Exploring the benefits of nature-based interventions in socio-economically deprived communities: a narrative review of the evidence to date

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Keywords

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Abstract

Aim: Socio-economic deprivation encompasses the relative disadvantage experienced by individuals or communities in relation to financial, material or social resources. Nature-based interventions (NBIs) are a public health approach that promote sustainable, healthy communities through engagement with nature and show potential to address inequalities experienced by socio-economically deprived communities. This narrative review aims to identify and evaluate the benefits of NBIs in socio-economically deprived communities.

Method: A systematic literature search of six electronic publication databases (APA PsycInfo, CENTRAL, CDSR, CINAHL, Medline and Web of Science) was conducted on 5 February 2021 and repeated on 30 August 2022. In total, 3852 records were identified and 18 experimental studies (published between 2015 and 2022) were included in this review.

Results: Interventions including therapeutic horticulture, care farming, green exercise and wilderness arts and craft were evaluated in the literature. Key benefits were observed for cost savings, diet diversity, food security, anthropometric outcomes, mental health outcomes, nature visits, physical activity and physical health. Age, gender, ethnicity, level of engagement and perception of environment safety influenced the effectiveness of the interventions.

Conclusion: Results demonstrate there are clear benefits of NBIs on economic, environmental, health and social outcomes. Further research including qualitative analyses, more stringent experimental designs and use of standardised outcome measures is recommended.

INTRODUCTION

Socio-economic deprivation within and between countries, and how to address this, is a global issue.[1] Socio-economic deprivation encompasses the relative disadvantage experienced by individuals or communities in relation to financial, material or social resources and opportunities.[2] Globally 1.3 billion people are estimated to be multidimensionally poor.[3] Such individuals are at greater risk of increased mortality,[4] chronic disease,[5] disparities in food consumption[6] and overall compromised mental and physical health.[7,8] Within the current context of the global COVID-19 pandemic, there is evidence to suggest that individuals from socio-economically deprived communities have been disproportionately affected.[9,10] A range of public health interventions are needed to address these profuse inequalities.[11,12]

One public health approach is the introduction of nature-based interventions (NBIs) that aim to promote sustainable and healthy communities through engagement with nature and the outdoor environment.[13–15] NBIs include a wide range of

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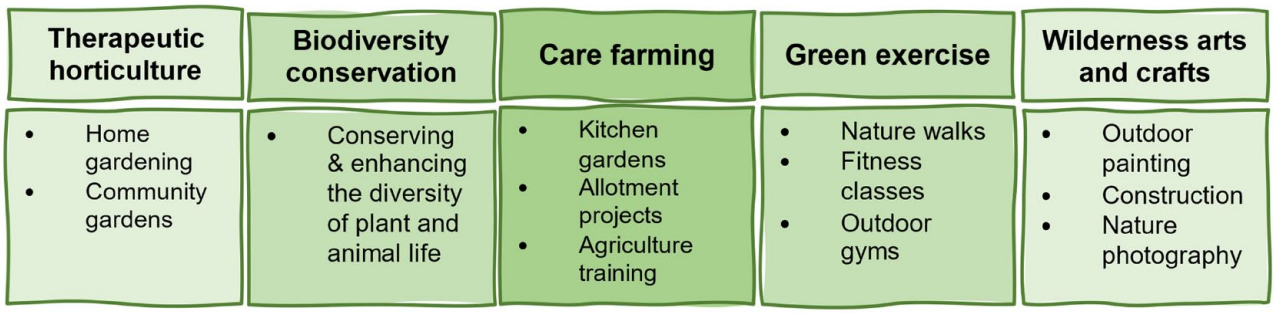
Figure 1

Examples of nature-based interventions (NBIs) based on the studies by Bragg and Leck[16] and Jepson et al.[17] that are included in this narrative review of the benefits of NBIs in socio-economically deprived communities



activities that can be broadly grouped into five categories as therapeutic horticulture, biodiversity conservation, care farming, green exercise or wilderness arts and crafts (see Figure 1).[16,17]

