


BMJ Open What is the evidence for the impact of gardens and gardening on health and well-being: a scoping review and evidence-based logic model to guide healthcare strategy decision making on the use of gardening approaches as a social prescription

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ABSTRACT

Objective To systematically identify and describe studies that have evaluated the impact of gardens and gardening on health and well-being. 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 well-being. 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 was 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 to 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 was included. Over 35 validated health, well-being 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 well-being, increased physical activity and a reduction in social isolation enabling the development of 2 logic models.

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 well-being 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.

Conclusions Gardens and gardening can improve the health and well-being 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-term conditions (LTCs). Our logic models provide an evidence-based illustration that can guide health strategy decision making about the referral of people with LTCs to socially prescribed, non-medical interventions involving gardens and gardening.

RATIONALE

Long-term conditions (LTCs), 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 Socioeconomic factors such as education and employment

can also influence health and well-being and health inequalities, and can often lead to increased risk of chronic conditions.³

In the UK, the management of LTCs is challenged by unmet social needs which are attributed to increased attendance at General Practitioner (GP) surgeries.⁴ Patients with LTCs require multipurpose, complex interventions combining interprofessional and intra-agency responses. Hence, it is predicted that LTCs will outstrip universal health and social care service provision, forcing healthcare strategists to appraise the effectiveness of existing pathogenic interventions. However, the traditional medical management of people with LTCs does not tackle their social needs leading to repeat primary care appointments and unnecessary admissions to secondary care.⁵ Consequently, there is a demand to explore alternative, non-medical, salutogenic (non-pathogenic) global approaches that could empower patients with LTCs 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 well-being by referral to a range of non-medical approaches, from exercise on prescription, to arts-based activities and beyond.⁶⁻⁹ The complex relationship between health communities and its citizens is largely influenced by wider social determinants.¹⁰ Place-based community organisations which invest in the community are able to respond to and support the wider social determinants of health.¹⁰

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 well-being.¹¹ The use of nature as an intervention is increasingly being recognised worldwide as a means of improving social, emotional, mental and physiological outcomes and is of potential value for people with LTCs. 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 well-being benefits.¹¹ 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 LTCs.¹² People with chronic conditions can engage in nature through being in gardens and through gardening activities such as allotment gardening¹³ to guerrilla gardening¹⁴ and community gardening.¹⁵ Gardens are used to cultivate flowers, 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 produce a range of logic models and results to 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 AND OBJECTIVES

Our scoping review aimed to identify and describe the evidence base on the impact of gardens and gardening on the physical and 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 healthcare strategists' decision to use of gardens and gardening as a non-medical, social prescription. We agreed on the following review question 'What evidence is there on the physical, mental, health and well-being benefits of gardens?'.¹⁶

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 question.¹⁶ We employed Arksey and O'Malley's validated framework to map the evidence.¹⁷ This was particularly relevant as the aim of the scoping review 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 well-being outcomes as graphic tools to support clinician and commissioner decision making.¹⁸ 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. **Boxes 1 and 2** detail the databases and journals searched.

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 as recommended by Arksey and O'Malley.¹⁷ In April 2017, we searched 15 electronic databases and six 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

Box 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

scoping reviews engage interprofessional teams as they bring a breadth and depth of knowledge.¹⁹ Correspondingly, our team was interdisciplinary 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.²¹

Box 2 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*
- ▶ *Public Health*
- ▶ *Environmental Science and Technology*
- ▶ *Journal of Epidemiology and Community Health*
- ▶ *Health and Place*
- ▶ *Environmental Sciences*

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

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 gardens,²¹ had a measurable outcome on health or well-being, and was published in English after 1990. Ultimately, gardens comprise numerous interacting components, outcomes and populations and may be described as complex interventions.²² We therefore ensured that there were no restrictions on study design, biometric indicators or population groups. Systematic reviews summarise the results of studies answering a focused question and within the evidence-based healthcare policy context, they are acknowledged as ‘gold standard’ evidence;²³ no systematic reviews covered the breadth of our review question, so they were included as studies in their own right. We searched for non-experimental and quasi-experimental studies, which included non-equivalent control group pretest post-test studies and single group non-controlled designs¹⁹ 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, abstracts 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 two out of three members of the project team (AB, MHa, Mho), then each abstract was screened by one member of a team of three (AB, MHa, Mho), and full-text screening was conducted by one member of a team of three (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.

