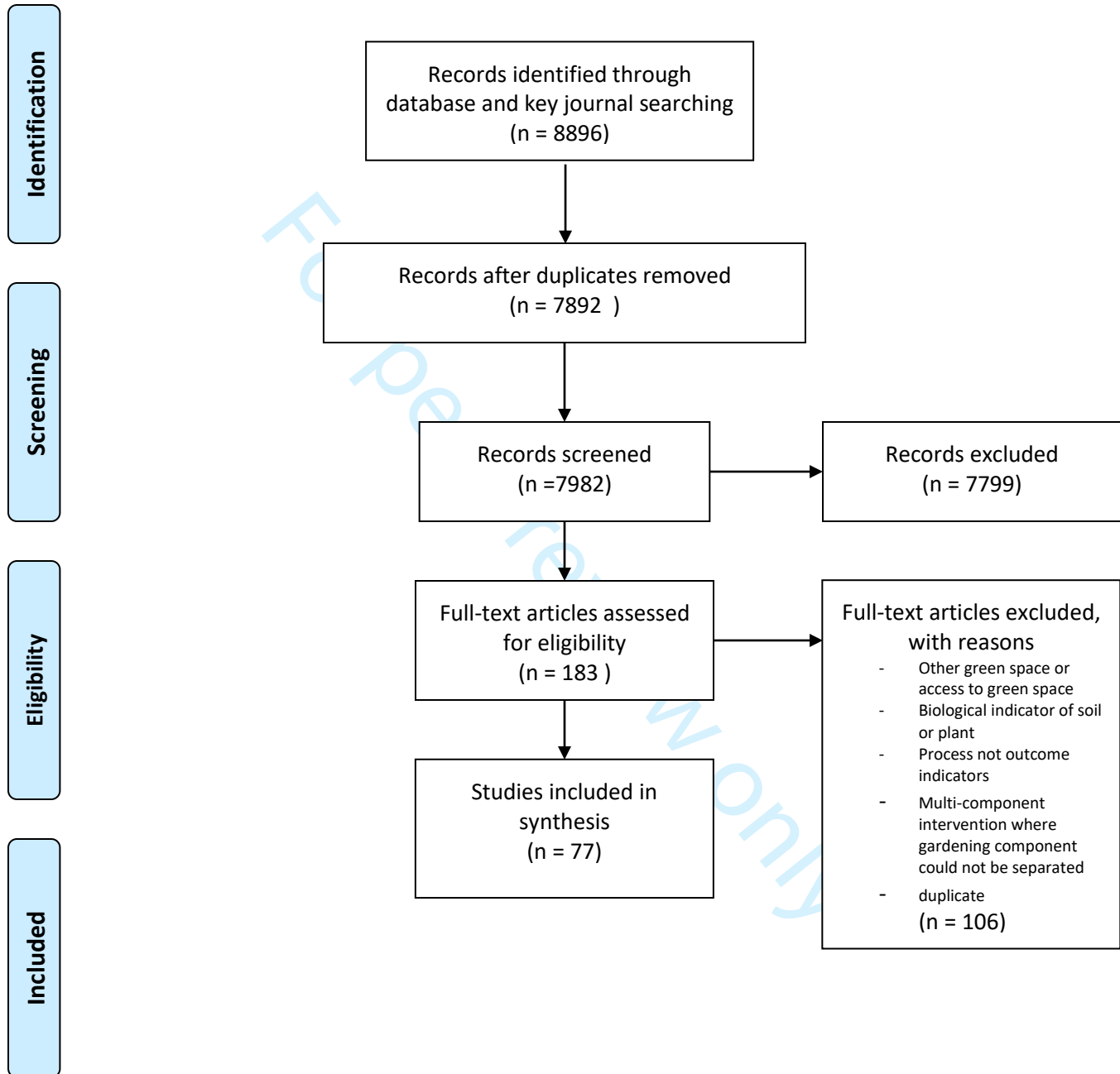
42. Garcia MT, Ribeiro SM, Germani ACCG, Bogus CM. The impact of urban gardens on adequate and healthy food: a systematic review. *Public Health Nutrition*. 2018;21(2):416-25. *
43. Kunpeuk W, Spence W, Phulkerd S, Suphanchaimat R, Pitayarangsarit S. The impact of gardening on nutrition and physical health outcomes: a systematic review and meta-analysis. *Health Promotion International*. 2019. *
44. Nicholas SO, Giang AT, Yap PLK. The Effectiveness of Horticultural Therapy on Older Adults: A Systematic Review. *Journal of the American Medical Directors Association*. 2019;20(10):1351. *
45. Joyce J, Warren A. A Case Study Exploring the Influence of a Gardening Therapy Group on Well-Being. *Occupational Therapy in Mental Health*. 2016;32(2):203-15. *
46. Wood CJ, Pretty J, Griffin M. A case-control study of the health and well-being benefits of allotment gardening. *Journal of Public Health*. 2016;38(3):e336-e44. *
47. Hawkins JL, Thirlaway KJ, Backx K, Clayton DA. Allotment Gardening and Other Leisure Activities for Stress Reduction and Healthy Aging. *Horttechnology*. 2011;21(5):577-85. *
48. Hawkins JL, Smith A, Backx K, Clayton DA. Exercise intensities of gardening tasks within older adult allotment gardeners in Wales. *Journal of Aging and Physical Activity*. 2015;23(2):161-8. *
49. Milligan C, Gatrell A, Bingley A. Cultivating health': therapeutic landscapes and older people in northern England. *Social Science & Medicine*. 2004;58(9):1781-93. *
50. Soga M, Cox DTC, Yamaura Y, Gaston KJ, Kurisu K, Hanaki K. Health Benefits of Urban Allotment Gardening: Improved Physical and Psychological Well-Being and Social Integration. *International Journal of Environmental Research and Public Health*. 2017;14(1). *
51. Dewi NS, Komatsuzaki M, Yamakawa Y, Takahashi H, Shibamura S, Yasue T, et al. Community Gardens as Health Promoters: Effects on Mental and Physical Stress Levels in Adults with and without Mental Disabilities. *Sustainability*. 2017;9(1). *
52. Zick CD, Smith KR, Kowaleski-Jones L, Uno C, Merrill BJ. Harvesting more than vegetables: The potential weight control benefits of community gardening. *American Journal of Public Health*. 2013;103(6):1110-5. *
53. Harris N, Minniss FR, Somerset S. Refugees connecting with a new country through community food gardening. *International Journal of Environmental Research and Public Health*. 2014;11(9):9202-16. *
54. Eriksson T, Westerberg Y, Jonsson H. Experiences of women with stress-related ill health in a therapeutic gardening program. *Canadian Journal of Occupational Therapy*. 2011;78(5):273-81. *
55. Lanier J, Schumacher J, Calvert K. Cultivating Community Collaboration and Community Health Through Community Gardens. *Journal of Community Practice*. 2015;23(3-4):492-507. *
56. Austin EN, Johnston YAM, Morgan LL. Community gardening in a senior center: a therapeutic intervention to improve the health of older adults. *Therapeutic Recreation Journal*. 2006;40(1):48-57. *
57. D'Andrea SJ, Batavia M, Sasson N. Effect of Horticultural Therapy on Preventing the Decline of Mental Abilities of Patients with Alzheimer's Type Dementia. *Journal of Therapeutic Horticulture*. 2007;18. *
58. Al-Delaimy WK, Webb M. Community Gardens as Environmental Health Interventions: Benefits Versus Potential Risks. *Curr Environ Health Rep*. 2017;4(2):252-65. *
59. Liu Y, Bo L, Sampson S, Roberts S, Zhang G, Wu W. Horticultural therapy for schizophrenia. *Cochrane Database of Systematic Reviews*. 2014(5):N.PAG-N.PAG. *
60. Kim MY, Kim GS, Mattson NS, Kim WS. Effects of Horticultural Occupational Therapy on the Physical and Psychological Rehabilitation of Patients with Hemiplegia after Stroke. *Korean Journal of Horticultural Science & Technology*. 2010;28(5):884-90. *
61. McCaffrey R, Liehr P. The Effect of Reflective Garden Walking on Adults with Increased Levels of Psychological Stress. *Journal of Holistic Nursing*. 2016;34(2):177-84. *
62. Gonzalez MT, Hartig T, Patil GG, Martinsen EW, Kirkevold M. Therapeutic horticulture in clinical depression: a prospective study. *Research & Theory for Nursing Practice*. 2009;23(4):312-28. *
63. Lai CK-Y, Lau CK-Y, Kan WY, Lam WM, Fung CYY. The effect of horticultural therapy on the quality of life of palliative care patients. *Journal of Psychosocial Oncology*. 2017;35(3):278-91. *
64. Farrier A, Baybutt M, Dooris M. Mental health and wellbeing benefits from a prisons horticultural programme. *International Journal of Prisoner Health*. 2019;15(1):91-104. *
65. Han A-R, Park S-A, Ahn B-E. Reduced stress and improved physical functional ability in elderly with mental health problems following a horticultural therapy program. *Complementary Therapies in Medicine*. 2018; 38:19-23. *

- 1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21
22
23
24
25
26
27
28
29
30
31
32
33
34
35
36
37
38
39
40
41
42
43
44
45
46
47
48
49
50
51
52
53
54
55
56
57
58
59
60
66. Lu L-C, Lan S-H, Hsieh Y-P, Yen Y-Y, Chen J-C, Lan S-J. Horticultural Therapy in Patients With Dementia: A Systematic Review and Meta-Analysis. *American Journal of Alzheimer's Disease and other Dementias*. 2019;1533317519883498.*
 67. Oh Y-A, Park S-A, Ahn B-E. Assessment of the psychopathological effects of a horticultural therapy program in patients with schizophrenia. *Complementary Therapies in Medicine*. 2018;36:54-8.*
 68. Clatworthy J, Hinds J, Camic PM. Gardening as a mental health intervention: A review. *Mental Health Review Journal*. 2013;18(4):214-25.*
 69. Robinson-O'Brien R, Story M, Heim S. Impact of Garden-Based Youth Nutrition Intervention Programs: A Review. *Journal of the American Dietetic Association*. 2009;109(2):273-80.*
 70. Hartwig KA, Mason M. Community Gardens for Refugee and Immigrant Communities as a Means of Health Promotion. *Journal of Community Health*. 2016;41(6):1153-9.*
 71. Masuya J, Ota K, Mashida Y. 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*. 2014.*
 72. Jarrott SE, Kwack HR, Relf D. An observational assessment of a dementia-specific horticultural therapy program. *Horttechnology*. 2002;12(3):403-10.*
 73. Luk KY, Lai KY, Li CC, Cheung WH, Lam SM, Li HY, et al. The effect of horticultural activities on agitation in nursing home residents with dementia. *Int J Geriatr Psychiatry*. 2011;26(4):435-6.*
 74. McCaffrey R, Hanson C, McCaffrey W. Garden walking for depression: a research report. *Holistic Nursing Practice*. 2010;24(5):252-9.*
 75. Rodiek S. Influence of an outdoor garden on mood and stress in older persons. *Journal of Therapeutic Horticulture*. 2002;13:13-21.*
 76. Nicklett EJ, Anderson LA, Yen IH. Gardening Activities and Physical Health Among Older Adults: A Review of the Evidence. *Journal of Applied Gerontology*. 2016;35(6):678-90.*
 77. Hewitt P, Watts C, Hussey J, Power K, Williams T. Does a structured gardening programme improve well-being in young-onset dementia? A preliminary study. *British Journal of Occupational Therapy*. 2013;76(8):355-61.*
 78. Edwards CA, McDonnell C, Merl H. An evaluation of a therapeutic garden's influence on the quality of life of aged care residents with dementia. *Dementia-International Journal of Social Research and Practice*. 2013;12(4):494-510.*
 79. Swank JM, Shin SM. Garden Counselling Groups and Self-Esteem: A Mixed Methods Study With Children With Emotional and Behavioral Problems. *Journal for Specialists in Group Work*. 2015;40(3):315-31.*
 80. Dunnett N, Qasim M. Perceived benefits to human well-being of urban gardens. *HortTechnology*. 2000;10(1):40-5.*
 81. Korpela K, De Bloom J, Sianoja M, Pasanen T, Kinnunen U. Nature at home and at work: Naturally good? Links between window views, indoor plants, outdoor activities and employee well-being over one year. *Landscape & Urban Planning*. 2017;160: 38-47.*
 82. Heim S, Bauer KW, Stang J, Ireland M. Can a community-based intervention improve the home food environment? Parental perspectives of the influence of the Delicious and Nutritious Garden. *Journal of Nutrition Education and Behavior*. 2011;43(2):130-4.*
 83. Matsunaga K, Park B-J, Kobayashi H, Miyazaki Y. Physiologically Relaxing Effect of a Hospital Rooftop Forest on Older Women Requiring Care. *Journal of the American Geriatrics Society*. 2011;59(11):2162-3.*
 84. Bragg R, Atkins, G. A review of nature-based interventions for mental health care. 2016. Report No.: 204*.
 85. Heliker D, Chadwick A, O'Connell T. The meaning of gardening and the effects on perceived well being of a gardening project on diverse populations of elders. *Activities, Adaptation & Aging*. 2000;24(3):35-56.*
 86. Lee Y, Kim S. Effects of indoor gardening on sleep, agitation, and cognition in dementia patients - a pilot study. *International Journal of Geriatric Psychiatry*. 2008;23(5):485-9.*
 87. Sempik J, Rickhuss C, Beeston A. The effects of social and therapeutic horticulture on aspects of social behaviour. *British Journal of Occupational Therapy*. 2014;77(6):313-9.*

- 1
- 2
- 3
- 4 88. Scott TL, Masser BM, Pachana NA. Exploring the health and wellbeing benefits of gardening for older
- 5 adults. *Ageing & Society*. 2015;35(10):2176-200. *
- 6 89. Park SA, Lee AY, Park HG, Son KC, Kim DS, Lee WL. Gardening Intervention as a Low- to Moderate-
- 7 Intensity Physical Activity for Improving Blood Lipid Profiles, Blood Pressure, Inflammation, and
- 8 Oxidative Stress in Women over the Age of 70: A Pilot Study. *Hortscience*. 2017;52(1):200-5. *
- 9 90. Mills T, Lawton R, Sheard L. Advancing complexity science in healthcare research: the logic of logic
- 10 models. *BMC Med Res Methodol* 2019: 19, 55 doi:10.1186/s12874-019-0701-4
- 11 91. Masuya J, Ota K. Efficacy of horticultural activity in elderly people with dementia: A pilot study on the
- 12 influence on vitality and cognitive function. *International Journal of Nursing & Clinical Practices*. 2014.
- 13 *
- 14 92. Li WW, Hodgetts D, Ho E. Gardens, Transitions and Identity Reconstruction among Older Chinese
- 15 Immigrants to New Zealand. *Journal of Health Psychology*. 2010;15(5):786-96. *
- 16 93. Hernandez RO. Effects of Therapeutic Gardens in Special Care Units for People with Dementia: Two
- 17 Case Studies. *Journal of Housing for the Elderly*. 2007;21(1-2):117-52. *
- 18 94. Jeong M-H, Lee I-S, Chung Y-M, Jeong S-J, Youn C-H, Cho H-G, et al. Effect of Horticultural Therapy on
- 19 Improvement of Mental Health and Social Adaptability of Schizoid of the Open Ward. *Korean Journal*
- 20 *of Horticultural Science and Technology*. 2004;22(4):499-503. *
- 21 95. Kohlleppe T, Bradley JC, Jacob S. A walk through the garden: Can a visit to a botanic garden reduce
- 22 stress? *HortTechnology*. 2002;12(3):489-92. *
- 23 96. Ga L, Gupta A. Gardening increases vegetable consumption in school-aged children: A meta-analytical
- 24 synthesis. *HortTechnology*. 2012;22:430-45. *
- 25 97. Leng CH, Wang J-D. Daily home gardening improved survival for older people with mobility
- 26 limitations: an 11-year follow-up study in Taiwan. *Clinical interventions in Aging*. 2016;11:947-59. *
- 27 98. Li WW, Hodgetts D, Ho E. Gardens, Transitions and Identity Reconstruction among Older Chinese
- 28 Immigrants to New Zealand. *Journal of Health Psychology*. 2010;15(5):786-96. *
- 29 99. M S, KJ G, Y Y. Gardening is beneficial for health: A meta-analysis. *Preventive Medicine Reports*.
- 30 2017;5:92-9. *
- 31 100. Kohlleppe T, Bradley JC, Jacob S. A walk through the garden: Can a visit to a botanic garden reduce
- 32 stress? *HortTechnology*. 2002;12(3):489-92. *
- 33 101. McCaffrey R. The effect of healing gardens and art therapy on older adults with mild to moderate
- 34 depression. *Holistic Nursing Practice*. 2007;21(2):79-84. *
- 35 102. Rohwer ., Pfenhauer L, Burns J. et al. *Logic models help make sense of complexity in systematic*
- 36 *reviews and health technology assessments*. *Journal of Clinical Epidemiology*. 2017: 83. pp. 37-47. ISSN
- 37 1878-5921
- 38 103. Tennant R, Hiller L, Fishwick R, Platt S, Joseph S, Weich S, Parkinson J, Secker J, Stewart-Brown S. The
- 39 Warwick-Edinburgh Mental Well-being Scale (WEMWBS): Development and UK validation. *Health and*
- 40 *Quality of Life Outcomes*. 2007: 5. 63. <https://doi.org/10.1186/1477-7525-5-63>
- 41 104. Aked J, Marks N, Cordon C, Thompson S. Five Ways to Wellbeing: A report presented to the Foresight
- 42 Project on communicating the evidence base for improving people's well-being. 2008: London: New
- 43 Economics Foundation.
- 44 105. Dodge R, Daly A, Huyton J, Sanders L. *The challenge of defining wellbeing*. *International Journal of*
- 45 *Wellbeing*. 2012: 2(3), 222-235.
- 46 106. Howarth, ML, Lister, C. Social prescribing in cardiology: rediscovering the nature of and within us. *British*
- 47 *Journal of Cardiac Nursing*. 2019: 14 (8) 1-9.
- 48 107. Cook PA, Howarth M, Wheeler CP. Biodiversity and Health in the Face of Climate Change:
- 49 Implications for Public Health. In: Marselle M, Stadler J, Korn H, Irvine K, Bonn A. (eds) *Biodiversity*
- 50 *and Health in the Face of Climate Change*. 2019: Springer Press.
- 51 108. Hajek A, Bock JO, König HH. Association of general psychological factors with frequent attendance in
- 52 primary care: a population-based cross-sectional observational study. *BMC Family Practice*. 2017; 18
- 53 (1) 48.
- 54 109. Pettigrew M, Cummin S, Ferrell C, Findlay A, Higgins C, Hoy C, Kearns A, Sparks L. Natural Experiments:
- 55 an underused tool for public health? *Public Health*. 2005: 119, 751-757.
- 56
- 57
- 58
- 59
- 60