The co-benefits associated with NBIs have been categorised as health, economic, environment and social outcomes.[14,18] Specifically, research has demonstrated the positive impact of NBIs on emotional wellbeing,[19,20] physical health,[21–23] social connection[24] and substantial health cost savings.[25] These can be understood through a range of theoretical lenses including the stress recovery theory, which posits that being in nature elicits positive emotions leading to reduced stress levels and the attention restoration theory, which proposes that nature-based environments are restorative as they demand less cognitive effort than man-made environments.[26,27]

While it is evident that engagement with nature provides a broad range of benefits, research suggests that individuals living in socio-economically deprived communities have less access to green space than more affluent neighbourhoods and are more likely to live in an area with poor environmental conditions (including water quality, flood risk, air quality and litter).[28] Barriers to access have been identified and include transport costs, safety fears of visiting risky green spaces and culturally insensitive nature-based programmes.[29] There is evidence to suggest that the positive relationships observed between access to nature and health outcomes may be stronger among individuals from socio-economically deprived communities.[30,31] As such, NBIs may play an important role in reducing the inequalities of socio-economic deprivation, particularly when the barriers to access are reduced and when these interventions are embedded within local communities and neighbourhoods.

While this area of research has been identified as a growing field,[32] the current evidence evaluating the benefits of specific NBIs for socio-economically deprived communities is limited. Previous reviews have focused largely on research from higher income countries with limited analysis of the impact of socio-economic deprivation.[33,34]

Aim of this review

This narrative review[35] aims to identify and evaluate the benefits of NBIs for individuals in socio-economically deprived communities. It is anticipated that the results of this review will be beneficial to a broad range of stakeholders including community members, nature-based organisations, public health, spatial planning and policy makers globally to guide decisions around investment and engagement in NBIs and future research in this field.

METHOD

A narrative synthesis approach was used to systematically explore the current evidence base.[35] The narrative synthesis design was appropriate for this review as it allowed a heterogeneous body of research that used varied experimental interventions and outcomes to be summarised in a succinct and coherent method. This review aimed to develop a preliminary synthesis of the reviewed literature characteristics and findings to highlight similarities and differences within NBIs and their outcomes.[35]

Data sources and search strategy

An initial scoping search guided the development of the search strategy. The PICO framework (Population, Intervention, Comparison, Outcome)[36] was used to operationalise the search concepts and terms related to socio-economic deprivation and NBIs were used in the search (see Table 1). NBI typology was guided by previous research, and included but was not limited to interventions categorised as therapeutic horticulture, biodiversity conservation, care farming, green exercise and wilderness arts and crafts.[15–18] Table 1 details complete eligibility criteria. Adaptations were made for each database to incorporate relevant Medical Subject Headings (MeSH), Boolean operations and appropriate truncation (see Supplemental material 1).