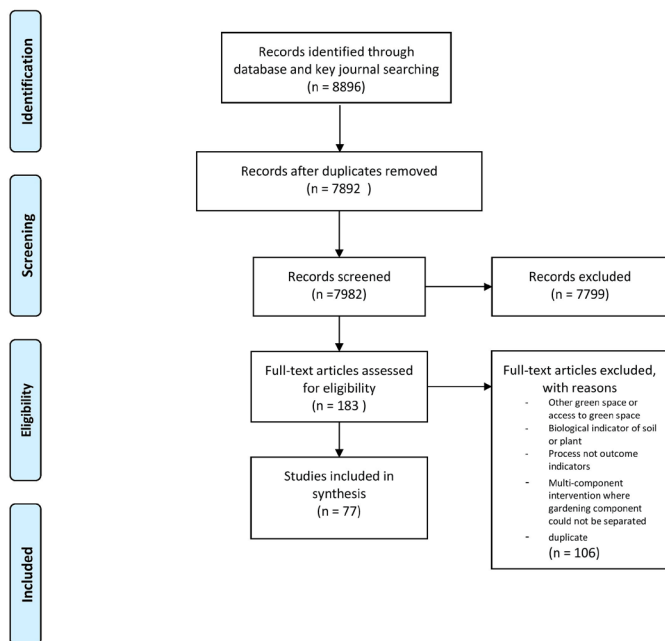


Figure 1 PRISMA diagram: searching and sifting process (adapted from Moher *et al* [24]). PRISMA, Preferred Reporting Items for Systematic Reviews and Meta-Analyses.

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 on 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 CIs 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 MHo 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 local nature-based partners throughout this review process. We involved a national nature-based stakeholder organisation in developing the review protocol and presented and sought feedback on the results at an Economic Social Research Council funded 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.

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 located 77 full-text studies* (figure 1).²⁴

Description of studies

A total of 77 studies was included in this review.^{11 25–100} 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 pretest, post-test were the most frequently used quasi-experimental study designs (20%). There were 8 randomised controlled trials (9%)^{28 31 35 43 56 59 65 96} and 13 (16%) systematic reviews.^{26 32 42 44 60 64 75 83 86 90 94 97 98} All, barring one⁶⁰ of the systematic reviews reported heterogeneous complex interventions. We present two evidence-based tables detailing higher-level evidence from systematic reviews and randomised controlled trials (see tables 1 and 2); full evidence tables available from authors on request.

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 (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 characterised 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, physical impact, nutritional behaviour changes and overall general well-being. There were over 35 validated health and well-being outcome measures reported. Most papers examined the impact of