Figure 1: PRISMA 2009 Flow Diagram

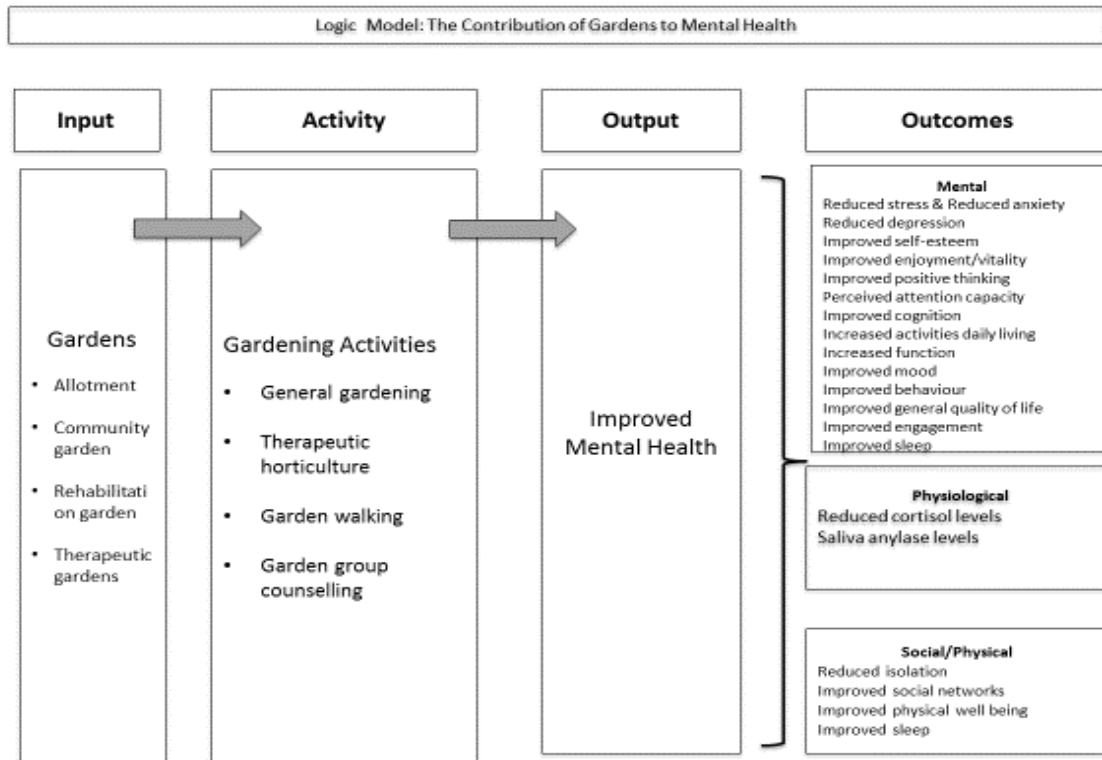


From: Moher D, Liberati A, Tetzlaff J, Altman DG, The PRISMA Group (2009). Preferred Reporting Items for Systematic Reviews and Meta-Analyses: The PRISMA Statement. PLoS Med 6(7): e1000097. doi:10.1371/journal.pmed1000097

For more information, visit www.prisma-statement.org.

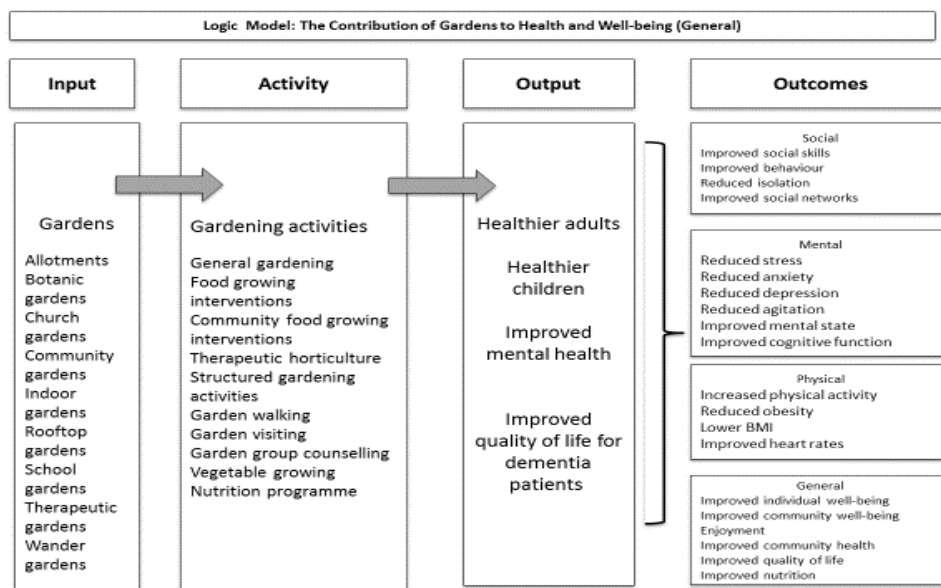
For peer review only - <http://bmjopen.bmj.com/site/about/guidelines.xhtml>

Figure 2: Logic Model: Mental Health



review only

Figure 3: Logic Model: Wellbeing.



Peer review only

Appendix 1

SAMPLE SEARCH STRATEGY**Medline**

Database: Ovid MEDLINE(R) 1946 to Present with Daily Update

Search Strategy:

-
- 1 Gardens/ (29)
 - 2 Gardening/ (745)
 - 3 Horticultural Therapy/ (32)
 - 4 Parks, Recreational/ (311)
 - 5 "Conservation of Natural Resources"/ (33544)
 - 6 Nature/ (755)
 - 7 garden*.mp. [mp=title, abstract, original title, name of substance word, subject heading word, keyword heading word, protocol supplementary concept word, rare disease supplementary concept word, unique identifier, synonyms] (8344)
 - 8 horticultur*.mp. [mp=title, abstract, original title, name of substance word, subject heading word, keyword heading word, protocol supplementary concept word, rare disease supplementary concept word, unique identifier, synonyms] (1641)
 - 9 green care.mp. [mp=title, abstract, original title, name of substance word, subject heading word, keyword heading word, protocol supplementary concept word, rare disease supplementary concept word, unique identifier, synonyms] (21)
 - 10 social prescrib*.mp. [mp=title, abstract, original title, name of substance word, subject heading word, keyword heading word, protocol supplementary concept word, rare disease supplementary concept word, unique identifier, synonyms] (17)
 - 11 (green space* or greenspace*).mp. [mp=title, abstract, original title, name of substance word, subject heading word, keyword heading word, protocol supplementary concept word, rare disease supplementary concept word, unique identifier, synonyms] (509)
 - 12 allotment*.mp. [mp=title, abstract, original title, name of substance word, subject heading word, keyword heading word, protocol supplementary concept word, rare disease supplementary concept word, unique identifier, synonyms] (448)
 - 13 ecotherap*.mp. [mp=title, abstract, original title, name of substance word, subject heading word, keyword heading word, protocol supplementary concept word, rare disease supplementary concept word, unique identifier, synonyms] (4)
 - 14 (plant* adj5 (garden* or shrub* or tree* or flower* or seed* or vegetable* or grass* or landscap* or lawn* or fruit* or cultivat*)).mp. [mp=title, abstract, original title, name of substance word, subject heading word, keyword heading word, protocol supplementary concept word, rare disease supplementary concept word, unique identifier, synonyms] (11776)
 - 15 or/1-14 (56079)
 - 16 Treatment Outcome/ (814853)
 - 17 "Outcome Assessment (Health Care)"/ (61518)

1
2
3
4 18 "Outcome and Process Assessment (Health Care)"/ (24767)
5 19 outcome assessment*.mp. [mp=title, abstract, original title, name of substance word, subject
6 heading word, keyword heading word, protocol supplementary concept word, rare disease
7 supplementary concept word, unique identifier, synonyms] (67872)
8
9 20 outcome measure*.mp. [mp=title, abstract, original title, name of substance word, subject
10 heading word, keyword heading word, protocol supplementary concept word, rare disease
11 supplementary concept word, unique identifier, synonyms] (169480)
12
13 21 exp Health Status/ (275273)
14
15 22 exp "Quality of Life"/ (154742)
16
17 23 Health Impact Assessment/ (388)
18
19 24 (well-being or wellbeing or "well being").mp. [mp=title, abstract, original title, name of substance
20 word, subject heading word, keyword heading word, protocol supplementary concept word, rare
21 disease supplementary concept word, unique identifier, synonyms] (55554)
22
23 25 (health* or wellness or mental health or mental* ill* or mental disorder* or quality of life or anxiet*
24 or anxious* or depress* or stress* or dementia or cardiovascular or myocardial infarction* or heart
25 attack* or stroke* or obesity or obese or overweight or learning disabilit* or learning disorder* or
26 outcome*).m_titl. (1454724)
27
28 26 exp Mental Health/ (29216)
29
30 27 exp Mental Disorders/ (1108313)
31
32 28 exp Depression/ (97090)
33
34 29 Anxiety/ (67031)
35
36 30 Stress, Psychological/ (104840)
37
38 31 exp Dementia/ (141332)
39
40 32 exp Cardiovascular Diseases/ (2171727)
41
42 33 Myocardial Infarction/ (159184)
43
44 34 exp Stroke/ (108360)
45
46 35 exp Obesity/ (176865)
47
48 36 exp Learning Disorders/ (22851)
49
50 37 or/16-36 (5055713)
51
52 38 exp Empirical Research/ (37340)
53
54 39 exp Research Design/ (398278)
55
56 40 exp Qualitative Research/ (33967)
57
58 41 exp epidemiologic studies/ (2076068)
59
60 42 or/38-41 (2437850)
43 15 and 37 and 42 (525)
44 15 and 37 (3842)
45 limit 44 to (meta analysis or "review" or systematic reviews) (497)
46 limit 44 to "reviews (maximizes sensitivity)" (1175)
47 43 or 45 or 46 (1476)

- 1
- 2
- 3
- 4 48 (review or synthesis or trial or meta-analysis or evaluation or cohort study or case control or
- 5 survey or qualitative or research).m_titl. (1399375)
- 6
- 7 49 15 and 37 and 48 (284)
- 8
- 9 50 47 or 49 (1594)
- 10
- 11 51 limit 50 to (english language and yr="1990 -Current") (1460)

12 Strategies for remaining databases available on request

13

14

15

16

17

18

19

20

21

22

23

24

25

26

27

28

29

30

31

32

33

34

35

36

37

38

39

40

41

42

43

44

45

46

47

48

49

50

51

52

53

54

55

56

57

58

59

60

For peer review only

Preferred Reporting Items for Systematic reviews and Meta-Analyses extension for Scoping Reviews (PRISMA-ScR) Checklist

SECTION	ITEM	PRISMA-ScR CHECKLIST ITEM	REPORTED ON PAGE #
TITLE			
Title	1	Identify the report as a scoping review.	1
ABSTRACT			
Structured summary	2	Provide a structured summary that includes (as applicable): background, objectives, eligibility criteria, sources of evidence, charting methods, results, and conclusions that relate to the review questions and objectives.	2
INTRODUCTION			
Rationale	3	Describe the rationale for the review in the context of what is already known. Explain why the review questions/objectives lend themselves to a scoping review approach.	3
Objectives	4	Provide an explicit statement of the questions and objectives being addressed with reference to their key elements (e.g., population or participants, concepts, and context) or other relevant key elements used to conceptualize the review questions and/or objectives.	3
METHODS			
Protocol and registration	5	Indicate whether a review protocol exists; state if and where it can be accessed (e.g., a Web address); and if available, provide registration information, including the registration number.	4
Eligibility criteria	6	Specify characteristics of the sources of evidence used as eligibility criteria (e.g., years considered, language, and publication status), and provide a rationale.	4,5
Information sources*	7	Describe all information sources in the search (e.g., databases with dates of coverage and contact with authors to identify additional sources), as well as the date the most recent search was executed.	5
Search	8	Present the full electronic search strategy for at least 1 database, including any limits used, such that it could be repeated.	appendix
Selection of sources of evidence†	9	State the process for selecting sources of evidence (i.e., screening and eligibility) included in the scoping review.	5
Data charting process‡	10	Describe the methods of charting data from the included sources of evidence (e.g., calibrated forms or forms that have been tested by the team before their use, and whether data charting was done independently or in duplicate) and any processes for obtaining and confirming data from investigators.	5
Data items	11	List and define all variables for which data were sought and any assumptions and simplifications made.	4
Critical appraisal of individual sources of evidence§	12	If done, provide a rationale for conducting a critical appraisal of included sources of evidence; describe the methods used and how this information was used in any data synthesis (if appropriate).	NA



SECTION	ITEM	PRISMA-ScR CHECKLIST ITEM	REPORTED ON PAGE #
Synthesis of results	13	Describe the methods of handling and summarizing the data that were charted.	7-21
RESULTS			
Selection of sources of evidence	14	Give numbers of sources of evidence screened, assessed for eligibility, and included in the review, with reasons for exclusions at each stage, ideally using a flow diagram.	5
Characteristics of sources of evidence	15	For each source of evidence, present characteristics for which data were charted and provide the citations.	6, 22, 23
Critical appraisal within sources of evidence	16	If done, present data on critical appraisal of included sources of evidence (see item 12).	NA
Results of individual sources of evidence	17	For each included source of evidence, present the relevant data that were charted that relate to the review questions and objectives.	7-21
Synthesis of results	18	Summarize and/or present the charting results as they relate to the review questions and objectives.	6, 22, 23
DISCUSSION			
Summary of evidence	19	Summarize the main results (including an overview of concepts, themes, and types of evidence available), link to the review questions and objectives, and consider the relevance to key groups.	23, 24 25
Limitations	20	Discuss the limitations of the scoping review process.	24
Conclusions	21	Provide a general interpretation of the results with respect to the review questions and objectives, as well as potential implications and/or next steps.	24
FUNDING			
Funding	22	Describe sources of funding for the included sources of evidence, as well as sources of funding for the scoping review. Describe the role of the funders of the scoping review.	825

JBI = Joanna Briggs Institute; PRISMA-ScR = Preferred Reporting Items for Systematic reviews and Meta-Analyses extension for Scoping Reviews.

* Where *sources of evidence* (see second footnote) are compiled from, such as bibliographic databases, social media platforms, and Web sites.

† A more inclusive/heterogeneous term used to account for the different types of evidence or data sources (e.g., quantitative and/or qualitative research, expert opinion, and policy documents) that may be eligible in a scoping review as opposed to only studies. This is not to be confused with *information sources* (see first footnote).

‡ The frameworks by Arksey and O'Malley (6) and Levac and colleagues (7) and the JBI guidance (4, 5) refer to the process of data extraction in a scoping review as data charting.