Table 1

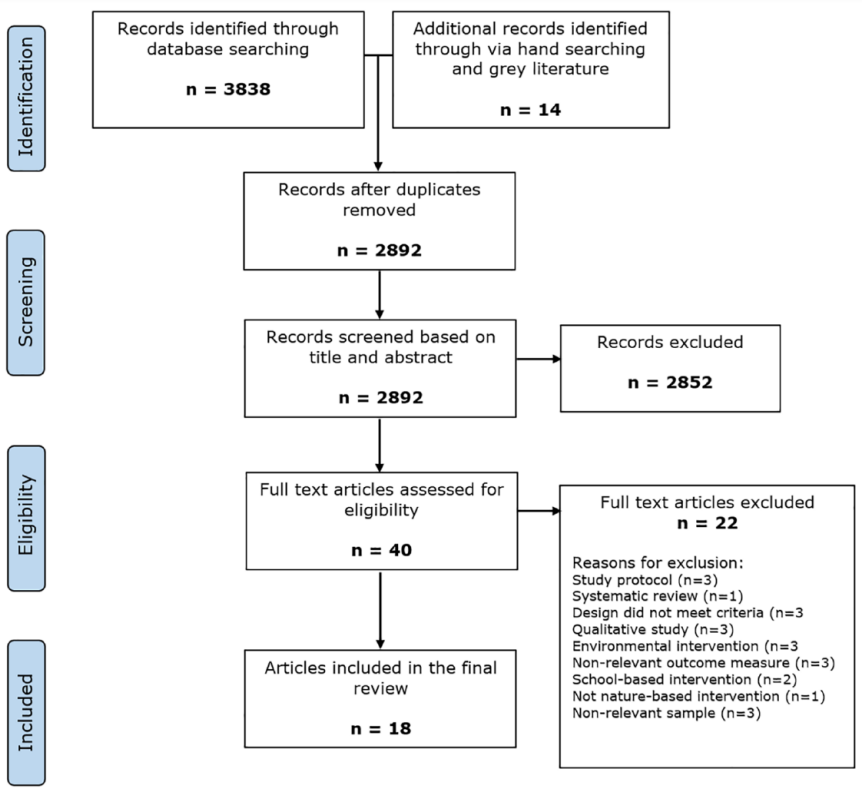
Search strategy used in the narrative review of the benefits of nature-based interventions in socio-economically deprived communities: concepts, search terms and screening eligibility criteria based on the PICO framework[36].

PICO	Concept	Search terms	Inclusion criteria	Exclusion criteria
Population	Individuals living in socio-economically deprived communities	'Socio-economic deprivation' OR 'Socio economic deprivation' OR SES OR 'socio economic status' OR 'socio-economic status' OR depriv* OR 'economic* depriv*' OR 'free school meal' OR disadvantag* OR 'social housing' OR 'poverty' OR 'income-poor' OR 'income poor' OR 'low-income' OR 'low income' OR 'index of multiple deprivation' OR IMD	Individuals that resided in socio-economically deprived communities (both urban and rural) as defined by local guidelines. Participants of all ages, genders and ethnicities	Studies in which the intervention was administered in school, hospital or non-community settings as there are previous reviews of research in these fields
Intervention	Nature-based interventions	'nature-based' OR 'nature based' OR NBI OR 'nature prescri*' OR 'nature play' OR 'green prescri*' OR 'green space*' OR greenspace* OR 'green exercise' OR 'green infrastructure' OR horticultural OR garden* OR allotment* OR outdoor OR 'natural environment' OR 'blue space*' OR 'park based' OR 'park prescri*' OR parks OR 'eco therapy' OR 'eco-therapy' OR 'wilderness therapy' OR 'wilderness-therapy' OR 'care-farming' OR 'care farming' OR 'farm therapy' OR 'farm-therapy' OR 'forest bathing' OR 'forest-bathing' OR 'environmental volunteering' OR 'wild play'	Any NBIs, activities or programmes that aimed to engage people in nature experiences. This included, but was not limited to, the following five categories:[16,17] • Therapeutic horticulture • Biodiversity conservation • Care farming • Green exercise • Wilderness arts and crafts Interventions of any frequency or duration. Interventions that are accessible within the local community that an individual resides in	Interventions that were delivered on an environmental level (i.e. improvements to green space at an organisational level) were excluded if they did not offer direct involvement of an individual, group or community
Comparison	Either within-subject comparisons (pre- and post intervention) or between-subject comparisons with control or additional intervention conditions		Studies in which an NBI is compared to either a control or alternative intervention OR Studies that provide a within-subjects comparison of the intervention	Studies that were not of experimental design
Outcome	Health, social, economic or environmental benefits		Any measures that evaluate benefits of NBIs on health, economic, environment or social outcomes[14]	Studies which do not report on outcomes for individuals

PICO: population, intervention, comparison, outcome; NBIs: nature-based interventions.