Table 1 Evidence summary: randomised controlled trials

Author, date and country	Study aims	Garden type	Age	Outcomes measured	Key findings	Author conclusions
Christian <i>et al</i> , 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 October 2011 to January 2012	Trial 1: Higher mean change of 8 g (95% CI –19 to 36) for combined fruit and vegetable intake for teacher-led group than for RHS-led group –32 g (95% CI –60 to –3), difference not significant (intervention effect –43 g, 95% CI –88 to 1, $p=0.06$). Trial 2: More fruit and vegetables consumed in teacher-led group (15 g (95% CI –36 to 148), 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, $p=0.05$) 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
Detweiler <i>et al</i> , USA ³⁵	To assess the effect of horticultural therapy on cortisol levels, depression, symptoms of post-traumatic stress disorder, alcohol cravings, and quality of life symptoms compared with a non-horticultural OT group.	Structured gardening programme	Mean age 46.4 years (SD=11.9)	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 pretreatment and post-treatment. Salivary cortisol samples were taken at weeks 1, 2, and 3	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 (analysis of variance (ANOVA) ($F_{2, 20}=0.878$), $p=0.43$). Separate one-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, $p=0.001$ and CES-D, $p<0.001$) compared with the OT group (Q-LES-Q-SF, $p=0.029$ and CES-D, $p=0.050$). HT group did not significantly improve in ACQ-NOW ($p=0.118$), whereas the OT group did ($p=0.040$). HT group did significantly improve in PCLC ($p=0.039$), whereas the OT group did ($p=0.135$)	HT may have a role in reducing stress and depression and quality of life more than the programmes in which the OT participated
Jarrott <i>et al</i> , USA ⁵⁶	To compare a randomly assigned treatment group, that received horticultural therapy-based programming to a comparison group, that engaged in traditional activities programming, on engagement and affect	HT**	Mean age of 80.09 years (SD=8.05)	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	No significant differences between groups were found on affect (pleasure ($z=-1.544$, $p=0.123$), anxiety ($z=-0.086$, $p=0.932$) and interest ($z=-1.26$, $p=0.208$)). Levels of adaptive behaviour differed between the groups, with the treatment group demonstrating higher levels of active ($z=-2.90$, $p=0.00$), passive ($z=-2.72$, $p=0.01$) and other engagement ($z=-3.47$, $p=0.00$) and the comparison group demonstrating higher levels of self-engagement ($z=-4.60$, $p=0.00$)	HT-based activities successfully facilitate lower levels of self-engaging behaviours and engage groups of dementia sufferers who are often difficult to engage in activities that elicit high levels of adaptive behaviour

Continued



Table 1 Continued

Author, date and country	Study aims	Garden type	Age	Outcomes measured	Key findings	Author conclusions
Van den Berg <i>et al</i> , The Netherlands ⁹⁶	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<0.001 vs. F (1, 13)=5.33, p<0.05). Postactivity, cortisol levels were marginally lower in the gardening group than in the reading group (F (1, 27)=3.21, p=0.08). A significant increase in positive mood was seen in the gardening group (F (1, 12)=4.91, p<0.05), but deteriorated by 4.3% in the reading group (p=0.53). Postactivity positive mood was significantly higher in the gardening group than in the reading group (F (1, 28)=4.93, p<0.05).	Gardening can promote relief from acute stress. Gardens can be used as a valuable resource to prevent disease and promote health
Gatto <i>et al</i> , USA ⁴³	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	Third, fourth and fifth grade students (age range 8–11 years)	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 groups	The findings are positive and indicate that LA Sprouts can benefit pupils' nutritional behaviours and impact on body mass index and waist circumference, but larger, longitudinal studies are required
Kam <i>et al</i> , China ¹¹⁰	To examine HT activity on reduced stress, improved quality of life and work performance for people with psychiatric disorders	HT**	Mean age of 44.3 years (SD=11.6)	Well-being and quality of life (Personal Well-being Index (PWI-C)), mental state and behaviour (Depression Anxiety Stress Scale (DASS-21)), general functioning (Work Behaviour Assessment (WBA)), PWI-C and DASS-21 measured before and after intervention	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 values range from 0.08 to 0.79) and PWI (p=0.84). Qualitative evidence suggested a positive impact on emotional, occupational, social and spiritual aspects	HT is effective in reducing anxiety, depression and stress but no difference was seen on work behaviour or quality of life
Bail <i>et al</i> (2018) UK ²⁸	To assess a mentor home-based vegetable garden as an intervention to cancer survivors to explicate health-related outcomes	Gardening programme	Adults—all ages, mean age of 60 years	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	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 body mass index recordings. Overall, positive changes were reported across both groups, with a marked improvement in the intervention groups scores compared with the controls.	Home-based mentoring gardening programme can significantly improve biometric outcomes and vegetable consumption