§ The process of systematically examining research evidence to assess its validity, results, and relevance before using it to inform a decision. This term is used for items 12 and 19 instead of "risk of bias" (which is more applicable to systematic reviews of interventions) to include and acknowledge the various sources of evidence that may be used in a scoping review (e.g., quantitative and/or qualitative research, expert opinion, and policy document).

From: Tricco AC, Lillie E, Zarin W, O'Brien KK, Colquhoun H, Levac D, et al. PRISMA Extension for Scoping Reviews (PRISMA-ScR): Checklist and Explanation. *Ann Intern Med.* 2018;169:467–473. doi: 10.7326/M18-0850.



BMJ Open

What Is the Evidence for the Impact of Gardens and Gardening on Health and Wellbeing: A Scoping Review and Evidence-Based Logic Model to Guide Healthcare Strategy Decision Making on the use of Gardening Approaches as a Social Prescription. .

Journal:	<i>BMJ Open</i>
Manuscript ID	bmjopen-2020-036923.R2
Article Type:	Original research
Date Submitted by the Author:	20-May-2020
Complete List of Authors:	Howarth, Michelle; University of Salford, ; University of Salford Brettle, Alison; University of Salford, School of Health and Society Hardman, Michael; University of Salford, School of Science, Engineering & Environment Maden, Michelle; University of Liverpool, Department of Health Services Research
Primary Subject Heading:	Public health
Secondary Subject Heading:	General practice / Family practice, Health services research, Patient-centred medicine
Keywords:	SOCIAL MEDICINE, PUBLIC HEALTH, PRIMARY CARE

SCHOLARONE™
Manuscripts



I, the Submitting Author has the right to grant and does grant on behalf of all authors of the Work (as defined in the below author licence), an exclusive licence and/or a non-exclusive licence for contributions from authors who are: i) UK Crown employees; ii) where BMJ has agreed a CC-BY licence shall apply, and/or iii) in accordance with the terms applicable for US Federal Government officers or employees acting as part of their official duties; on a worldwide, perpetual, irrevocable, royalty-free basis to BMJ Publishing Group Ltd ("BMJ") its licensees and where the relevant Journal is co-owned by BMJ to the co-owners of the Journal, to publish the Work in this journal and any other BMJ products and to exploit all rights, as set out in our [licence](#).

The Submitting Author accepts and understands that any supply made under these terms is made by BMJ to the Submitting Author unless you are acting as an employee on behalf of your employer or a postgraduate student of an affiliated institution which is paying any applicable article publishing charge ("APC") for Open Access articles. Where the Submitting Author wishes to make the Work available on an Open Access basis (and intends to pay the relevant APC), the terms of reuse of such Open Access shall be governed by a Creative Commons licence – details of these licences and which [Creative Commons](#) licence will apply to this Work are set out in our licence referred to above.

Other than as permitted in any relevant BMJ Author's Self Archiving Policies, I confirm this Work has not been accepted for publication elsewhere, is not being considered for publication elsewhere and does not duplicate material already published. I confirm all authors consent to publication of this Work and authorise the granting of this licence.

1
2
3 **What Is the Evidence for the Impact of Gardens and Gardening on Health and Wellbeing: A**
4 **Scoping Review and Evidence-Based Logic Model to Guide Healthcare Strategy Decision**
5 **Making on the use of Gardening Approaches as a Social Prescription.**
6
7
8

9 **Author and Co-Authors.**

- 10
11 1. Dr Michelle Howarth: Senior Lecturer/ Deputy Director PGR - (training). School of Health &
12 Society. Room 1.65 Mary Seacole Building, Frederick Rd Campus Salford, M6 6PU T:
13 +44(0) 0161 295 2873. m.l.howarth2@salford.ac.uk
14
15 2. Professor Alison Brettle: Research Centre Director / CARE. 1:90 Mary Seacole, University of
16 Salford, M6 6PU T: +44(0) 0161 295 0447. A.brettle@salford.ac.uk
17
18 3. Dr Michael Hardman: Senior Lecturer in Urban Geography Programme Leader UG
19 Geography & Environmental Management School of Science, Engineering & Environment
20 G33, Peel Building, University of Salford, Manchester M5 4WT. Tel: +44(0) 0161 295
21 2201. m.hardman@salford.ac.uk
22
23 4. Dr Michelle Maden: Postdoctoral Research Associate, Evidence Synthesis | Liverpool
24 Reviews & Implementation Group. University of Liverpool. Rm 2.19. Whelan
25 Building. Liverpool. L69 3GB. Tel: 0151 795 1088 . michelle.maden@liverpool.ac.uk
26
27
28
29
30
31
32

33 **Corresponding Author:** Dr Michelle Howarth: Senior Lecturer/ Deputy Director PGR -
34 (training). School of Health & Society. Room 1.65 Mary Seacole Building, Frederick Rd Campus
35 Salford, M6 6PU T: +44(0) 0161 295 2873 /
36 m.l.howarth2@salford.ac.uk
37
38
39

40 **Keywords:** Social Medicine, Public Health, Primary Care.

41 **Wordcount:** excluding title page, references, figures and tables is 3649
42
43
44
45
46
47
48
49
50
51
52
53
54
55
56
57
58
59
60

ABSTRACT

Objective: To systematically identify and describe studies that have evaluated the impact of gardens and gardening on health and wellbeing. A secondary objective was to use this evidence to build evidence-based logic models to guide health strategy decision making about gardens and gardening as a non-medical, social prescription.

Design: Scoping review of the impact of gardens and gardening on health and wellbeing. Gardens include private spaces and those open to the public or part of hospitals, care homes, hospices or third sector organisations.

Data Sources: A range of biomedical and health management journals were searched including Medline, CINAHL, Psychinfo, Web of Knowledge, ASSIA, Cochrane, Joanna Briggs, Greenfile, Environment Complete and a number of indicative websites were searched to locate context specific data and grey literature. We searched from 1990 – November 2019.

Eligibility Criteria: We included research studies (including systematic reviews) that assessed the effect, value or impact of any garden that met the gardening definition.

Data Extraction and Synthesis: Three reviewers jointly screened 50 records by titles and abstracts to ensure calibration. Each record title was screened independently by 2 out of 3 members of the project team and each abstract was screened by 1 member of a team of 3. Random checks on abstract and full text screening were conducted by a fourth member of the team and any discrepancies were resolved through double-checking and discussion.

Results: From the 8896 papers located, a total of 77* studies were included. Over 35 validated health, wellbeing and functional biometric outcome measures were reported. Interventions ranged from viewing gardens, taking part in gardening or undertaking therapeutic activities. The findings demonstrated links between gardens and improved mental wellbeing, increased physical activity and a reduction in social isolation enabling the development of 2 logic models.

Conclusions: Gardens and gardening can improve the health and wellbeing for people with a range of health and social needs. The benefits of gardens and gardening could be used as a ‘social prescription’ globally, for people with Long Terms Conditions (LTC). Our logic models provide an evidence-based illustration that can guide health strategy decision making about the referral of people with LTC to socially prescribed, non-medical interventions involving gardens and gardening.

ARTICLE SUMMARY: ‘Strengths and limitations of this study’,

- This is the first scoping review to explicate the breadth and depth of evidence about the impact of gardens and gardening on a range of health and wellbeing outcomes.
- Gardening as a construct lacks definition leading to associated challenges with the location and curation of papers.
- Lack of a ‘standardised’ garden or gardening approach has influenced a myriad of research designs, preventing meta-analysis.
- Our paper provides robust evidence-based guidance via logic models to guide health strategy decision making.

RATIONALE:

Long term conditions (LTC’s), also referred to as chronic diseases, such as cardiovascular disease, chronic respiratory disorders and cancer remain a significant cause of death globally ¹. Contributing to these figures, mental ill-health is the largest single cause of disability worldwide representing 14% of the global population, with depression accounting for 4.3%². Socio-economic factors such as education and employment can also influence health and wellbeing and health inequalities, and can often lead to increased risk of chronic conditions³.

In the UK, the management of LTC’s are challenged by unmet social needs which are attributed to increased attendance at GP surgeries⁴. Patients with LTC’s require multipurpose, complex interventions combining inter-professional and intra-agency responses. Hence, it is predicted that LTC’s will outstrip universal health and social care service provision, forcing health care strategists to appraise the effectiveness of existing pathogenic interventions. However, the traditional medical management of people with LTC’s does not tackle their social needs leading to repeat primary care appointments and unnecessary admissions to secondary care⁵. Consequently, there is a demand to explore alternative, non-medical, salutogenic (non-pathogenic) global approaches that could empower patients with LTC’s to reduce their dependence on health and social care services ⁶.

Social prescribing is a non-medical method of care which “*links patients in primary care with sources of support within the community to help improve their health and well-being*” ⁷. This salutogenic process focuses on promoting wellbeing by referral to a range of non-medical approaches, from exercise on prescription, to arts-based activities and beyond ^{6, 7, 8, 9}. The complex relationship between health communities and its citizens is largely influenced by wider social determinants¹⁰. Place- based community organisations which invest in the community are able to respond to and support the wider social determinants of health¹⁰.

1
2
3 A popular social prescribing approach offered by place-based organisations is the use of gardens and
4 gardening as a nature-based activity to improve health and wellbeing¹¹. The use of nature as an
5 intervention is increasingly being recognised worldwide as a means of improving social, emotional,
6 mental and physiological outcomes and are of potential value for people with LTC's. In a recent meta-
7 analysis by Soga et al., the impact of gardening and gardens on a range of physical and mental health
8 outcomes was demonstrated to have positive health and wellbeing benefits¹¹. However, this meta-
9 analysis only considered a limited range of methodologies, focusing on papers that compared health
10 outcomes in control and treatment groups after participating in gardening. Typically, nature-based
11 interventions comprise a broad spectrum of interventions, activities and outcomes that include plants,
12 the natural environment and living creatures, and of interest here, is the recognition that gardening
13 supports people with LTC's¹². People with chronic conditions can engage in nature through being in
14 gardens and through gardening activities such as allotment gardening¹³ to guerrilla gardening¹⁴ and
15 community gardening¹⁵. Gardens are used to cultivate flowers, take exercise, connect with others and
16 grow food. In this article, we adopt this broad definition of gardening and evaluate the full range of
17 interventions within our scoping review. In doing so, we produce a range of logic models and results to
18 demonstrate the benefit of different forms of gardening across the globe.

19 To date, there have been no studies that have specifically explored the breadth of literature about the
20 effectiveness of gardens and gardening that could help prevent the impact of rising levels of chronic
21 disease.

22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 **REVIEW AIM & OBJECTIVES**

37 Our scoping review aimed to identify and describe the evidence base on the impact of gardens and
38 gardening on the physical, mental, health and well-being of populations. The objectives were to
39 understand the benefits of gardens, provide a map of the literature, types of gardens and health outcomes
40 and build evidence-based logic models to guide health care strategists decision to use of gardens and
41 gardening as a non-medical, social prescription. We agreed the following review question '*What
42 evidence is there on the physical, mental, health and well-being benefits of gardens?*'
43
44
45
46
47
48

49 **METHODS**

50 To address the global gap in evidence, we employed a scoping review methodology. Scoping reviews
51 provide a systematic and robust means of reviewing the breadth of evidence in a wide field and are
52 useful in synthesising the increasing arsenal of evidence, in contrast to a more traditional systematic
53 review that focuses on answering a particular question¹⁶. We employed Arksey & O'Malley's validated
54 framework to map the evidence¹⁷. This was particularly relevant as the scoping review aim was to
55 explicate the impact of gardens and gardening on diverse outcomes and populations. The resultant map
56 of the evidence was used to develop evidence-based logic models to illustrate the key health and
57
58
59
60

wellbeing outcomes as graphic tools to support clinician and commissioner decision making¹⁸. The initial scoping review framework was refined to provide an appropriate method based on the following steps^{19 20}. This involved: 1. Identifying the research question, 2. Identifying relevant studies, 3. Study selection, 4. Charting the data, 5. Collating, summarising and reporting the results. 6. Consultation. Stages 1-4 were conducted iteratively. Stage 5 was undertaken following stages 1-4 and stage 6 (consultation) occurred throughout the lifetime of the review between our research team and our external national stakeholder. Tables 1 & 2 detail the databases and journals searched.

Table 1: Databases Searched.

Database name
Medline
Cinahl
Psychinfo
Web of Knowledge/Science
Scopus
HMIC
Science Direct
Social Care Online
ASSIA
Cochrane Database of Promoting Health Effectiveness Reviews
Joanna Briggs Systematic Reviews
Greenfile
Environment complete
AMED
Social Policy and Practice

Table 2: Journals Searched.

Journals Searched
International Journal of Agricultural Sustainability.
Journal of Environmental Planning and Management.
Health and the Natural Outdoors.
Journal of Environmental Psychology.
Psychological Science.
Environment and Behaviour.
Environmental Health Perspectives.
Landscape and Urban Planning.
Urban Forestry and Urban Greening.
Journal of Social Issues.
International Journal of Environment and Health.
International Journal of Environmental Health Research.
International Journal of Environmental Research and Public Health.
Journal of Public Health.

1
2
3
4
5
6
7
8
9
10
11
12
13

Public Health.
Environmental Science and Technology.
Journal of Epidemiology and Community Health.
Health and Place.
Environmental Sciences.

14 **Search and selection of studies**

15 We undertook a comprehensive and iterative search to capture the range of perspectives relating to
16 gardens. We searched from 1990 onwards to capture evidence as recommended by Arksey and
17 O'Malley¹⁷. In April 2017, we searched 15 electronic databases and 6 key journals capturing health,
18 social, psychological and environmental perspectives, grey literature sources and websites (including
19 Google Scholar). We repeated the search in September 2018 and November 2019 to capture additional
20 literature published. It is recommended that scoping reviews engage inter-professional teams as they
21 bring a breadth and depth of knowledge¹⁹. Correspondingly, our team was inter-disciplinary with
22 subject and methodological expertise comprising a nurse with experience in social prescribing and
23 nature-based approaches, a geographer with expertise in urban agriculture and sustainable cities, and
24 two health information specialists with additional expertise in systematic review methodology. Our
25 external stakeholder was a national body representing a wide range of gardening interests. We defined
26 gardens as being:
27
28
29
30
31
32
33

34 *“intimate private spaces attached to private households but they can also be large private or*
35 *formal gardens open to the public, or part of hospitals care homes or hospices.*²¹
36
37
38

39 We modified the protocol throughout the initial search and filtering process to ensure the project
40 remained manageable and faithful to the initial research question and definitions. We searched in a wide
41 and sensitive manner to encompass the diverse types of gardens that could be located within green space
42 or nature-based type of activities. A range of thesaurus and free text terms (adapted per database) to
43 describe the different types of gardens, and potential breadth of health outcomes were used (see
44 Appendix for example). To ensure robustness, our search followed the agreed protocol and the results
45 were stored on Endnote web reference management software function to manage and track references
46 throughout the scoping review process which was shared across the project team. We recorded search
47 strategies with details of the date the search was undertaken and the number of results obtained and
48 issues arising during the searching to provide a complete history of the search process and provide
49 transparency of the review process.
50
51
52
53
54
55
56
57

58 We agreed an initial set of inclusion and exclusion criteria following the scoping searches and set these
59 out in the protocol. A study was included if it met the definition of gardens²¹, had a measurable outcome
60

1
2
3 on health or well-being and was published in English after 1990. Ultimately, gardens comprise of
4 numerous interacting components, outcomes and populations and may be described as complex
5 interventions²². We therefore ensured that there were no restrictions on study design, biometric
6 indicators or population groups. Systematic reviews summarise the results of studies answering a
7 focused question and within the evidence-based health care policy context, they are acknowledged as
8 'gold standard' evidence;²³ no systematic reviews covered the breadth of our review question, so they
9 were included as studies in their own right. We searched for non-experimental and quasi-experimental
10 studies, which included non-equivalent control group pre-test post-test studies and single group non-
11 controlled designs¹⁹ and studies that determined causality through non-randomization. We excluded
12 other green spaces such as forests or parks and studies on access to green spaces or living near green
13 spaces. We excluded biological indicators of soil or plants, dissertations, theses, conference
14 presentations, abstract or posters. We also excluded studies which used process indicators rather than
15 health outcomes and studies which included gardening as part of other interventions where the effects
16 could not be separated.

17
18
19
20
21
22
23
24
25
26
27 Three reviewers (AB, MHo, MHa) jointly screened 50 records by titles and abstracts to ensure
28 calibration. Once this was achieved each record title was screened independently by 2 out of 3 members
29 of the project team (AB, MHa, Mho), then each abstract was screened by 1 member of a team of 3 (AB,
30 MHa, Mho), and full text screening was conducted by 1 member of a team of 3 (AB, MHa, Mho).
31 Random checks on abstract and full text screening were conducted by a fourth member of the team
32 (MM). Any discrepancies were resolved through double-checking and discussion.