Figure 2

PRISMA flow diagram,[38] for the narrative review of the benefits of nature-based interventions in socio-economically deprived communities



Initial searches were conducted on 5 February 2021 and repeated on 30 August 2022 in the following databases:

1. APA PsycInfo;
2. Cochrane Central Register of Controlled Trials (CENTRAL);
3. Cochrane Database of Systematic Reviews (CDSR);
4. Cumulated Index to Nursing and Allied Health Literature (CINAHL);
5. OVID Medline;
6. Web of Science.

A search of unpublished and grey literature was also conducted using APA PsycExtra to minimise the potential effects of publication bias.[37] A manual hand search of relevant dissertation theses, previous reviews and government documents was also conducted. The search was not restricted by publication time frame.

Study selection

This review included peer-reviewed, quantitative research of experimental design. Studies that utilised an independent groups design where an NBI was compared to a control condition or alternative intervention were included. In addition, studies that utilised a matched pairs or repeated measures design to evaluate the effect of an NBI on outcome variables were also included. Where studies utilised mixed methods, only the quantitative data were synthesised. Studies that utilised a quantitative, experimental design were included to enable comparisons of NBIs within the literature. Publications were eligible if the research evaluated the effectiveness of a NBI for individuals from socio-economically deprived communities on either health, economic, environmental or social outcomes. Meta-analyses and systematic reviews were excluded. Reference lists of relevant reviews were hand searched[34] and studies that met the inclusion criteria were included. Non-English language studies were excluded. Full inclusion and exclusion criteria are detailed in Table 1.

In total, 3838 records were retrieved from the publication database search and 14 identified via hand-searching. All records were transferred to Endnote Software and duplicates were removed ($n = 960$). The titles and abstracts were screened according to the eligibility criteria, 2852 records were excluded, 40 full-text publications were screened for eligibility. A total of 18 records were eligible for inclusion (see PRISMA diagram in Figure 2).[38]

Data extraction and synthesis

A comprehensive data extraction table was designed to address the aims of this review (see Supplemental material 2). The data were synthesised following a narrative approach. Data were grouped based on intervention and outcome characteristics and presented descriptively in text, diagrams and tables to allow broad comparisons within the literature.[35] A 'traffic light' coding system was used to enable an evaluation of the overall effectiveness of NBIs on study outcomes. Studies were coded green if they demonstrated an overall positive effect of the intervention on study outcomes or red if there was no overall positive effect. Studies with mixed results were coded yellow if there were mostly positive effects (on over half of the outcomes assessed) or orange if there were some positive effects (less than half of the assessed outcomes).

The quality of the eligible studies was assessed using the 'Standard Quality Assessment Criteria',[39] an appropriate tool for comparing the quality of a studies with differing methodologies and designs. While scoring was guided by a standardised manual, there remained substantial potential subjectivity on the reviewer's part thus quality appraisal scores were used to enhance the data synthesis process rather than determine the inclusion or exclusion of studies.

RESULTS

Overview of included studies

The 18 publications included in this review were all articles published in peer-reviewed journals between 2015 and 2022.

Study settings

Nine studies (50%) were conducted in the USA, two (11%) in the UK, two (11%) in Ghana and the remaining five in Australia, Bangladesh, France, Peru and Tanzania (see Table 2). The context of the study settings and definitions of socio-economic deprivation varied but included communities where levels of annual income and paid employment were significantly below average and rates of state, government or charitable support were high (see Supplemental material 3).

Study designs

Fifteen of the included studies exclusively reported quantitative data and three utilised a mixed-methods design. Qualitative data were not included in this review. The included studies utilised a range of experimental designs including randomised controlled trials ($n=6$, 33%); quasi-experimental studies ($n=4$, 22%); repeated-measures designs ($n=4$, 22%); non-controlled prospective cohort studies ($n=2$, 11%), prospective randomised trials ($n=1$, 6%) and non-controlled cross-sectional designs ($n=1$, 6%).