Continued

Table 1 Continued

Author, date and country	Study aims	Garden type	Age	Outcomes measured	Key findings	Author conclusions
Lai <i>et al</i> , China ⁶⁵	To explicate the impact of HT on frail older nursing home residents on psychological well-being	HT**	Frail older adult and prefrail	Happiness was measured using the subjective happiness scale; frailty was measured using the five-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 well-being was measured using the Personal Well-being Index	Significant improvement in the interaction time was observed in the happiness scale in the HT groups ($\beta=1.457$, $p=0.036$). 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, $p<0.001$) as compared with the controls at baseline	Frail and prefrail older people living in a nursing home can benefit from HT and can promote subjective happiness

HT**, horticultural therapy.

gardens on mental health (36%). General well-being 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, emphasising the contributory factors to successful programmes.¹⁰¹ 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 and gardening, and the multiple outcomes.¹⁰² Logic models can represent causal processes and encapsulate complex interventions and illustrate heterogeneous outcomes.¹⁸ Hence, logic models provide an evidence-based tool that can support policy makers, healthcare strategists and/or primary healthcare 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 well-being to include four main areas of interest: psychological well-being, depression, anxiety and mental status. In the latter, we resolved that mental status included pathological disorders such as dementia, schizophrenia, bipolar and other chronic LTCs. Some

categories overlapped, for example, papers with a focus on psychological well-being 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 Scale¹⁰³ or New Economic Foundation's Five Ways to Well-being,¹⁰⁴ 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 others⁹² and improved physical activity,¹⁰⁰ thus improving overall mental well-being,³² reducing depression⁷⁶ and anxiety.⁵⁹

A significant percentage of papers (36%) focused on mental health, and of these, the majority (57%) used experimental or quasi-experimental designs. The causal relationships illustrated in our first logic model highlights the range of garden activities that contributed to an improvement in mental health (see figure 2). These papers typically reported that gardens and gardening augmented physical activities resulting in improved physiological outcomes such as reduced cortisol levels^{32 35 96} and saliva amylase levels.⁹⁶ Additionally, the logic model graphic enables visual representation of how mental health was improved through enhancing sociological outcomes leading to reduced socialisation through improved social networks.

Logic model: evidence evaluating the impact of gardens on general well-being

In determining a parameter for well-being, we used the study by Dodge *et al*¹⁰⁵ who asserts that 'stable *well-being* is when individuals have the psychological, social and physical resources they need to meet a particular psychological, social and/or physical challenge'. Hence, a range of well-being

Table 2 Evidence summary: systematic reviews

Author, date and country	Aims	Type of gardens	Outcomes measured	Key findings	Authors' conclusions
Cipriani <i>et al</i> , USA ³²	To conduct a systematic review on the benefits of 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, Post-traumatic Stress Disorder Checklist Civilian Version, Centre for Epidemiologic Studies Depression Scale (CES-D), cortisol levels, modified DCM (dementia care mapping) Scale, home-made 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 of 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 randomised controlled trial, 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
Genter <i>et al</i> , UK ⁴⁴	To address the question, does allotment gardening contribute to health and well-being?	Allotment	Health, well-being. No other outcomes were included in the search strategy	10 studies were included published between 1999 and 2013, 7 qualitative studies, 3 quantitative studies. Overall, the review found that allotment gardening has a positive impact on health and well-being, 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 well-being. Allotment gardening can be recommended as a form of occupational therapy and can help promote health and well-being