33 34 35 36 37 38 39 **Charting, collating and summarising the data**

40
41 We used Microsoft Excel to create a data extraction template that could automatically populate evidence
42 tables. Through team discussion we agreed elements to extract (column headings) based on study
43 characteristics, green space characteristics, intervention characteristics, health condition, age group,
44 outcome measures, findings and author conclusions. When reporting findings for experimental studies,
45 effect sizes and confidence intervals were included as appropriate; for systematic reviews and other
46 designs narrative findings were reported. One member of the project team (MM) extracted all the data
47 up to 2017 and MH to 2019. We used the evidence tables to organise and synthesise the data to enable
48 us to map the benefits of gardens in relation to different types of gardens, health outcomes (physical,
49 mental and well-being) and health conditions.

50 51 52 53 54 55 56 57 **Consultation with partners and patients**

58 We engaged local nature-based partners throughout this review process. We involved a national nature-
59 based stakeholder organisation in developing the review protocol and presented and sought feedback
60

1
2
3 on the results at an Economic Social Research Council (ESRC) funded event of community leaders
4 (including the national stakeholder organisation), third sector organisations, the general public and
5 public health representatives with an interest in gardens and gardening.
6
7
8

9
10 **Figure 1: PRISMA Diagram: Searching & Sifting Process**
11

12
13 **Patient and Public Involvement.**

14 This research was done without patient involvement. Patients were not invited to comment on the study
15 design and were not consulted to develop patient relevant outcomes or interpret the results. Patients
16 were not invited to contribute to the writing or editing of this document for readability or accuracy.
17 However, we consulted the general public through a community engagement event with residents and
18 local providers of gardening programmes.
19
20
21
22
23
24

25
26 **RESULTS**

27 **Search results**

28 From 8896 citations, we located 77 full text studies* (figure 1²⁴).
29
30

31
32 **Description of studies**

33 A total of 77 studies were included in this review^{25-101*}. Country of origin included the UK, USA,
34 Brazil, South Korea, Taiwan, Japan and the Netherlands. All the studies described complex
35 interventions, using heterogeneous methodologies, comprising 14 types of study designs. The scoping
36 review highlights the methodological challenges associated in determining causality with complex
37 interventions. There was an even split between experimental/quasi-experimental (29%) and non-
38 experimental studies located (37%). Non-equivalent control group and single group pre-test, post-test
39 was the most frequently used quasi-experimental study designs (20%). There were 8 RCTs (9%)^{28,31,}
40 35, 43, 56, 59, 65, 97* and 13 (16%) systematic reviews^{26, 32, 42,44,60,64,75,83,86,90, 95,98,99*}. All, bar one⁶⁰ of the
41 systematic reviews reported heterogeneous complex interventions. We present two evidence tables
42 detailing higher level evidence from systematic review and RCT's (see tables 3 & 4); full evidence
43 tables available from authors on request.
44
45
46
47
48
49
50
51
52
53
54
55
56
57
58
59
60

1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21
22
23
24
25
26
27
28
29
30
31
32
33
34
35
36
37
38
39
40
41
42
43
44
45
46
47
48
49
50
51
52
53
54
55
56
57
58
59
60

For peer review only

Table 3: Evidence Summary: RCT's.

Author, Date and Country	Study Aims	Garden Type	Age	Outcomes Measured	Key Findings	Author Conclusions
Christian <i>et al</i> (2014) UK ³¹	To evaluate the impact of a school gardening programme, the Royal Horticultural Society (RHS) Campaign for School Gardening, on children's fruit and vegetable intake	School gardening	8–11 years	Change in fruit and vegetable intake. Child level data - School food diary, home food diary - Child and Diet Evaluation Tool (CADET), knowledge and attitude questionnaire. School level – school gardening level questionnaire, gardening in schools – process measures email, information collected from RHS advisor on school gardening in intervention schools. Outcomes measured at baseline (May/June 2010) and Oct 2011-Jan 2012)	Trial 1: Higher mean change of 8 g (95% CI –19 to 36 g) for combined fruit and vegetable intake for teacher-led group than for RHS-led group –32 g (95% CI –60 to –3 g), difference not significant (intervention effect –43 g, 95% CI –88 to 1 g; p = 0.06). Trial 2: More fruit and vegetables consumed in teacher-led group (15 g (95% CI –36 to 148 g), difference not significant. Schools which improved their RHS gardening score by three levels, on average, an increase in intake of fruit and vegetables by 81 g (95% CI 0 to 163 g; p = 0.05) compared with children attending schools that had no change in gardening score.	There is little evidence that school gardening alone can improve children's fruit and vegetable intake. When gardening was implemented at the highest intensities the findings suggest it could improve children's fruit and vegetable intake by a portion per day.

<p>Detweiler <i>et al</i> (2015) USA ³⁵</p>	<p>To assess the effect of horticultural therapy on cortisol levels, depression, symptoms of posttraumatic stress disorder, alcohol cravings, and quality of life symptoms compared with a non-horticultural OT group.</p>	<p>Structured gardening programme</p>	<p>Mean age 46.4 years (SD=11.9)</p>	<p>Quality of Life[Quality of Life Enjoyment and Satisfaction Questionnaire– Short Form (Q-LES-Q-SF)] Alcohol craving [Alcohol Craving Questionnaire (ACQ-NOW)] PTSD [Posttraumatic Stress Disorder Checklist Civilian Version (PCLC)] Depression [Centre for Epidemiologic Studies Depression Scale (CES-D)] Outcomes assessed pre- and posttreatment. Salivary cortisol samples were taken at weeks 1, 2, and 3</p>	<p>24 participants completed protocol. Although a positive impact of HT was seen in a 12% reduction in salivary cortisol levels from week 1 to week 3, the difference was not statistically significant (ANOVA (F_{2,20} = 0.878), P = 0.43). Separate 1-way analyses of covariance (ANCOVAs) found no statistically significant differences in the self-administered tests. A positive trend was seen in improving quality of life and depressive symptoms in the HT group (Q-LES-Q-SF, P = .001 and CES-D, P < .001) compared with the OT group (Q-LES-Q-SF, P=.029 and CES-D, P = .050). HT group did not significantly improve in ACQ-NOW (P = .118), whereas the OT group did (P = .040). HT group did significantly improve in PCLC (P=.039), whereas the OT group did (P=.135).</p>	<p>HT may have a role in reducing stress and depression and quality of life more than the programmes in which the OT participated.</p>
<p>Jarott <i>et al</i> (2010) USA ⁵⁶</p>	<p>To compare a randomly assigned treatment group, who received horticultural therapy-based programming to a comparison group, who engaged in traditional activities</p>	<p>HT**</p>	<p>Mean age of 80.09 years, SD= 8.05</p>	<p>Level of cognitive impairment [mini mental status exam] Affect [Apparent Affect Rating Scale] Engagement [Menorah Park Engagement Scale] Observations took place twice a week during weeks 1, 2, 5, and 6</p>	<p>No significant differences between groups were found on affect (pleasure (z = -1.544, P=.123), anxiety (z = -.086, P = .932), and interest (z = -1.26, P = .208). Levels of adaptive behaviour differed between the groups, with the treatment group demonstrating higher levels</p>	<p>Horticultural therapy based activities successfully facilitate facilitates lower levels of self-engaging behaviours and engages groups of dementia sufferers who are often difficult to engage in activities that elicit high levels of adaptive behaviour.</p>

1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21
22
23
24
25
26
27
28
29
30
31
32
33
34
35
36
37
38
39
40
41
42
43
44
45
46

	programming, on engagement and affect				of active ($z = -2.90, P = .00$), passive ($z = -2.72, P = .01$), and other engagement ($z = -3.47, P = .00$) and the comparison group demonstrating higher levels of self-engagement ($z = -4.60, P = .00$).	
Van den Berg <i>et al</i> (2011) The Netherlands ⁹⁷	To hypothesise and test the Stress-relieving effects of gardening	Gardening	Mean age 57.6 years (range 38–79)	Stress - Salivary cortisol levels and self-reported mood [Positive and Negative Affect Schedule (PANAS)] Saliva samples collected shortly after arrival at the experimental location, before/after the stressful task, halfway through and after experimental activity. PANAS assessed prior to/after stressor and after experimental activity	Study findings suggest that gardening has a positive impact on relief from acute stress. Both gardening and reading decreased cortisol levels during the recovery period, with significantly stronger decreases seen in the gardening group [(F (1, 11) = 24.15, $p < .001$ vs. F (1, 13) = 5.33, $p < .05$]. Post-activity, cortisol levels were marginally lower in the gardening group than in the reading group [F (1, 27) = 3.21, $p = .08$]. A significant increase in positive mood was seen in the gardening group [F (1, 12) = 4.91, $p < .05$], but deteriorated by 4.3 percent in the reading group [$p = .53$]. Post-activity positive mood was significantly higher in the gardening group than in reading group [F (1, 28) = 4.93, $p < .05$].	Gardening can promote relief from acute stress. Gardens can be used as a valuable resource to prevent disease and promote health.

<p>Gatto <i>et al</i> (2017) USA ⁴³</p>	<p>To explore the effects of a novel 12-week gardening, nutrition and cooking intervention {'LA Sprouts'} on dietary intake, obesity parameters and metabolic disease risk among low-income, primarily Hispanic/Latino youth in Los Angeles.</p>	<p>structured gardening programme</p>	<p>3rd, 4th & 5th grade students (age range 8-11 yrs)</p>	<p>Dietary intake measured via food frequency questionnaire, anthropometric measures {body mass index, waist circumference}, body fat, and fasting blood samples.</p>	<p>Study findings indicate that pupils participating in LA sprouts had significant reductions in body mass index z-scores as compared with the controls (-0.1 vs. -0.04, p=0.01). Waist circumference in the LA Sprouts group decreased more than the control (-1.2 vs. 0.1 cm: p<0.001). Dietary fibre increased with LA sprouts as compared with the controls (+3.4% vs. -16.5%; p=0.04) however there was no difference in the fruit intake between the LA Sprouts and control group.</p>	<p>The findings are positive and indicate that LA Sprouts can benefit pupils nutritional behaviours and impact on BMI and waist circumference, but larger, longitudinal studies are required.</p>
<p>Kam <i>et al</i> (2010) China ⁵⁹</p>	<p>To examine HT activity on reduced stress, improved quality of life and work performance for people with psychiatric disorders.</p>	<p>HT**</p>	<p>Mean age of 44.3 (SD = 11.6).</p>	<p>Well-being and quality of life [Personal Wellbeing Index (PWI-C)] Mental state and behaviour [Depression Anxiety Stress Scale (DASS21)] General functioning [Work Behaviour Assessment (WBA)] PWI-C and DASS21 measured before and after intervention</p>	<p>A significant positive impact of the horticultural programme was seen in DASS-21 total (p=0.01), depression (p=0.04), anxiety (p=0.01) and stress (p=0.5) subscales. No significant differences were seen in change of WBA and its subscales (p ranges from 0.08-0.79) and PWI (p=0.84). Qualitative evidence suggested a positive impact on emotional, occupational, social and spiritual aspects.</p>	<p>Horticultural therapy is effective in reducing anxiety, depression and stress but no difference was seen on work behaviour or quality of life.</p>

1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21
22
23
24
25
26
27
28
29
30
31
32
33
34
35
36
37
38
39
40
41
42
43
44
45
46

<p>Bail et al (2018) UK²⁸</p>	<p>To assess a mentor home based vegetable garden as an intervention to cancer survivors to explicate health related outcomes</p>	<p>Gardening programme</p>	<p>adults – all ages, mean age of 60 years</p>	<p>Health-related outcomes (secondary outcomes of vegetable consumption, physical activity, performance and function, HRQOL, anthropometrics, and biomarkers) veg consumption, physical activity, HRQUL, Physical Performance, Anthropometrics, biomarkers such as toenail clippings to measure chronic stress levels.</p>	<p>100 % satisfaction with the programme. Statistically significant improvements with physical activities and vegetable consumption. Positive changes reported in the HRQUL scores. Non-significant trends noted in the BMI recordings. Overall, positive changes were reported across both groups, with a marked improvement in the intervention groups scores compared to the controls.</p>	<p>Home based mentoring gardening programme can significantly improve biometric outcomes and vegetable consumption.</p>
<p>Lai et al (2018) China⁶⁵</p>	<p>To explicate the impact of HT on frail older nursing home residents on psychological wellbeing</p>	<p>HT**</p>	<p>Frail older adult and pre-frail</p>	<p>Happiness was measured using the subjective happiness scale; Frailty was measured using the 5 item Fried Frailty Index; Depressive symptoms were measured using the Geriatric Depression Scale; self-efficacy was measured using the 10 item General Self-Efficacy Scale; social engagement measured using the Social Engagement Scale; social networks were measured using Lubben Social Network Scale and wellbeing was measured using the Personal Well-being Index.</p>	<p>Significant improvement in the interaction time was observed in the happiness scale in the HT groups ($\beta = 1.457, P = .036$). No significant changes noted in any of the other outcomes. A later cluster analysis (follow up) indicated greater effects on subjective happiness for the HT group (mean difference =6.23, $P < .001$) as compared to the controls at baseline.</p>	<p>Frail and prefrail older people living in a nursing home can benefit from HT and can promote subjective happiness.</p>

HT** = Horticultural Therapy

Table 4: Evidence Summary: Systematic Reviews.

Author, date and country	Aims	Type of Garden	Outcomes measured	Key findings	Authors Conclusions
Cipriani <i>et al</i> (2017) USA ³²	To conduct a systematic review on the benefits of horticultural therapy (HT) on persons with mental health conditions who are receiving services in either inpatient settings or outpatient community-based settings	HT**	Outcome measures reported in included studies: Affect, agitation, behaviour/engagement, cognitive functioning, interpersonal relationship, physical well-being, psychiatric symptomatology, psychological/mental well-being, quality of life, self-esteem, sleep, social behaviour, stress and coping, volition, work behaviour. Tools reported in included studies: Affect Balance Scale, Test for Severe Impairment, Quality of Life Enjoyment and Satisfaction Questionnaire Short Form (Q-LES-Q-SF), Alcohol Craving Questionnaire, Posttraumatic Stress Disorder Checklist Civilian Version, Centre for Epidemiologic Studies Depression Scale (CES-D), cortisol levels, modified DCM [dementia care mapping] scale, homemade assessment for behaviour and a modified DCM, interviews, The Bradford Well-Being Profile, Mini Mental State Examination, Apparent Affect Rating Scale, Menorah Park Engagement Scale, Chinese version of Depression Anxiety Stress Scale 21, Work Behaviour Assessment, Chinese version Personal Well-being Index, sleep diary, Modified Cohen-Mansfield Agitation Inventory, Revised Hasegawa Dementia Scale, Cohen-Mansfield Agitation Inventory, Physical and Mental Impairment Functional Evaluation, Multi-focus Assessment Scale for the Frail Elderly, Participation Index (Caplovitz) and Participation Index (Phillips), Volitional Questionnaire, Relationship Change Scale, Self-Esteem Scale, Social Behaviour Scale, Symptom Checklist 90 Revision, Evaluation of Horticultural Activity.	14 studies were included in the review. Study designs include 5 RCT, 6 Cohort, 2 Before and After, 1 Cross-sectional. 11/14 studies found statistically significant findings in support of HT for at least one dependent variable. Studies were conducted in a variety of settings and mental health conditions. Limitations of the studies include, a lack of detail on the interventions in the included studies would limit reproducibility and a lack of information on the reliability and validity of outcome measures.	Moderate evidence exists that horticultural therapy can improve client factors and performance skills.