Participant characteristics

The total sample sizes ranged from 23 to 1445. Most studies ($n=13$, 72%) recruited adults (aged 18 and over) and two (11%) recruited samples of children and young people (aged 18 under). One study (6%) recruited mother and infant pairs and one study (6%) recruited parent–child pairs, although only reported data for the adult sample. One study (6%) reported data for children and adults but utilised an observation style outcome measure, which limited the ability to identify individual participant characteristics.

Most of the reviewed literature included both male and female participants ($n=13$, 72%). Five studies (28%) reported data for female-only samples. Almost half of the included publications ($n=8$, 44%) did not report the ethnicity of study participants. Where reported, most participants represented African American, Latino, Krobo, Hispanic and White ethnic groups. Table 2 presents an overview of participant characteristics.

Intervention characteristics

The reviewed studies included interventions categorised as therapeutic horticulture ($n=7$, 39%); green exercise ($n=7$, 39%); care farming ($N=3$; 16%) and wilderness arts and crafts ($n=1$, 6%; see Table 2). Detail of the specific interventions is provided in Supplemental material 4.

Outcome measures

The included studies evaluated the effects of NBIs on health ($n=18$, 100%); environmental ($n=7$, 39%); economic ($n=4$, 22%) and social outcomes ($n=4$, 22%; see Table 3). Health outcomes included assessments of both physical and mental health. Specifically, physical health changes in diet, nutrition, physical activity and anthropometric measures (e.g. body size, form and functional capacities) were evaluated. Mental health outcomes included measures of personal wellbeing, stress, quality of life, resilience and depression. Environmental outcomes included assessments of nature affinity and time spent in nature environments while economic outcomes considered changes in household expenditure, food security and food production. Assessments of social capital, social support, social connectedness and sense of community were included in the social outcomes. A wide variety of measures were used to collect participant data including self-report or researcher administered surveys, physiological or anthropometric measures, global positioning system (GPS) trackers and observational methods (see Table 3).

Overall benefits and quality of studies

To assess the overall benefits, a 'traffic light' coding system was applied (see Supplemental material 5). As illustrated in Table 3, six (33%) studies were coded green (overall positive effect), five (28%) yellow (mostly positive effects – over half of outcomes), six (33%) orange (some positive effects – less than half outcomes) and one (6%) red (no overall positive effect).

Overall, the quality appraisal scores on the Kmet et al.[39] checklist ranged from 50% to 96.2% ($M=79\%$; see Supplemental material 6 for detailed scoring). Based on the criteria, strengths were identified in appropriate and justified analytic methods, detailed reporting of study findings, providing estimates of variance in results and reporting of conclusions that were supported by the results. Partial scores were attributed to studies that lacked sufficient detail regarding the research question ($n=7$), recruitment processes ($n=6$) and participant characteristics ($n=7$). In addition, studies that relied on small sample sizes or failed to provide justification for the sample size used ($n=11$) were awarded partial scores.

While a broad range of outcomes were utilised in the reviewed studies, partial ($n=5$) and no scores ($n=1$) were attributed to those that failed to evidence the reliability or validity of the outcome measures used. Only seven studies provide sufficient evidence of controlling for confounding factors while partial ($n=7$) and no scores ($n=4$) were attributed to the remaining studies. Less than half of the reviewed studies ($n=8$) were accredited full scores for evident and appropriate study designs with limitations identified in those studies that were feasibility projects or utilised non-controlled designs. Most of the reviewed studies evaluated between-group differences ($n=12$) and eight studies included a control comparison condition. However, only six studies utilised a randomised approach to allocate participants to the experimental or control groups.

The biggest limitations observed in the reviewed literature were evident in the blinding criteria. Only two studies scored full marks for reporting on blinding of investigators to participant condition. One study scored partial marks, six studies received no marks and the remaining nine were studies in which blinding was not

Table 2

Narrative review of the benefits of nature-based interventions in socio-economically deprived communities: summary of the setting, participants, intervention, comparison and outcome(s) for the included studies.