Continued

Table 2 Continued

Author, date and country	Aims	Type of gardens	Outcomes measured	Key findings	Authors' conclusions
Ohly <i>et al</i> , UK ⁸⁶	To review whether school gardens benefited health and well-being of pupils and understand factors that enabled or challenged the success	School gardening	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, Child and Diet Evaluation Tool (CADET), lunchtime observations, parent questionnaire, 24 hours recall workbooks, parent survey, Garden Vegetables Frequency Questionnaire, taste test); nutrients intake (CADET, 24-hour urine samples; flame photometry, Block Food Screener, Parent Questionnaire, 24-hour recall workbooks); physical (waist circumference, body mass index, and systolic and diastolic blood pressures, 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)	40 studies were included (quantitative n=24, qualitative n=16, mixed-methods 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; 2 out of 13 non-randomised studies report a positive statistically significant impact of gardening on increasing intake of fruit and vegetables. 4 out of 6 studies found statistically significant changes in nutrient intake, one of which found a decrease in dietary fibre in the control group rather than an improvement in the 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-randomised controlled trial reported 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. 2 out of 4 studies reported no difference in impact between a gardening intervention compared with a control group, data in the other 2 studies was found to be inadequate for assessment	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/well-being outcomes. There are few studies that have used logic models to illustrate the impact of school gardens as complex interventions
Stern, Australia ⁹⁴	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 one 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 to 0.99; HR, 0.64, 95% CI 0.50 to 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	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 were extracted only for gardening

Continued

Table 2 Continued

Author, date and country	Aims	Type of gardens	Outcomes measured	Key findings	Authors' conclusions
Wang <i>et al</i> , USA ⁹⁷	Systemic review evidence for beneficial effects of gardening on older adults	Gardening	Range of outcome 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 Well-Being 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 used, 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 socialisation. 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 while 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
Whear <i>et al</i> , UK ⁹⁸	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 prepost studies, 2 randomised controlled trials, 1 prospective cohort, 1 cross-over 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 generalising the findings on other aspects of physical and mental well-being. Evidence on the impact of HT was inconclusive	Garden use provides 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
Savoie-Roskos <i>et al</i> , USA ⁹⁰	To identify the effectiveness of gardening interventions that have been implemented to increase fruit and vegetables consumption among children	Gardening	Fruit and vegetable consumption among children aged 2–15 years before and after implementation of a gardening intervention in a school, community or after-school setting	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. While the effects are small, the evidence reports a positive benefit on the consumption of F/V in the children who participated in gardening	The evidence suggests a modest but positive influence of gardens on F/V intake of children
Annerstedt <i>et al</i> , 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 randomised controlled trials; randomised controlled trial's; non-randomised intervention studies, observational studies and qualitative studies. Nature-based, nature-assisted, gardening, horticulture, sociohorticulture, ecotherapy were included. A range of psychological, intellectual, social and physiological outcomes were included	38 papers (3 systematic reviews/meta-analysis, 6 randomised controlled trials, 12 non-randomised trials, 14 observational, 4 qualitative) published between May 1980 and 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

Continued

Table 2 Continued

Author, date and country	Aims	Type of gardens	Outcomes measured	Key findings	Authors' conclusions
Kamioka <i>et al</i> , Japan ⁶⁰	To summarise evidence of randomised controlled trials 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 (DASS-21) Work Behaviour Assessment (WBA) Chinese version of the Personal Well-being 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)	4 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 randomised controlled trials 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
Masset <i>et al</i> , UK ⁷⁵	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 undernutrition, 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 randomised controlled trial, 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 to 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 of 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> , Brazil ⁴²	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 a positive impact on food beliefs, knowledge and practices. Longer-term studies with more robust methodological frameworks are needed to verify the benefits of community gardens on nutrition and diet
Kunpeuk <i>et al</i> , Thailand ⁶⁴	Systematic review and meta analysis to explore association between community gardening, nutrition and physical health in adults	Community gardening	Diverse measurement units, but body mass index only was pooled to enable meta analysis	19 articles were included in the review. 14 cross-sectional, 1 case-control and four quasi-experimental. Results suggest a modest positive impact of gardens on body mass index reduction. A greater pooled effect size was reported for the subgroup analysis of the quasi-experimental and case-control studies	Gardens reduced body mass index and should be integrated into health policy

Continued



Table 2 Continued

Author, date and country	Aims	Type of gardens	Outcomes measured	Key findings	Authors' conclusions
Nicholas <i>et al</i> , Singapore ⁸³	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 randomised controlled trials. 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