1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21
22
23
24
25
26
27
28
29
30
31
32
33
34
35
36
37
38
39
40
41
42
43
44
45
46

Genter <i>et al</i> (2015) UK ⁴⁴	To address the question of, does allotment gardening contribute to health and wellbeing?	Allotment	Health, wellbeing. No other outcomes were included in the search strategy.	10 studies were included published between 1999-2013, 7 qualitative studies, 3 quantitative studies. Overall, the review found that allotment gardening has a positive impact on health and wellbeing, provides a stress-relieving refuge and valued contact with nature, contributes to a healthier lifestyle, creates social opportunities and enables self-development. It was also found to reduce stress levels and increase positive mood. 3 qualitative papers found that allotment gardening is a suitable therapeutic group activity for people with mental health issues, while 4 papers recognised that individual and group allotment gardening supported healthy ageing.	Allotment gardening has a positive impact on health and wellbeing. Allotment gardening can be recommended as a form of occupational therapy and can help promote health and wellbeing.
--	--	-----------	--	---	--

For peer review only

<p>1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40 41 42 43 44 45 46</p> <p>Ohly <i>et al</i> (2016) UK ⁸⁶</p>	<p>To review whether school gardens benefited health and wellbeing of pupils and understand factors that enabled or challenged the success.</p>	<p>School gardening</p>	<p>Studies were included if they reported quantitative or qualitative health and well-being outcomes. Outcomes reported include fruit and vegetable intake [Structured dietary assessment method, CADET, Lunchtime observations, parent questionnaire, 24 hr recall workbooks, parent survey, Garden Vegetables Frequency Questionnaire, Taste Test]; nutrients intake [CADET, 24 h urine samples; flame photometry, Block Food Screener, parent questionnaire, 24 hr recall workbooks]; physical [waist circumference, body mass index (BMI), and systolic and diastolic blood pressure, Urinary sodium, Total fat (%), GEMS Activity Questionnaire, Accelerometry, well-being [KIDSCREEN-10, Teacher Questionnaire, Quality of school life instrument, Youth Life Skills Inventory, Self-Report of Personality Scale for children and adolescents].</p>	<p>40 studies included (quantitative n=24, qualitative n=16, mixed method n=3). Included studies were from the UK, Australia, Portugal and USA. Quantitative evidence was of poor quality often relying on self-report. Evidence for changes in fruit and vegetable intake was limited; Two out of 13 non-randomised studies report a positive statistically significant impact of gardening on increasing intake of fruit and vegetables. Four out of 6 studies found statistically significant changes in nutrient intake, one of which found a decrease in dietary fibre in control group rather than an improvement in intervention group. One non-randomised controlled study reported a positive statistically significant impact for diastolic blood pressure in favour of the intervention group, but reviewers note that all blood pressure readings were within normal range. One cluster-RCT report that children in the intervention group were 'usually' less sedentary and spent more time engaged in 'moderate'</p>	<p>There is limited quantitative evidence for the impacts of school gardens. Qualitative evidence suggests that participants of gardening programmes may experience or perceive a range of health/wellbeing outcomes. There are few studies that have used logic models to illustrate the impact of school gardens as complex interventions.</p>
---	---	-------------------------	---	--	--

1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21
22
23
24
25
26
27
28
29
30
31
32
33
34
35
36
37
38
39
40
41
42
43
44
45
46

				physical activity than control group, but when measured objectively, there was no increase in 'light' physical activity or decrease in sedentary behaviour. Two out of 4 studies reported no difference in impact between a gardening intervention compared to a control group, data in the other 2 studies was found to be inadequate for assessment.	
Stern (2009) Australia ⁹⁵	To locate and synthesise best evidence about impact of physical activities on people with dementia.	Gardening	The Diagnostic Statistical Manual of Mental Disorders was used to classify the absence or presence of Dementia. Mental examination tools such as the mini-mental state examination and activities of daily living.	9/17 studies included in the systematic review looked at gardening as an intervention. Positive impacts of gardening were reported by 1 case-control study on a beneficial association with a reduction in the chance of developing Alzheimer's disease. Two cohort studies found that gardening was significantly associated with a reduced risk of dementia (RR = 0.53, 95% CI, 0.28–0.99; HR, 0.64, 95% CI, 0.50–0.83). Another cohort reported that exposure to gardening over at least 10-years may be associated with	While the evidence is equivocal on whether participation in physical activities is protective against onset of dementia, gardening appears more beneficial than other types of activities. DATA extracted only for gardening

1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21
22
23
24
25
26
27
28
29
30
31
32
33
34
35
36
37
38
39
40
41
42
43
44
45
46

				a reduced risk of developing Alzheimer’s disease.	
Wang <i>et al</i> (2013) USA⁹⁸	Systemic review evidence for beneficial effects of gardening on older adults	Gardening	Range of outcomes measures, as authors sought to locate papers based on methodological approach rather than outcomes. Hence, outcomes were mixed and included Mini Mental State examination, Apparent Affect rating scales, nutrition Menorah Park Engagement Scale, Life Satisfaction Inventory, Stress tests, Perceived health and wellbeing scales, self-reported pain, SF36, Hand Function, Self-Rated Health and Happiness Scale, Pearlines ad Schoolers Mastery Scale, Sleep diaries, Modified Cohen-Mansfield Agitation Inventory and Revised Hasegave Dementia Scale.	22 articles were reviewed (adults. Through various research designs (quantitative and qualitative) and measurements utilized, the results reveal that gardening can be an activity that promotes overall health and quality of life, physical strength, fitness and flexibility, cognitive ability, and socialization. The implementation of various aspects of gardening as health-promoting activities transcend contexts of practice and disciplines and can be used in urban and rural communities as both individual and group activities	The authors conclude that the literature reported variable findings, and whilst most of these were positive, the majority were at an exploratory stage. The evidence base provides an intriguing foundation for further research. Gardening has positive effects on older adults and help improve engagement and activity participation for people with dementia.

1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21
22
23
24
25
26
27
28
29
30
31
32
33
34
35
36
37
38
39
40
41
42
43
44
45
46

<p>Whear <i>et al</i> (2014) UK ⁹⁹</p>	<p>To examine the impact of gardens and outdoor spaces on the mental and physical well-being of people with dementia who are resident in care homes and understand the views of people with dementia, their carers, and care home staff on the value of gardens and outdoor spaces.</p>	<p>Garden visiting</p>	<p>Included studies had to report on agitation, number of falls, aggression, physical activity, cognitive functioning, or quality of life (quantitative) or report on the views of people with dementia who were resident in care homes, care home staff, carers, and families on the use of gardens and outdoor spaces (qualitative). [Tools reported in included studies – Agitation: Cohen-Mansfield Agitation Inventory (CMAI); Emotional outcomes: Affect Rating Scale;</p>	<p>A total of 17 studies were included (9 quantitative, 7 qualitative, and 1 mixed methods). Quantitative designs included 6 pre-post studies, 2 RCTs, 1 prospective cohort, 1 crossover trial. Quantitative designs were of poor quality but suggest a beneficial effect associated with garden use on reduced levels of agitation. There was insufficient evidence from quantitative studies generalise the findings on other aspects of physical and mental wellbeing. Evidence on the impact of Horticulture Therapy was inconclusive.</p>	<p>Garden use provide promising impacts on levels of agitation in care home residents with dementia who spend time in a garden. Future research should focus on using comparative outcome measures.</p>
<p>Savoie-Roskos <i>et al</i> (2017) USA ⁹⁰</p>	<p>To identify the effectiveness of gardening interventions that have been implemented to increase fruit & vegetables consumption among children.</p>	<p>Gardening</p>	<p>Fruit and vegetable consumption among children aged 2 to 15 years before and after implementation of a gardening intervention in a school, community, or afterschool setting.</p>	<p>There were 14 papers located and included in the review. A total of 10 articles reported statistically significant increases in fruit or vegetable consumption for those who participated in the gardening intervention. The papers located varied in methodologies and many had small sample sizes and relied on the use of convenience samples, and self-reported measurements of F/V consumption. Whilst the effects are small, the evidence report a positive benefit on the consumption of F/V in the children who</p>	<p>The evidence suggests a modest but positive influence of gardens on F/V intake of children.</p>

				participated in the gardening.	
Annerstedt et al (2011) Sweden ²⁶	To systematically review the literature regarding effects of nature-assisted therapy (NAT), for patients with well-defined diseases, as a treatment option either alone, or together with other evidence-based treatment options.	Gardens	Studies were included if they reported systematic review and meta-analyses of RCT's; RCT's; non-randomised intervention studies, observational studies and qualitative studies. Nature based, nature assisted, gardening, horticulture, socio-horticulture, ecotherapy were included. A range of psychological, intellectual, social and physiological outcomes were included	38 papers (3 systematic reviews/meta-analysis, 6 RCTs, 12 non-randomised trials, 14 observational, 4 qualitative) published between 1980-May 2009 were included. The authors report 13 significant improvements for psychological goals, 6 for social goals, 4 for physical goals, and 2 for intellectual goals.	The authors conclude that the evidence base reports a small, but reliable resource that highlights the benefits of NAT as an approach to promote health. Future studies should be adequately powered with clearly defined definitions.
Kamioka et al (2014) Japan ⁶⁰	To summarize RCTs evidence on the effects of horticultural therapy.	HT**	Inclusion criteria looked for all cure and rehabilitation effects in accordance with the International Classification of Diseases-10. Included studies reported on; Affect (the Apparent Affect Rating Scale) Engagement (Menorah Park Engagement Scale) Chinese version of Depression Anxiety Stress Scale 21 (DASS21) Work Behaviour Assessment (WBA) Chinese version Personal Wellbeing Index (PWI-C) Life Satisfaction Index-A Form, Revised UCLA Loneliness Scale The Lubben Social Network Scale Self-esteem scale Powerlessness Beck Depression Inventory (BDI) neurobehavioral cognitive status examination (NCSE), motor-free visual perception test (MVPT), and functional independence measure (FIM).	Four studies met all inclusion criteria. All studies showed significant effectiveness in one or more outcomes for mental health and behaviour. No studies report cost-effectiveness. Methodological quality of the RCTs was low.	People with mental and behavioural disorders such as dementia, schizophrenia, depression, and terminal-care for cancer, may benefit from HT, however the evidence supporting this is of low quality.

1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21
22
23
24
25
26
27
28
29
30
31
32
33
34
35
36
37
38
39
40
41
42
43
44
45
46

Masset <i>et al</i> (2012) UK⁷⁵	To assess the effectiveness of agricultural interventions in improving the nutritional status of children in developing countries.	range for review including gardens	Dietary diversity, micronutrient intake, prevalence of under-nutrition, participation and household income. Studies were included if they were cross-sectional and longitudinal project-control comparisons and randomised field trials and studies that compared participants and non-participants over a single cross-section.	15 studies assessed the effectiveness of home gardens (1 RCT, others longitudinal comparison and cross-sectional studies). A positive impact of home gardens was found on increased consumption of fruit and vegetables. No evidence of impact was found on iron intake in children. Some evidence of impact was found on improved intake of vitamin A among children <5 years (Mean difference 2.4 µg/dL, 95%CI 1.67-3.16). Data for overall effects of garden interventions on children’s nutritional status not reported separately from other interventions. Methodological quality of included studies was poor.	The review authors concluded that there was limited evidence on the impact of agricultural interventions on the nutritional status of children. The authors were unable to answer the systematic review question with any confidence due to the methodological weaknesses of the studies.
Garcia <i>et al</i> (2017) Brazil⁴²	Systematic review to explore the impact of urban gardens on use of healthy food	Community gardening	Key nutrition related outcomes; Participation in urban gardens, food security, healthy food practices, increase in intake of fruit and vegetables, healthy diet and improved family nutrition. Impact on healthy food beliefs, healthy food access, reduction in food costs, greater interest in cooking and meal planning.	24 studies were located. The studies were heterogeneous and included methodological flaws. People who participated in community gardens had improved healthy diet intake, shared food and valued healthy food. People who participate in gardens have an increased fruit and vegetable intake, improved access to health foods through harvest sharing and improved family diet.	Community gardens can have positive impact on food beliefs, knowledge and practices. Longer terms studies with more robust methodological frameworks are needed to verify the benefits of community gardens on nutrition and diet.

Kunpeuk <i>et al</i> (2019) Thailand⁶⁴	Systematic review and meta analysis to explore association between community gardening, nutrition and physical health in adults	Community gardening	Diverse measurement units, but BMI only was pooled to enable meta analysis	19 articles were included in the review. 14 cross-sectional, 1 case-control and 4 quasi-experimental. Results suggest a modest positive impact of gardens on BMI reduction. A greater pooled effect size was reported for the subgroup analysis of the quasi-experimental and case-control studies.	Gardens reduced BMI and should be integrated into health policy.
Nicholas <i>et al</i> (2019) Singapore⁸³	To assess whether HT was beneficial for older people	HT**	Psychosocial, QOL, SF36, Ryffs Scales of Psychological wellbeing, Subjective Happiness scale, Personal Wellbeing index, life satisfaction, dementia QOL	20 articles were included in the systematic review. 6 experimental studies of which 4 were RCTs. Other papers were quasi-experimental. Most studies reported significant effects of HT on a range of outcomes although there were mixed results on the effect of HT on function. Significant associations were reported on agitation, mood and engagement for people with dementia.	The evidence for HT is promising, but more robust evidence is required to draw firm conclusions.

HT** = Horticultural Therapy

Description of gardening interventions

The scoping framework¹⁷ enabled us to locate and include a broad range of evidence, likewise, using the predetermined²¹ definition of gardens enabled the capture of diverse types of gardens. Typical gardening interventions included ‘allotment gardening’ ($n=8$) and ‘Community gardens’ ($n=11$). The most common garden intervention reported was Horticultural Therapy (HT) ($n=17$) which integrates a structured gardening programme with qualified therapist input. The second most popular approach was ‘structured gardening’ ($n=17$) which provides a structured programme of activities but does not include a qualified therapist. Irrespective of garden ‘type’ all garden activities were characterized through a range of physical activities such as ‘planting seeds’, ‘potting on’, ‘taking cuttings’, ‘pricking out’, ‘sweeping and maintaining the garden’, ‘using and cleaning tools’, and other similar tasks.

Description of Outcome Types

We located a range of study methods which reported outcomes related to mental health (MH), physical impact (P), nutritional behaviour changes (N) and overall general wellbeing (WB). There were over 35 validated health and wellbeing outcome measures reported. Most papers examined the impact of gardens on MH (36%) General wellbeing represented 32% of the total outcomes reported. There was an even split between those papers reporting on specific physical outcomes (14%) and those reporting on nutrition as an outcome (18%). The heterogeneous outcomes may explain the paucity of meta-analyses (3.7%).

Development of the Logic Models

A secondary objective was to use this evidence to build evidence-based logic models to guide health strategy decision making about gardens and gardening as a non-medical, social prescription. Logic models illustrate causal relationships between service inputs, resultant activities, outputs and goals, emphasizing the contributory factors to successful programmes¹⁰². The structure and organisation of logic models enable the results from scoping reviews and systematic reviews to delineate complex interventions, such as those without specific, controlled parameters thus enabling greater insight into the interactions between the intervention, in this case gardens & gardening, and the multiple outcomes¹⁰³. Logic models can represent causal processes and encapsulate complex interventions and illustrate heterogeneous outcomes¹⁸. Hence, logic models provide an evidence-based tool that can support policy makers, health care strategists and/or primary health care clinician’s decisions about commissioning non-medical approaches through social prescribing.

Logic Model: Evidence Evaluating the Impact of Gardens on Mental Health.

There were 29 (36%) studies that focused on the impact of gardening on mental health. We set parameters for mental wellbeing to include four main areas of interest: Psychological Wellbeing, Depression, Anxiety and Mental Status. In the latter, we resolved that mental status included

1
2
3 pathological disorders such as dementia, schizophrenia, bi-polar and other chronic long-term
4 conditions. Some categories overlapped, for example, papers with a focus on psychological wellbeing
5 often captured outcomes relating to depression making the creation of distinct categories problematic.
6
7 Commonly reported data collection methods included validated tools such as the Warwick-Edinburgh
8 Mental Well-being Scale (WEMWBs)¹⁰⁴ or New Economic Foundation's Five Ways to Wellbeing¹⁰⁵
9 which offer observational subjective data as opposed to direct causality. Evidence from our review
10 indicated a range of benefits that gardening had on diverse populations. Typically, gardening enabled
11 greater social interaction with others^{92*} and improved physical activity^{101*}, thus improving overall
12 mental wellbeing^{32*}, reducing depression^{76*} and anxiety^{59*}.

13
14 A significant percentage of papers (36%) focused on mental health, and of these, the majority (57%)
15 used experimental or quasi-experimental designs. The causal relationships illustrated in our first logic
16 model highlights the range of garden activities that contributed to an improvement in mental health (see
17 fig 2). These papers typically reported that gardens and gardening augmented physical activities
18 resulting in improved physiological outcomes such as reduced cortisol levels^{32 35 97*} and saliva amylase
19 levels^{97*}. Additionally, the logic model graphic enables visual representation of how mental health was
20 improved through enhancing sociological outcomes leading to reduced socialisation through improved
21 social networks.

31 **INSERT Figure 2: Logic Model: Mental Health**

34 **Logic Model: Evidence Evaluating the Impact of Gardens on General Wellbeing.**

35
36 In determining a parameter for wellbeing, we used Dodge *et al*¹⁰⁶ who asserts that “‘*stable ‘well-being’*
37 *is when individuals have the psychological, social and physical resources they need to meet a particular*
38 *psychological, social and/or physical challenge*”. Hence, a range of wellbeing indicators were reported
39 that relate to both mental and physical wellbeing outcomes. A total of 26 (32%) papers reported general
40 wellbeing and typically focussed on positive health, examples are; ^{27, 78, 101, *} social health ^{26, 30 32, 47, 48*},
41 subjective wellbeing ^{95, 54*}, and/or quality of life ^{35, 38, 77, 79 99 *}. Typical LTC's studied included chronic
42 lung disease ^{27*} diabetes, hypertension and kidney disease ^{70*}. Outcomes that measured impact of
43 gardens on nutrition were broad and included dietary changes, increase in fruit and vegetable intake.
44 There were 13 studies that explicated the impact of gardens and gardening on nutritional intake ^{29, 31, 42,}
45 ^{51, 54, 58, 60, 75, 81, 86, 97, 99 *}. Key outcomes used as predictors for nutritional impact included validated scales
46 for wellbeing, emotional health, mental health and physiological indicators. Overall, the findings report
47 that the gardening interventions have a positive impact (81%) on nutritional intake of fruit and
48 vegetables and a range of physiological outcomes and general wellbeing.