Publication	Setting	Participants	Intervention (category)	Comparison	Outcome(s)
Algert et al.[40]	San Jose, California (USA)	*n* = 135 (62% F) Adults Ethnicity[a]: White (46%); American Indian (20%); Hispanic (12%); Black (5%); Pacific Islander (5%); Other (12%)	Home gardening (TH)	Between-subjects (community gardening intervention)	Economic Health
Baliki et al.[41]	Jessore, Barisal, Faridpur and Patuakhali Districts of Bangladesh	*n* = 619 (100% F) Adults Ethnicity not reported	Home gardening (TH)	Between-subjects (control condition)	Economic Environmental Health
Blakstad et al.[42]	Pwani Region, Tanzania	*n* = 874 (100% F) Adults Ethnicity not reported	Agriculture training (CF)	Between-subjects (control condition)	Economic Health
Booth et al.[43]	Miami-Dade County, Florida (USA)	*n* = 66 (40% F) Children (8–14 years) Ethnicity: White Hispanic (57%); Non-Hispanic Black (25%); Black Hispanic (14%); Non-Hispanic White (5%)	Park-based activity sessions (GE)	Within-subjects	Health
Suyin Chalmin-Pui et al.[44]	Greater Manchester, UK	*n* = 42 (64% F) Adults Ethnicity: White (93%); Arab (5%); African/Caribbean/Black (2%)	Home gardening (TH)	Within-subjects and between-subjects (wait-list control)	Health
Cohen et al.[45]	Los Angeles, California (USA)	*n* = 1422 (62% F) Adults Ethnicity[b]: Latino (72%); African American (10%); White (6%)	Park-based fitness classes (GE)	Between-subjects (alternative intervention and control conditions)	Environmental Health
Dallmann et al.[46]	Upper Manya Krobo District, Ghana	*n* = 492 (100% F) Adults Ethnicity: Krobo (75%); Other (25%)	Agriculture training (CF)	Between-subjects (control condition)	Health
Davies et al.[47]	Wales, UK	*n* = 123 (30% F) Adults Ethnicity not reported	Sustainable building project (WAC)	Within-subjects	Health Social
Grey et al.[48]	Sydney, Australia	*n* = 23 (61% F) Adults Ethnicity not reported	Community gardening (TH)	Within-subjects	Health Social

(Continued)

Table 2 (Continued)

Publication	Setting	Participants	Intervention (category)	Comparison	Outcome(s)
Grier et al.[49]	Dan River Region, Virginia (USA)	*n* = 43 (54% F) Children (5–17 years) Ethnicity: African American (98%); Other (2%)	Community gardening (TH)	Within-subjects	Environmental Health
Han et al.[50]	San Fernando, California (USA)	*n* = 187.3[c] (55% F)[c] Adults and children Ethnicity not reported	Park-based fitness classes (GE)	Within-subjects and between-subjects (control condition)	Environmental Health
Kling et al.[51]	Miami-Dade County, Florida (USA)	*n* = 380 (85% F) Adults Ethnicity: Hispanic (45%); Non-Hispanic Black (41%); Non-Hispanic White (5%); Other (9%)	Park-based fitness classes (GE)	Within-subjects	Health
Korn et al.[52]	Lima, Peru	*n* = 29 (93% F) Adults Ethnicity not reported	Home gardening (TH)	Within-subjects	Health Social
Marquis et al.[53]	Upper Manya Krobo District, Ghana	*n* = 500 Mother–infant pairs (Infants = 48% F) Ethnicity: Krobo (76%), Other (24%)	Agriculture training (CF)	Between-subjects (control condition)	Health
Martin et al.[54]	Marseille, France	*n* = 21 (100% F) Adults Ethnicity not reported	Community gardening (TH)	Between-subjects (control condition)	Economic Health
Razani et al.[55]	Oakland, California (USA)	*n* = 78 (87% F) Parent–child pairs Ethnicity: African American (67%), Latino (15%); Non-Latino White (5%); Other (13%)	Park prescriptions (GE)	Between-subjects (alternative intervention)	Environmental Health Social
South et al.[56]	Philadelphia (USA)	*n* = 36 (100% F) Adults Ethnicity: Black Non-Hispanic (62%), White Non-Hispanic (14%); Asian Non-Hispanic (8%); Hispanic Black (5%); Other (11%)	Park prescriptions (GE)	Between-subjects (control condition)	Environmental Health
Wexler et al.[57]	Minneapolis (USA)	*n* = 171 (50% F) Adults Ethnicity not reported	Park prescriptions (GE)	Between-subjects (control condition)	Environmental Health