F/V, fruit and vegetables; GEMS, Girls health Enrichment Multi-site Studies (GEMS) research team; HRQOL, Health Related Quality of Life ; HT**, horticultural therapy; QOL, Quality of Life; SF36, Health Survey Questionnaire (SF-36); UCLA, Loneliness Scale.

indicators were reported that relate to both mental and physical well-being outcomes. A total of 26 (32%) papers reported general well-being and typically focused on positive health; examples are^{27 78 100} social health,^{26 30 32 47 48} subjective well-being^{54 94} and/or quality of life.^{35 38 77 79 98} Typical LTCs studied included chronic lung disease²⁷ diabetes, hypertension and kidney disease.⁷⁰ Outcomes that measured impact of gardens on nutrition were broad and included dietary changes, and increase in fruit and vegetable intake. There were 13 studies that explicated the impact of gardens and gardening on nutritional intake.^{29 31 42 51 54 58 60 75 81 86 96 98} Key outcomes used as predictors for nutritional impact included validated scales for well-being, emotional health, mental health and physiological indicators. Overall, the findings report that the gardening interventions have a positive impact (81%) on nutritional intake of fruit and vegetables and a range of physiological outcomes and general well-being.

The second logic model (see figure 3) provides an illustration of how gardens can benefit general well-being. The range of garden types located in the scoping review influenced activities that led to improved well-being outputs for adults, children and older people. Several positive

outcomes were reported including social: involving skills, behaviours and networks; general mental well-being, such as stress reduction,^{35 94} reduced anxiety and depression.^{28 60 65} As with the mental health logic model, the graphic illustration enables visual representation of the overlap between the mental, physical, social and emotional outcomes. Thus, papers that reported impact on general well-being also included outcome measures that indicated increased physical activity resulting in reduced body mass index⁴³ and healthier blood glucose levels,⁴³ and general well-being that benefited community growth,⁶⁶ social interaction^{62 68} and quality of life.^{44 66 76}

These evidence-based logic models report the diversity of gardens and gardening interventions and subsequent benefits on a range of populations that may typically live with LTCs. The resultant outcomes reported provide confidence for clinicians considering gardens or gardening as a social prescription for a range of populations.

DISCUSSION

The increasing interest in social prescribing as a non-medical approach, has gained international attention.¹⁰⁶

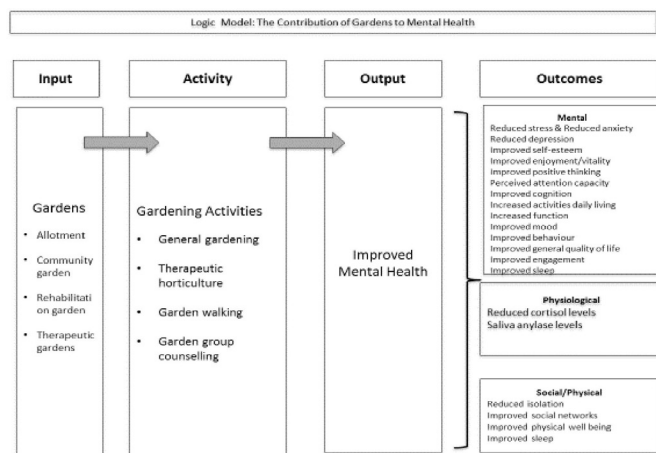


Figure 2 Logic model: mental health.

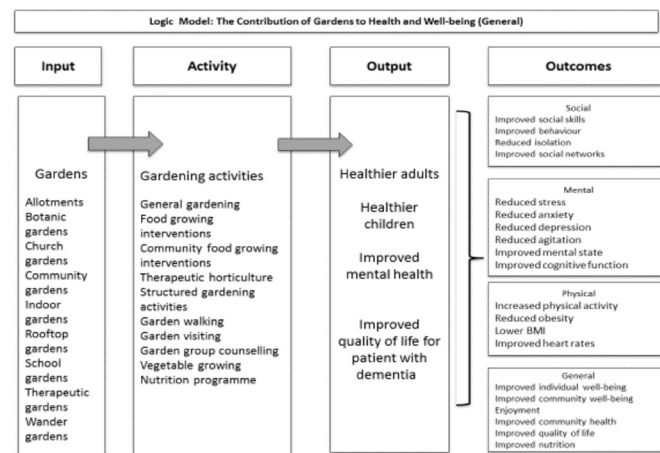


Figure 3 Logic model: well-being.