49
50 The second logic model (see fig 3) provides an illustration of how gardens can benefit general
51 wellbeing. The range of garden types located in the scoping review influenced activities that led to
52
53
54
55
56
57
58
59
60

1
2
3 improved wellbeing outputs for adults, children and older people. Several positive outcomes were
4 reported including social: involving skills, behaviours and networks; general mental wellbeing, such as
5 stress reduction ^{35,95*}, reduced anxiety and depression ^{28, 60 65*} As with the mental health logic model, the
6 graphic illustration enables visual representation of the overlap between the mental, physical, social and
7 emotional outcomes. Thus, papers that reported impact on general wellbeing also included outcome
8 measures that indicated increased physical activity resulting in reduced BMI ^{43*} and healthier blood
9 glucose levels ^{43*}, and general wellbeing that benefited community growth ^{66*}, social interaction ^{62, 68,}
10 and quality of life ^{44, 76, 66 *}.
11
12
13
14
15

16 17 **INSERT Figure 3: Logic Model: Wellbeing**

18
19
20 These evidence-based logic models report the diversity of gardens and gardening interventions and
21 subsequent benefits on a range of populations that may typically live with LTC's. The resultant
22 outcomes reported provide confidence for clinicians considering gardens or gardening as a social
23 prescription for a range of populations.
24
25
26
27
28
29
30
31

32 **DISCUSSION**

33 The increasing interest in social prescribing as a non-medical approach, has gained international
34 attention ¹⁰⁷. Salutogenesis influences the question 'what makes people healthy?' rather than, 'how do
35 we treat disease?'. Wellbeing is increasingly promoted through contemporary public health strategies
36 to help reduce LTC's ¹⁰⁸. Although research explicating the impact of gardens and gardening may be
37 inhibited by the broad construct, the paradox here, suggests that it is the range offered that instigates
38 the salutogenic response, ultimately impacting on the wider social determinants of health and
39 benefitting diverse populations. Our findings indicate that diverse populations with LTC's could benefit
40 from gardens and gardening as a salutogenic, social prescription and is the first to use a robust scoping
41 review using a systematic approach to highlight these benefits.
42
43
44
45
46
47
48

49 Typically, gardening can help improve physiological outcomes associated with LTC's such as blood
50 glucose levels, cortisol levels, HRV, blood lipids and salivary stress cortisol. Similar findings were
51 identified by Nicklett et al ^{84*} and Ohly et al ^{86*} who reported positive physiological outcomes measures
52 on a range of biometrics including urinalysis, total fat, BMI and systolic/diastolic blood pressure as
53 outcomes. These findings, coupled with this review, demonstrate positive outcomes for a range of
54 population needs including those living with obesity, diabetes, cardiovascular disease and other LTC's.
55 The wellbeing of an individual is fundamental to health and is predicated on the social progression and
56 quality of life, typically influenced by positive physical and mental health. Similar to Bragg et al ^{30*}
57
58
59
60

1
2
3 our review identified that gardens and subsequent activities can help improve mental health. Bragg et
4 al ^{30*} suggest that growing food can help combat stress and reduce associated depression. Likewise,
5 Kam et al ^{59*} report positive emotional and social improvements for those who participated in a
6 gardening programme. The benefits of gardening on mental health outcomes also extends to other long
7 terms conditions known to influence frequent attendance to Accident & Emergency (A&E,) front line
8 health providers or GP's ¹⁰⁹.

9
10
11
12
13
14 Our scoping review has implications for researchers seeking to explicate the impact of nature-based
15 solutions on populations. There is a predilection for the use of quasi-experimental pre-test, post-test
16 designs as they appear to provide a good opportunity to test out nature-based solutions in a range of
17 contexts and populations. This suggests that research favours natural experiments that enable
18 observation of communities and populations with allocation of control. As an assessment of
19 effectiveness rather than efficiency, natural experiments may also provide opportunity for external
20 validity and local meaningful generalisation ¹¹⁰. However, challenges associated with refining nature-
21 based interventions and controlling confounders may have influenced the dearth noted in natural
22 experiments within this review. The lack of definition limited the ability of the review to categorise
23 gardens and gardening as typical interventions. Ultimately, this also resulted in a plethora of methods
24 used to examine the impact of gardens, and limited opportunities for meta-analysis. The prevailing
25 positivist paradigm needs to be revisited within this context and greater consideration proffered for the
26 use of natural experiments or those that use mixed methods to demonstrate impact rather than causality.
27 Hence, natural experiments that include mixed methods are a potential solution to this methodological
28 quagmire that exists within contemporary evidence for complex nature- based interventions.

29
30
31
32
33
34
35
36
37
38
39
40 The multiple benefits reported in this scoping review illustrate the breadth of the literature, and highlight
41 the benefits of gardens and gardening on diverse populations. This has wider implications for health
42 care practitioners and can offer non-clinical solutions that build on traditional asset-based community
43 approaches. Our findings suggest that socially prescribed referrals to gardens and gardening have the
44 potential to change people's behaviours and activate wellbeing. In addressing the wider determinants
45 of health, social prescriptions using nature-based solutions could help improve mental, physical and
46 physiological outcomes, ultimately influencing a potential to minimise inappropriate GP consultations
47 and A&E attendance and improve resilience. As a social prescription, nature-based solutions, such as
48 gardening, provide clinicians with an evidence-based opportunity to promote wellbeing through non-
49 medical methods.

Conclusions:

A strength of our scoping review was its rigorous and systematic approach to locate and understand the breadth of evidence reporting the effects of gardens and gardening on people with LTC's. The scoping review has exposed a myriad of paradigmatic solutions that have been used to capture wellbeing outcomes. Irrespective of the heterogeneous methods used, our scoping review indicates that gardens and gardening could have a positive dual benefit on a range of mental, social and psychological outcomes, thus, may be of relevance to those considering gardens and gardening as a non-medical, social prescription. Our logic models could be used as a decision support aid to enable more confident referral to nature-based solutions as part of a wider social prescription.

CONTRIBUTORSHIP STATEMENT: Mho, AB, MHa, MM made substantial contributions to the conception or design of the work and drafted the work and provide final approval of the version to be published. All authors are accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved.

COMPETING INTERESTS: There are no competing interests.

FUNDING: This research received no specific grant from any funding agency in the public, commercial or not-for-profit sectors.

DATA SHARING STATEMENT

No primary data were used. The search protocol is available on request. Data are available upon reasonable request.

1. World Health Organisation Global Health Observatory NCD Morality and Morbidity [Online] Available at: http://www.who.int/gho/ncd/mortality_morbidity/en/ 2017: [Accessed 14 September 2017]
2. World Health Organization. *Mental health action plan 2013-2020*. World Health Organization. 2013: <https://apps.who.int/iris/handle/10665/89966> .
3. Koh, Howard K,M.D., M.P.H., Bantham, Amy,M.S., M.P.P., Geller, Alan C,R.N., M.P.H., Rukavina, M. A., M.B.A., Emmons, K. M., PhD., Yatsko, P., M.A., & Restuccia, R., M.P.A. (2020). Anchor institutions: Best practices to address social needs and social determinants of health. *American Journal of Public Health, 110*(3), 309-316. doi:<http://dx.doi.org/10.2105/AJPH.2019.305472>
4. Mcmanus, S., Bebbington, P., Jenkins, R. & Brugha T. (Eds.) *Mental Health And Wellbeing In England: Adult Psychiatric Morbidity Survey 2014*. 2016: [Online] Available at: <Http://Content.Digital.Nhs.Uk/Catalogue/ Pub21748/Apms-2014-Full-Rpt.Pdf> [Accessed 7 August 2017]
5. Wakefield JRH, Sani, F, Dingle GA, Jetten. Social Isolation Predicts Frequent Attendance in Primary Care. *Annals of Behavioural Medicine*. 2018: 52:817–829
6. Henry H, Howarth ML. An overview of using an asset-based approach to nursing. *General Practice Nursing*. 2018: 4: (4) pp. 61-66.
7. Bickerdike L, Booth A, Wilson PM, Farley K, Wight K. Social prescribing: Less rhetoric and more reality. A systematic review of the evidence. *BMJ Open*. 2017: 7 (4): 1-17
8. Polley, M.J. and Pilkington, K. *A review of the evidence assessing impact of social prescribing on healthcare demand and cost implications*. 2017. University of Westminster.
9. Howarth, M., Rogers , M., Withnell, N., & McQuarrie, C. Growing spaces: an evaluation of the mental health recovery programme using mixed methods. *Journal of Research in Nursing*, 2018: 23(6), 476-489. <https://doi.org/10.1177/1744987118766207>
10. Croft, B. Self-direction and the Social Determinants of Health. *Community Ment Health J*(2020). <https://doi.org/10.1007/s10597-020-00597-5>
11. Soga M, Gaston KJ, Yamaura Y. Gardening is beneficial for health: A meta-analysis. *Preventative Medicine Reports*. 2017: 92-99.
12. Collins C C, O’Callaghan, AM. The Impact Of Horticultural Responsibility On Health Indicators And Quality Of Life In Assisted Living. *Horttechnology*. 2008: 18: 611–618
13. Wiskerke J. S. C. and Viljoen, A. (2012) ‘Sustainable Urban Food Provisioning: Challenges for Scientists, Policymakers, Planners and Designers’, in: Viljoen, A. and Wiskerke J. S. C. (Eds.) *Sustainable Food Planning: Evolving Theory and Practice*, Wageningen: Wageningen Academic Publishers.
14. Hardman, M. and Larkham, P.J. (2014) *Informal Urban Agriculture*, Berlin: Springer.
15. Holland, L. (2004) Diversity and Connections in Community Gardens: A Contribution to Local Sustainability, *Local Environment: The International Journal of Justice and Sustainability*, 9 (3): 285 – 305.
16. Munn, Z., Peters, M.D.J., Stern, C. *et al*. Systematic review or scoping review? Guidance for authors when choosing between a systematic or scoping review approach. *BMC Med Res Methodol*. 2018: 18, 143 doi:10.1186/s12874-018-0611-x
17. Arksey H, O’Malley L: Scoping studies: Towards a Methodological Framework. *Int J Soc Res Methodol*. 2005, 8: 19-32. 10.1080/1364557032000119616.
18. Midlands and Lancashire Commissioning Support Unit (nd) Using Logic Models [Online] Available At: <Https://Midlandsandlancashirecsu.Nhs.Uk/News-Insight/Press-Releases/236-Using-Logic-Models> [Accessed 1 September 2017]
19. Levac, D., Colquhoun, H. & O’Brien, K.K. Scoping studies: advancing the methodology. *Implementation Sci* 2010: 5, 69 doi:10.1186/1748-5908-5-69

20. Daudt, H.M., van Mossel, C. & Scott, S.J. Enhancing the scoping study methodology: a large, inter-professional team's experience with Arksey and O'Malley's framework. *BMC Med Res Methodol.* 2013; 13, 48 doi:10.1186/1471-2288-13-48
21. Buck D. Gardens and Health: Implications for Policy and Practice. 2016: Kings Fund: London.
22. Craig P, Diepe P, Macintyre S, Michie S, Nazareth I, Petticrew M. Medical Research Council (MRC) Developing and Evaluating Complex Interventions. 2006: MRC: London.
23. Muir Gray JA. Evidence-based Healthcare. How to make Health Policy and Management Decisions. 2001: 2nd Ed. Churchill-Livingstone.
24. PLoS Medicine (OPEN ACCESS) Moher D, Liberati A, Tetzlaff J, Altman DG, The PRISMA Group (2009). *Preferred Reporting Items for Systematic Reviews and Meta-Analyses: The PRISMA Statement.* PLoS Med 6(7): e1000097. doi:10.1371/journal.pmed1000097
25. Al-Delaimy WK, Webb M. Community Gardens as Environmental Health Interventions: Benefits Versus Potential Risks. *Curr Environ Health Rep.* 2017;4(2):252-65.
26. Annerstedt M, Währborg P. Nature-assisted therapy: Systematic review of controlled and observational studies. *Scandinavian Journal of Public Health.* 2011;39(4):371-88*.
27. Austin EN, Johnston YAM, Morgan LL. Community gardening in a senior center: a therapeutic intervention to improve the health of older adults. *Therapeutic Recreation Journal.* 2006;40(1):48-57*.
28. Bail JR, Frugé AD, Cases MG, De Los Santos JF, Locher JL, Smith KP, et al. A home-based mentored vegetable gardening intervention demonstrates feasibility and improvements in physical activity and performance among breast cancer survivors. *Cancer* (0008543X). 2018;124(16):3427-35*.
29. Blair CK, Madan-Swain A, Locher JL, Desmond RA, de Los Santos J, Affuso O, et al. Harvest for health gardening intervention feasibility study in cancer survivors. *Acta Oncologica.* 2013;52(6):1110-8*.
30. Bragg R, Atkins, G. A review of nature-based interventions for mental health care. 2016. Report No.: 204*.
31. Christian MS, Evans CEL, Cade JE. Public Health Research. Does the Royal Horticultural Society Campaign for School Gardening increase intake of fruit and vegetables in children? Results from two randomised controlled trials. Southampton (UK): NIHR Journals Library*.
32. Cipriani J, Benz A, Holmgren A, Kinter D, McGarry J, Rufino G. A Systematic Review of the Effects of Horticultural Therapy on Persons with Mental Health Conditions. *Occupational Therapy in Mental Health.* 2017;33(1):47-69. *
33. Clatworthy J, Hinds J, Camic PM. Gardening as a mental health intervention: A review. *Mental Health Review Journal.* 2013;18(4):214-25. *
34. D'Andrea SJ, Batavia M, Sasson N. Effect of Horticultural Therapy on Preventing the Decline of Mental Abilities of Patients with Alzheimer's Type Dementia. *Journal of Therapeutic Horticulture.* 2007;18. *
35. Detweiler MB, Self JA, Lane S, Spencer L, Lutgens B, Kim DY, et al. 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.* 2015;21(4):36-41. *
36. Dewi NS, Komatsuzaki M, Yamakawa Y, Takahashi H, Shibanuma S, Yasue T, et al. Community Gardens as Health Promoters: Effects on Mental and Physical Stress Levels in Adults with and without Mental Disabilities. *Sustainability.* 2017;9(1). *
37. Dunnett N, Qasim M. Perceived benefits to human well-being of urban gardens. *HortTechnology.* 2000;10(1):40-5. *
38. Edwards CA, McDonnell C, Merl H. An evaluation of a therapeutic garden's influence on the quality of life of aged care residents with dementia. *Dementia-International Journal of Social Research and Practice.* 2013;12(4):494-510. *
39. Eriksson T, Westerberg Y, Jonsson H. Experiences of women with stress-related ill health in a therapeutic gardening program. *Canadian Journal of Occupational Therapy.* 2011;78(5):273-81. *

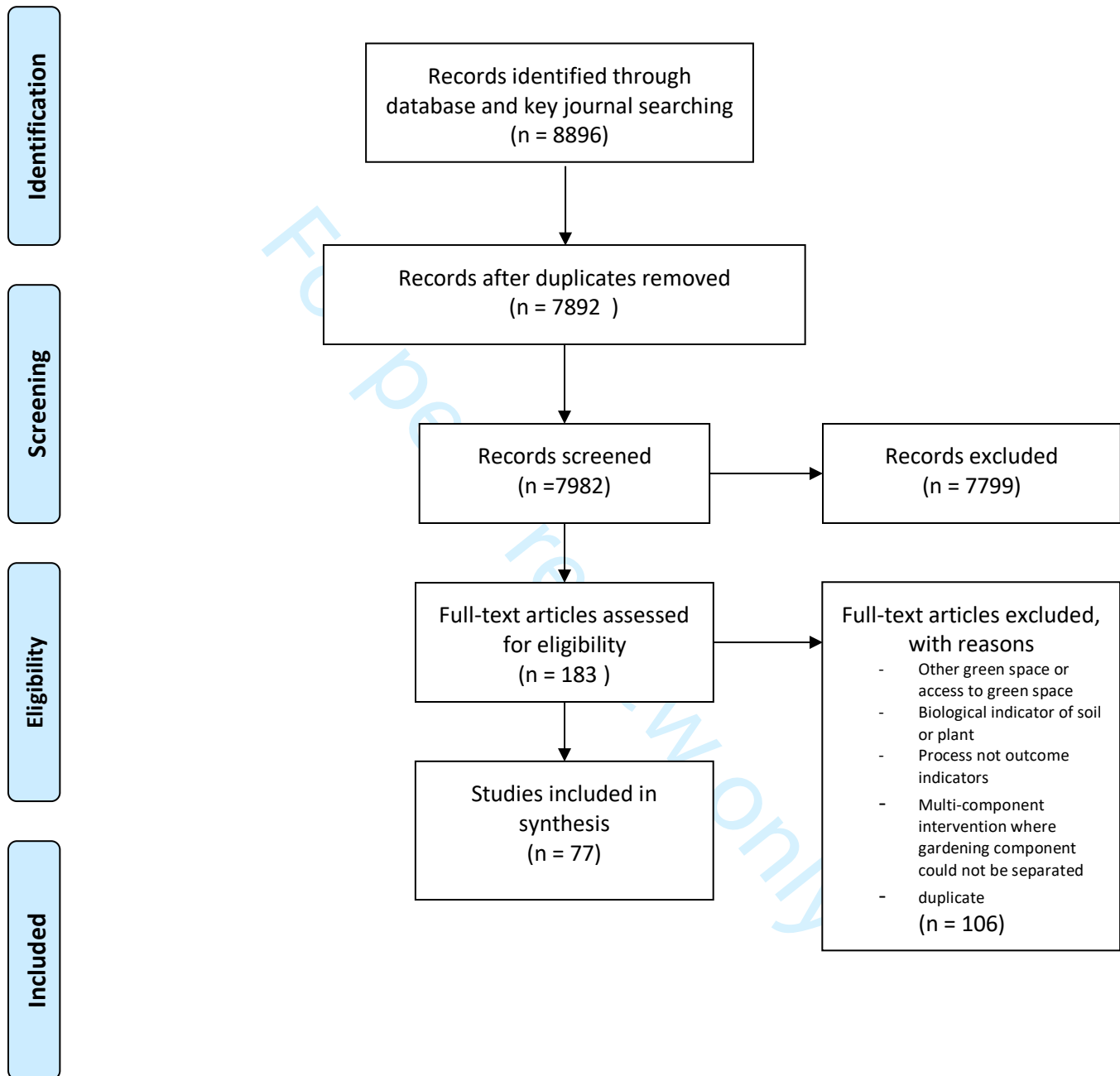
- 1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21
22
23
24
25
26
27
28
29
30
31
32
33
34
35
36
37
38
39
40
41
42
43
44
45
46
47
48
49
50
51
52
53
54
55
56
57
58
59
60
40. Farrier A, Baybutt M, Dooris M. Mental health and wellbeing benefits from a prisons horticultural programme. *International Journal of Prisoner Health*. 2019;15(1):91-104. *
 41. Ford Murphy P, Miyazaki Y, Detweiler MB, Kim KY. Longitudinal analysis of differential effects on agitation of a therapeutic wander garden for dementia patients based on ambulation ability. *Dementia*. 2010;9(3):355-73. *
 42. Garcia MT, Ribeiro SM, Germani ACCG, Bogus CM. The impact of urban gardens on adequate and healthy food: a systematic review. *Public Health Nutrition*. 2018;21(2):416-25. *
 43. Gatto NM, Martinez LC, Spruijt-Metz D, Davis JN. LA sprouts randomized controlled nutrition, cooking and gardening programme reduces obesity and metabolic risk in Hispanic/Latino youth. *Paediatric Obesity*. 2017;12(1):28-37. *
 44. Genter C, Roberts A, Richardson J, Sheaff M. The contribution of allotment gardening to health and wellbeing: A systematic review of the literature. *British Journal of Occupational Therapy*. 2015;78(10):593-605. *
 45. Gonzalez MT, Hartig T, Patil GG, Martinsen EW, Kirkevold M. Therapeutic horticulture in clinical depression: a prospective study. *Research & Theory for Nursing Practice*. 2009;23(4):312-28. *
 46. Han A-R, Park S-A, Ahn B-E. Reduced stress and improved physical functional ability in elderly with mental health problems following a horticultural therapy program. *Complementary Therapies in Medicine*. 2018; 38:19-23. *
 47. Harris N, Minniss FR, Somerset S. Refugees connecting with a new country through community food gardening. *International Journal of Environmental Research and Public Health*. 2014;11(9):9202-16.
 48. Hartwig KA, Mason M. Community Gardens for Refugee and Immigrant Communities as a Means of Health Promotion. *Journal of Community Health*. 2016;41(6):1153-9. *
 49. Hawkins JL, Thirlaway KJ, Backx K, Clayton DA. Allotment Gardening and Other Leisure Activities for Stress Reduction and Healthy Aging. *Horttechnology*. 2011;21(5):577-85. *
 50. Hawkins JL, Smith A, Backx K, Clayton DA. Exercise intensities of gardening tasks within older adult allotment gardeners in Wales. *Journal of Aging and Physical Activity*. 2015;23(2):161-8. *
 51. Heim S, Bauer KW, Stang J, Ireland M. Can a community-based intervention improve the home food environment? Parental perspectives of the influence of the Delicious and Nutritious Garden. *Journal of Nutrition Education and Behavior*. 2011;43(2):130-4. *
 52. Heliker D, Chadwick A, O'Connell T. The meaning of gardening and the effects on perceived well being of a gardening project on diverse populations of elders. *Activities, Adaptation & Aging*. 2000;24(3):35-56. *
 53. Hernandez RO. Effects of Therapeutic Gardens in Special Care Units for People with Dementia: Two Case Studies. *Journal of Housing for the Elderly*. 2007;21(1-2):117-52. *
 54. Hewitt P, Watts C, Hussey J, Power K, Williams T. Does a structured gardening programme improve well-being in young-onset dementia? A preliminary study. *British Journal of Occupational Therapy*. 2013;76(8):355-61. *
 55. Jarrott SE, Gigliotti CM. Comparing responses to horticultural-based and traditional activities in dementia care programs. *American Journal of Alzheimer's Disease & Other Dementias*. 2010;25(8):657-65. *
 56. Jarrott SE, Kwack HR, Relf D. An observational assessment of a dementia-specific horticultural therapy program. *Horttechnology*. 2002;12(3):403-10. *
 57. Jeong M-H, Lee I-S, Chung Y-M, Jeong S-J, Youn C-H, Cho H-G, et al. Effect of Horticultural Therapy on Improvement of Mental Health and Social Adaptability of Schizoid of the Open Ward. *Korean Journal of Horticultural Science and Technology*. 2004;22(4):499-503. *
 58. Joyce J, Warren A. A Case Study Exploring the Influence of a Gardening Therapy Group on Well-Being. *Occupational Therapy in Mental Health*. 2016;32(2):203-15. *
 59. Kam MCY, Siu AMH. Evaluation of a horticultural activity programme for persons with psychiatric illness. *Hong Kong Journal of Occupational Therapy*. 2010;20(2):80-6. *

- 1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21
22
23
24
25
26
27
28
29
30
31
32
33
34
35
36
37
38
39
40
41
42
43
44
45
46
47
48
49
50
51
52
53
54
55
56
57
58
59
60
60. Kamioka H, Tsutani K, Yamada M, Park H, Okuizumi H, Honda T, et al. Effectiveness of horticultural therapy: a systematic review of randomized controlled trials. *Complementary Therapies in Medicine*. 2014;22(5):930-43. *
 61. Kim MY, Kim GS, Mattson NS, Kim WS. Effects of Horticultural Occupational Therapy on the Physical and Psychological Rehabilitation of Patients with Hemiplegia after Stroke. *Korean Journal of Horticultural Science & Technology*. 2010;28(5):884-90. *
 62. Kohlleppe T, Bradley JC, Jacob S. A walk through the garden: Can a visit to a botanic garden reduce stress? *HortTechnology*. 2002;12(3):489-92. *
 63. Korpela K, De Bloom J, Sianoja M, Pasanen T, Kinnunen U. Nature at home and at work: Naturally good? Links between window views, indoor plants, outdoor activities and employee well-being over one year. *Landscape & Urban Planning*. 2017;160:38-47. *
 64. Kunpeuk W, Spence W, Phulkerd S, Suphanchaimat R, Pitayarangsarit S. The impact of gardening on nutrition and physical health outcomes: a systematic review and meta-analysis. *Health Promotion International*. 2019. *
 65. Lai CKY, Kwan RYC, Lo SKL, Fung CYY, Lau JKH, Tse MMY. Effects of Horticulture on Frail and Prefrail Nursing Home Residents: A Randomized Controlled Trial. *Journal of the American Medical Directors Association*. 2018;19(8):696-702. *
 66. Lai CK-Y, Lau CK-Y, Kan WY, Lam WM, Fung CYY. The effect of horticultural therapy on the quality of life of palliative care patients. *Journal of Psychosocial Oncology*. 2017;35(3):278-91.
 67. Ga L, Gupta A. Gardening increases vegetable consumption in school-aged children: A meta-analytical synthesis. *HortTechnology*. 2012;22:430-45. *
 68. Lanier J, Schumacher J, Calvert K. Cultivating Community Collaboration and Community Health Through Community Gardens. *Journal of Community Practice*. 2015;23(3-4):492-507. *
 69. Lee Y, Kim S. Effects of indoor gardening on sleep, agitation, and cognition in dementia patients - a pilot study. *International Journal of Geriatric Psychiatry*. 2008;23(5):485-9. *
 70. Leng CH, Wang J-D. Daily home gardening improved survival for older people with mobility limitations: an 11-year follow-up study in Taiwan. *Clinical interventions in Aging*. 2016;11:947-59.
 71. Li WW, Hodgetts D, Ho E. Gardens, Transitions and Identity Reconstruction among Older Chinese Immigrants to New Zealand. *Journal of Health Psychology*. 2010;15(5):786-96. *
 72. Liu Y, Bo L, Sampson S, Roberts S, Zhang G, Wu W. Horticultural therapy for schizophrenia. *Cochrane Database of Systematic Reviews*. 2014(5):N.PAG-N.PAG. *
 73. Lu L-C, Lan S-H, Hsieh Y-P, Yen Y-Y, Chen J-C, Lan S-J. Horticultural Therapy in Patients With Dementia: A Systematic Review and Meta-Analysis. *American Journal of Alzheimer's Disease and other Dementias*. 2019:1533317519883498.*
 74. Luk KY, Lai KY, Li CC, Cheung WH, Lam SM, Li HY, et al. The effect of horticultural activities on agitation in nursing home residents with dementia. *Int J Geriatr Psychiatry*. 2011;26(4):435-6. *
 75. Masset E, Haddad L, Cornelius A, Isaza-Castro J. Effectiveness of agricultural interventions that aim to improve nutritional status of children: systematic review. *BMJ (Clinical research ed)*. 2012;344:d8222. *
 76. Masuya J, Ota K. Efficacy of horticultural activity in elderly people with dementia: A pilot study on the influence on vitality and cognitive function. *International Journal of Nursing & Clinical Practices*. 2014. *
 77. Masuya J, Ota K, Mashida Y. 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*. 2014. *
 78. Matsunaga K, Park B-J, Kobayashi H, Miyazaki Y. Physiologically Relaxing Effect of a Hospital Rooftop Forest on Older Women Requiring Care. *Journal of the American Geriatrics Society*. 2011;59(11):2162-3. *
 79. McCaffrey R. The effect of healing gardens and art therapy on older adults with mild to moderate depression. *Holistic Nursing Practice*. 2007;21(2):79-84. *

- 1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21
22
23
24
25
26
27
28
29
30
31
32
33
34
35
36
37
38
39
40
41
42
43
44
45
46
47
48
49
50
51
52
53
54
55
56
57
58
59
60
80. McCaffrey R, Hanson C, McCaffrey W. Garden walking for depression: a research report. *Holistic Nursing Practice*. 2010;24(5):252-9. *
 81. McCaffrey R, Liehr P. The Effect of Reflective Garden Walking on Adults with Increased Levels of Psychological Stress. *Journal of Holistic Nursing*. 2016;34(2):177-84. *
 82. Milligan C, Gatrell A, Bingley A. Cultivating health': therapeutic landscapes and older people in northern England. *Social Science & Medicine*. 2004;58(9):1781-93. *
 83. Nicholas SO, Giang AT, Yap PLK. The Effectiveness of Horticultural Therapy on Older Adults: A Systematic Review. *Journal of the American Medical Directors Association*. 2019;20(10):1351. *
 84. Nicklett EJ, Anderson LA, Yen IH. Gardening Activities and Physical Health Among Older Adults: A Review of the Evidence. *Journal of Applied Gerontology*. 2016;35(6):678-90. *
 85. Oh Y-A, Park S-A, Ahn B-E. Assessment of the psychopathological effects of a horticultural therapy program in patients with schizophrenia. *Complementary Therapies in Medicine*. 2018;36:54-8. *
 86. Ohly H, Gentry S, Wigglesworth R. A systematic review of the health and well-being impacts of school gardening : synthesis of quantitative and qualitative evidence. *BMC Public Health*. 2016;16(286). *
 87. Park SA, Lee AY, Park HG, Son KC, Kim DS, Lee WL. Gardening Intervention as a Low-to Moderate-Intensity Physical Activity for Improving Blood Lipid Profiles, Blood Pressure, Inflammation, and Oxidative Stress in Women over the Age of 70: A Pilot Study. *Hortscience*. 2017;52(1):200-5. *
 88. Robinson-O'Brien R, Story M, Heim S. Impact of Garden-Based Youth Nutrition Intervention Programs: A Review. *Journal of the American Dietetic Association*. 2009;109(2):273-80. *
 89. Rodiek S. Influence of an outdoor garden on mood and stress in older persons. *Journal of Therapeutic Horticulture*. 2002;13:13-21. *
 90. Savoie-Roskos MR, Wengreen H, Durward C. Increasing Fruit and Vegetable Intake among Children and Youth through Gardening-Based Interventions: A Systematic Review. *Journal of the Academy of Nutrition & Dietetics*. 2017;117(2):240-50. *
 91. Scott TL, Masser BM, Pachana NA. Exploring the health and wellbeing benefits of gardening for older adults. *Ageing & Society*. 2015;35(10):2176-200. *
 92. Sempik J, Rickhuss C, Beeston A. The effects of social and therapeutic horticulture on aspects of social behaviour. *British Journal of Occupational Therapy*. 2014;77(6):313-9. *
 93. M S, KJ G, Y Y. Gardening is beneficial for health: A meta-analysis. *Preventive Medicine Reports*. 2017;5:92-9. *
 94. Soga M, Cox DTC, Yamaura Y, Gaston KJ, Kurisu K, Hanaki K. Health Benefits of Urban Allotment Gardening: Improved Physical and Psychological Well-Being and Social Integration. *International Journal of Environmental Research and Public Health*. 2017;14(1). *
 95. Stern C, Munn Z. Physical Leisure Activities and their Role in Preventing Dementia: A Systematic Review. *Int J Evid Based Healthc*. 2010; 8(1):2-17. doi: 10.1111/j.1744-1609.2010.00150.x 7.:260-308. *
 96. Swank JM, Shin SM. Garden Counselling Groups and Self-Esteem: A Mixed Methods Study With Children With Emotional and Behavioral Problems. *Journal for Specialists in Group Work*. 2015;40(3):315-31. *
 97. Van Den Berg AE, Custers MHG. Gardening Promotes Neuroendocrine and Affective Restoration from Stress. *Journal of Health Psychology*. 2011;16(1):3-11. *
 98. Wang D, MacMillan T. The Benefits of Gardening for Older Adults: A Systematic Review of the Literature. *Activities, Adaptation and Aging*. 2013;37(2):153-81. *
 99. Whear R, Coon JT, Bethel A, Abbott R, Stein K, Garside R. What Is the Impact of Using Outdoor Spaces Such as Gardens on the Physical and Mental Well-Being of Those With Dementia? A Systematic Review of Quantitative and Qualitative Evidence. *Journal of the American Medical Directors Association*. 2014;15(10):697-705. *
 100. Wood CJ, Pretty J, Griffin M. A case-control study of the health and well-being benefits of allotment gardening. *Journal of Public Health*. 2016;38(3):e336-e44. *

- 1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21
22
23
24
25
26
27
28
29
30
31
32
33
34
35
36
37
38
39
40
41
42
43
44
45
46
47
48
49
50
51
52
53
54
55
56
57
58
59
60
101. Zick CD, Smith KR, Kowaleski-Jones L, Uno C, Merrill BJ. Harvesting more than vegetables: The potential weight control benefits of community gardening. *American Journal of Public Health*. 2013;103(6):1110-5. *
 102. Mills T, Lawton R, Sheard L. Advancing complexity science in healthcare research: the logic of logic models. *BMC Med Res Methodol* 2019; 19, 55 doi:10.1186/s12874-019-0701-4
 103. Rohwer ., Pfadenhauer L, Burns J. *et al. Logic models help make sense of complexity in systematic reviews and health technology assessments*. *Journal of Clinical Epidemiology*. 2017; 83. pp. 37-47. ISSN 1878-5921
 104. Tennant R, Hiller L, Fishwick R, Platt S, Joseph S, Weich S, Parkinson J, Secker J, Stewart-Brown S. The Warwick-Edinburgh Mental Well-being Scale (WEMWBS): Development and UK validation. *Health and Quality of Life Outcomes*. 2007; 5. 63. <https://doi.org/10.1186/1477-7525-5-63>
 105. Aked J, Marks N, Cordon C, Thompson S. Five Ways to Wellbeing: A report presented to the Foresight Project on communicating the evidence base for improving people's well-being. 2008: London: New Economics Foundation.
 106. Dodge R, Daly A, Huyton J, Sanders L. *The challenge of defining wellbeing*. *International Journal of Wellbeing*. 2012; 2(3), 222-235.
 107. Howarth, ML, Lister, C. Social prescribing in cardiology: rediscovering the nature of and within us. *British Journal of Cardiac Nursing*. 2019; 14 (8) 1-9.
 108. Cook PA, Howarth M, Wheater CP. Biodiversity and Health in the Face of Climate Change: Implications for Public Health. In: Marselle M, Stadler J, Korn H, Irvine K, Bonn A. (eds) *Biodiversity and Health in the Face of Climate Change*. 2019: Springer Press.
 109. Hajek A, Bock JO, König HH. Association of general psychological factors with frequent attendance in primary care: a population-based cross-sectional observational study. *BMC Family Practice*. 2017; 18 (1) 48.
 110. Pettigrew M, Cummin S, Ferrell C, Findlay A, Higgins C, Hoy C, Kearns A, Sparks L. Natural Experiments: an underused tool for public health? *Public Health*. 2005; 119, 751-757.