Salutogenesis influences the question ‘what makes people healthy?’ rather than, ‘how do we treat disease?’. Well-being is increasingly promoted through contemporary public health strategies to help reduce LTCs.¹⁰⁷ Although research explicating the impact of gardens and gardening may be inhibited by the broad construct, the paradox here, suggests that it is the range offered that instigates the salutogenic response, ultimately impacting on the wider social determinants of health and benefiting diverse populations. Our findings indicate that diverse populations with LTCs could benefit from gardens and gardening as a salutogenic, social prescription and is the first to use a robust scoping review using a systematic approach to highlight these benefits.

Typically, gardening can help improve physiological outcomes associated with LTCs such as blood glucose levels, cortisol levels, HRV, blood lipids and salivary stress cortisol. Similar findings were identified by Nicklett *et al*⁸⁴ and Ohly *et al*⁸⁶ who reported positive physiological outcome measures on a range of biometrics including urinalysis, total fat, body mass index and systolic/diastolic blood pressure as outcomes. These findings, coupled with this review, demonstrate positive outcomes for a range of population needs including those living with obesity, diabetes, cardiovascular disease and other LTCs. The well-being of an individual is fundamental to health and is predicated on the social progression and quality of life, typically influenced by positive physical and mental health. Similar to Bragg *et al*³⁰ our review identified that gardens and subsequent activities can help improve mental health. Bragg *et al*³⁰ suggest that growing food can help combat stress and reduce associated depression. Likewise, Kam *et al*⁵⁹ report positive emotional and social improvements for those who participated in a gardening programme. The benefits of gardening on mental health outcomes also extends to other LTCs known to influence frequent attendance to Accident & Emergency (A&E), front-line health providers or GPs.¹⁰⁸

Our scoping review has implications for researchers seeking to explicate the impact of nature-based solutions on populations. There is a predilection for the use of quasi-experimental pretest, post-test designs as they appear to provide a good opportunity to test out nature-based solutions in a range of contexts and populations. This suggests that research favours natural experiments that enable observation of communities and populations with allocation of control. As an assessment of effectiveness rather than efficiency, natural experiments may also provide opportunity for external validity and local meaningful generalisation.¹⁰⁹ However, challenges associated with refining nature-based interventions and controlling confounders may have influenced the dearth noted in natural experiments within this review. The lack of definition limited the ability of the review to categorise gardens and gardening as typical interventions. Ultimately, this also resulted in a plethora of methods used to examine the impact of gardens, and limited opportunities for meta-analysis. The prevailing positivist paradigm needs to

be revisited within this context and greater consideration proffered for the use of natural experiments or those that use mixed methods to demonstrate impact rather than causality. Hence, natural experiments that include mixed methods are a potential solution to this methodological quagmire that exists within contemporary evidence for complex nature-based interventions.

The multiple benefits reported in this scoping review illustrate the breadth of the literature, and highlight the benefits of gardens and gardening on diverse populations. This has wider implications for healthcare practitioners and can offer non-clinical solutions that build on traditional asset-based community approaches. Our findings suggest that socially prescribed referrals to gardens and gardening have the potential to change people’s behaviours and activate well-being. In addressing the wider determinants of health, social prescriptions using nature-based solutions could help improve mental, physical and physiological outcomes, ultimately influencing a potential to minimise inappropriate GP consultations and A&E attendance and improve resilience. As a social prescription, nature-based solutions, such as gardening, provide clinicians with an evidence-based opportunity to promote well-being through non-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 LTCs. The scoping review has exposed a myriad of paradigmatic solutions that have been used to capture well-being 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, and 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.

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