Figure 1: PRISMA Diagram: Searching & Sifting Process

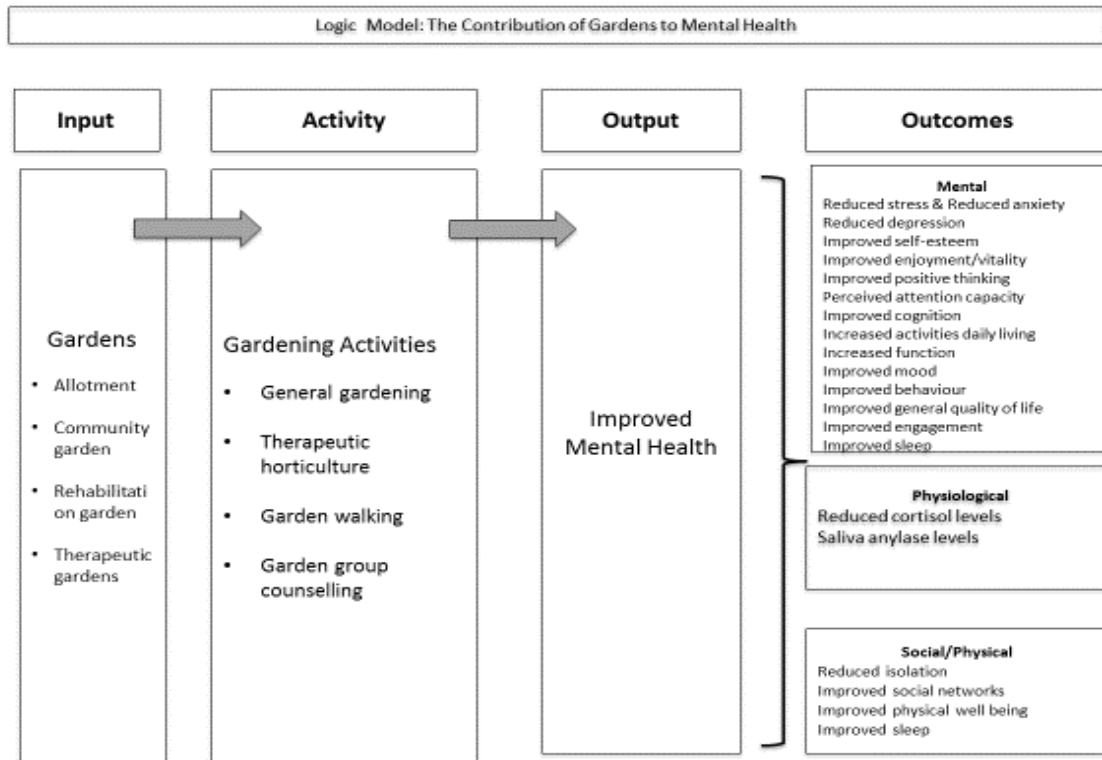


From: Moher D, Liberati A, Tetzlaff J, Altman DG, The PRISMA Group (2009). Preferred Reporting Items for Systematic Reviews and Meta-Analyses: The PRISMA Statement. PLoS Med 6(7): e1000097. doi:10.1371/journal.pmed1000097

For more information, visit www.prisma-statement.org.

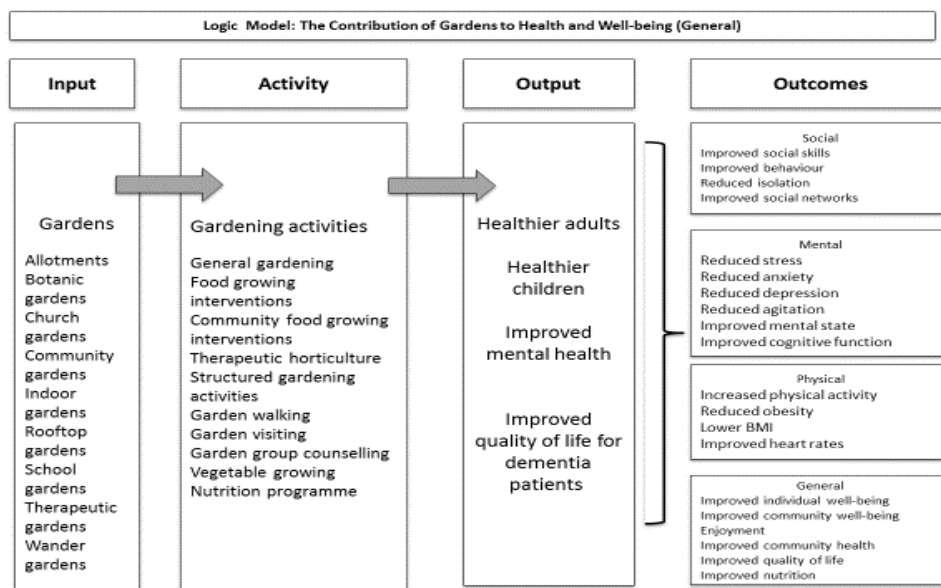
For peer review only - <http://bmjopen.bmj.com/site/about/guidelines.xhtml>

Figure 2: Logic Model: Mental Health



review only

Figure 3: Logic Model: Wellbeing.



Peer review only

Appendix 1

SAMPLE SEARCH STRATEGY**Medline**

Database: Ovid MEDLINE(R) 1946 to Present with Daily Update

Search Strategy:

-
- 1 Gardens/ (29)
 - 2 Gardening/ (745)
 - 3 Horticultural Therapy/ (32)
 - 4 Parks, Recreational/ (311)
 - 5 "Conservation of Natural Resources"/ (33544)
 - 6 Nature/ (755)
 - 7 garden*.mp. [mp=title, abstract, original title, name of substance word, subject heading word, keyword heading word, protocol supplementary concept word, rare disease supplementary concept word, unique identifier, synonyms] (8344)
 - 8 horticultur*.mp. [mp=title, abstract, original title, name of substance word, subject heading word, keyword heading word, protocol supplementary concept word, rare disease supplementary concept word, unique identifier, synonyms] (1641)
 - 9 green care.mp. [mp=title, abstract, original title, name of substance word, subject heading word, keyword heading word, protocol supplementary concept word, rare disease supplementary concept word, unique identifier, synonyms] (21)
 - 10 social prescrib*.mp. [mp=title, abstract, original title, name of substance word, subject heading word, keyword heading word, protocol supplementary concept word, rare disease supplementary concept word, unique identifier, synonyms] (17)
 - 11 (green space* or greenspace*).mp. [mp=title, abstract, original title, name of substance word, subject heading word, keyword heading word, protocol supplementary concept word, rare disease supplementary concept word, unique identifier, synonyms] (509)
 - 12 allotment*.mp. [mp=title, abstract, original title, name of substance word, subject heading word, keyword heading word, protocol supplementary concept word, rare disease supplementary concept word, unique identifier, synonyms] (448)
 - 13 ecotherap*.mp. [mp=title, abstract, original title, name of substance word, subject heading word, keyword heading word, protocol supplementary concept word, rare disease supplementary concept word, unique identifier, synonyms] (4)
 - 14 (plant* adj5 (garden* or shrub* or tree* or flower* or seed* or vegetable* or grass* or landscap* or lawn* or fruit* or cultivat*)).mp. [mp=title, abstract, original title, name of substance word, subject heading word, keyword heading word, protocol supplementary concept word, rare disease supplementary concept word, unique identifier, synonyms] (11776)
 - 15 or/1-14 (56079)
 - 16 Treatment Outcome/ (814853)
 - 17 "Outcome Assessment (Health Care)"/ (61518)

1
2
3
4 18 "Outcome and Process Assessment (Health Care)"/ (24767)
5 19 outcome assessment*.mp. [mp=title, abstract, original title, name of substance word, subject
6 heading word, keyword heading word, protocol supplementary concept word, rare disease
7 supplementary concept word, unique identifier, synonyms] (67872)
8
9 20 outcome measure*.mp. [mp=title, abstract, original title, name of substance word, subject
10 heading word, keyword heading word, protocol supplementary concept word, rare disease
11 supplementary concept word, unique identifier, synonyms] (169480)
12
13 21 exp Health Status/ (275273)
14
15 22 exp "Quality of Life"/ (154742)
16
17 23 Health Impact Assessment/ (388)
18
19 24 (well-being or wellbeing or "well being").mp. [mp=title, abstract, original title, name of substance
20 word, subject heading word, keyword heading word, protocol supplementary concept word, rare
21 disease supplementary concept word, unique identifier, synonyms] (55554)
22
23 25 (health* or wellness or mental health or mental* ill* or mental disorder* or quality of life or anxiet*
24 or anxious* or depress* or stress* or dementia or cardiovascular or myocardial infarction* or heart
25 attack* or stroke* or obesity or obese or overweight or learning disabilit* or learning disorder* or
26 outcome*).m_titl. (1454724)
27
28 26 exp Mental Health/ (29216)
29
30 27 exp Mental Disorders/ (1108313)
31
32 28 exp Depression/ (97090)
33
34 29 Anxiety/ (67031)
35
36 30 Stress, Psychological/ (104840)
37
38 31 exp Dementia/ (141332)
39
40 32 exp Cardiovascular Diseases/ (2171727)
41
42 33 Myocardial Infarction/ (159184)
43
44 34 exp Stroke/ (108360)
45
46 35 exp Obesity/ (176865)
47
48 36 exp Learning Disorders/ (22851)
49
50 37 or/16-36 (5055713)
51
52 38 exp Empirical Research/ (37340)
53
54 39 exp Research Design/ (398278)
55
56 40 exp Qualitative Research/ (33967)
57
58 41 exp epidemiologic studies/ (2076068)
59
60 42 or/38-41 (2437850)
43 15 and 37 and 42 (525)
44 15 and 37 (3842)
45 limit 44 to (meta analysis or "review" or systematic reviews) (497)
46 limit 44 to "reviews (maximizes sensitivity)" (1175)
47 43 or 45 or 46 (1476)

- 1
- 2
- 3
- 4 48 (review or synthesis or trial or meta-analysis or evaluation or cohort study or case control or
- 5 survey or qualitative or research).m_titl. (1399375)
- 6
- 7 49 15 and 37 and 48 (284)
- 8
- 9 50 47 or 49 (1594)
- 10
- 11 51 limit 50 to (english language and yr="1990 -Current") (1460)

12 Strategies for remaining databases available on request

13

14

15

16

17

18

19

20

21

22

23

24

25

26

27

28

29

30

31

32

33

34

35

36

37

38

39

40

41

42

43

44

45

46

47

48

49

50

51

52

53

54

55

56

57

58

59

60

For peer review only

Preferred Reporting Items for Systematic reviews and Meta-Analyses extension for Scoping Reviews (PRISMA-ScR) Checklist

SECTION	ITEM	PRISMA-ScR CHECKLIST ITEM	REPORTED ON PAGE #
TITLE			
Title	1	Identify the report as a scoping review.	1
ABSTRACT			
Structured summary	2	Provide a structured summary that includes (as applicable): background, objectives, eligibility criteria, sources of evidence, charting methods, results, and conclusions that relate to the review questions and objectives.	2
INTRODUCTION			
Rationale	3	Describe the rationale for the review in the context of what is already known. Explain why the review questions/objectives lend themselves to a scoping review approach.	3
Objectives	4	Provide an explicit statement of the questions and objectives being addressed with reference to their key elements (e.g., population or participants, concepts, and context) or other relevant key elements used to conceptualize the review questions and/or objectives.	3
METHODS			
Protocol and registration	5	Indicate whether a review protocol exists; state if and where it can be accessed (e.g., a Web address); and if available, provide registration information, including the registration number.	4
Eligibility criteria	6	Specify characteristics of the sources of evidence used as eligibility criteria (e.g., years considered, language, and publication status), and provide a rationale.	4,5
Information sources*	7	Describe all information sources in the search (e.g., databases with dates of coverage and contact with authors to identify additional sources), as well as the date the most recent search was executed.	5
Search	8	Present the full electronic search strategy for at least 1 database, including any limits used, such that it could be repeated.	appendix
Selection of sources of evidence†	9	State the process for selecting sources of evidence (i.e., screening and eligibility) included in the scoping review.	5
Data charting process‡	10	Describe the methods of charting data from the included sources of evidence (e.g., calibrated forms or forms that have been tested by the team before their use, and whether data charting was done independently or in duplicate) and any processes for obtaining and confirming data from investigators.	5
Data items	11	List and define all variables for which data were sought and any assumptions and simplifications made.	4
Critical appraisal of individual sources of evidence§	12	If done, provide a rationale for conducting a critical appraisal of included sources of evidence; describe the methods used and how this information was used in any data synthesis (if appropriate).	NA



SECTION	ITEM	PRISMA-ScR CHECKLIST ITEM	REPORTED ON PAGE #
Synthesis of results	13	Describe the methods of handling and summarizing the data that were charted.	7-21
RESULTS			
Selection of sources of evidence	14	Give numbers of sources of evidence screened, assessed for eligibility, and included in the review, with reasons for exclusions at each stage, ideally using a flow diagram.	5
Characteristics of sources of evidence	15	For each source of evidence, present characteristics for which data were charted and provide the citations.	6, 22, 23
Critical appraisal within sources of evidence	16	If done, present data on critical appraisal of included sources of evidence (see item 12).	NA
Results of individual sources of evidence	17	For each included source of evidence, present the relevant data that were charted that relate to the review questions and objectives.	7-21
Synthesis of results	18	Summarize and/or present the charting results as they relate to the review questions and objectives.	6, 22, 23
DISCUSSION			
Summary of evidence	19	Summarize the main results (including an overview of concepts, themes, and types of evidence available), link to the review questions and objectives, and consider the relevance to key groups.	23, 24 25
Limitations	20	Discuss the limitations of the scoping review process.	24
Conclusions	21	Provide a general interpretation of the results with respect to the review questions and objectives, as well as potential implications and/or next steps.	24
FUNDING			
Funding	22	Describe sources of funding for the included sources of evidence, as well as sources of funding for the scoping review. Describe the role of the funders of the scoping review.	825

JBI = Joanna Briggs Institute; PRISMA-ScR = Preferred Reporting Items for Systematic reviews and Meta-Analyses extension for Scoping Reviews.

* Where *sources of evidence* (see second footnote) are compiled from, such as bibliographic databases, social media platforms, and Web sites.

† A more inclusive/heterogeneous term used to account for the different types of evidence or data sources (e.g., quantitative and/or qualitative research, expert opinion, and policy documents) that may be eligible in a scoping review as opposed to only studies. This is not to be confused with *information sources* (see first footnote).

‡ The frameworks by Arksey and O'Malley (6) and Levac and colleagues (7) and the JBI guidance (4, 5) refer to the process of data extraction in a scoping review as data charting.

§ The process of systematically examining research evidence to assess its validity, results, and relevance before using it to inform a decision. This term is used for items 12 and 19 instead of "risk of bias" (which is more applicable to systematic reviews of interventions) to include and acknowledge the various sources of evidence that may be used in a scoping review (e.g., quantitative and/or qualitative research, expert opinion, and policy document).

From: Tricco AC, Lillie E, Zarin W, O'Brien KK, Colquhoun H, Levac D, et al. PRISMA Extension for Scoping Reviews (PRISMA-ScR): Checklist and Explanation. *Ann Intern Med.* 2018;169:467–473. doi: [10.7326/M18-0850](https://doi.org/10.7326/M18-0850).



St. Michael's

Inspired Care.
Inspiring Science.

For peer review only - <http://bmjopen.bmj.com/site/about/guidelines.xhtml>