F: female; TH: therapeutic horticulture; GE: green exercise; CF: care farming; WAC: wilderness arts and crafts.
[a]Where reported.
[b]Survey responses.
[c]Averages calculated through SOPARC methodology (see Table 3).

Table 3

Narrative review of the benefits of nature-based interventions in socio-economically deprived communities: summary of primary outcome(s) and main findings for the included studies.

Intervention category	Publication	Primary outcome(s)	Key finding(s)	Overall effect
Therapeutic Horticulture				
Home Gardening				
	Algert et al.[40]	1. Vegetable intake (food behaviour checklist)[58] 2. Cost savings (self-report survey)[40]	1. No statistical differences in vegetable consumption between home gardeners and community gardeners when they ate from their gardens 2. No statistical differences in cost savings per month for community and home gardeners	G
	Baliki et al.[41]	1. Vegetable production (kg per household member) 2. Nutrient yields (food composition tables) 3. Quantity of vegetables consumed (24 h recall)	1. Statistically significant increases at 1 and 3 years post intervention 2. Significant increase in calcium and vitamin C at 1 and 3 years post intervention 3. Statistically significant increase in the share of women selling any vegetable in the market and level of vegetable consumption	G
	Chalmin-Pui et al.[44]	1. Perceived stress (Perceived Stress Scale)[59] 2. Stress cortisol levels[60] 3. Subjective wellbeing (Short Warwick and Edinburgh Mental Well-being Scale)[61] 4. Physical activity (subjective Likert scale)[44]	1. Pooling data across both groups showed a significant decrease in perceived stress postintervention. Comparing intervention to control, differences were only significant at 10% level 2. Statistically significant improvements in cortisol patterns for 6/8 of the cortisol analyses 3. No significant difference in wellbeing scores post intervention 4. No significant difference in physical activity post intervention	O
	Korn et al.[52]	1. Height, weight, waist circumference, resting blood pressure and fasting blood glucose 2. Quality of life (World Health Organisation Quality of Life-Brief Version)[62] 3. Perceived stress (Perceived Stress Scale)[63] 4. Life-threatening experiences (Life-Threatening Experiences Scale)[64] 5. Social capital (Social Capital Scale)[65] 6. Empathy (Parent/Partner Empathy Scale)[66]	1. No significant change in BMI, waist circumference or blood pressure at either follow-up 2. Non-significant increase in all domains of quality of life at 6 months. Significant improvements on all quality-of-life domains at 12 months 3. Perceived stress scores increased significantly at 6 and 12 months 4. Reports of life-threatening experiences decreased significantly from the baseline to 12 months 5. Mean social capital scale scores increased significantly at 12 months for participants who identified as parents or partners 6. No significant differences reported at 6 or 12 months postintervention	Y

(Continued)

Table 3 (Continued)

Intervention category	Publication	Primary outcome(s)	Key finding(s)	Overall effect
Community Gardening				
	Grey et al.[48]	1. Sense of community (The Sense of Community Index)[67] 2. Personal wellbeing (The Personal Wellbeing Index)[68]	1. Statistically significant result for only one domain – satisfaction with health whereby participants reported being less satisfied with their health at post-test compared to pretest 2. Statistically significant increase in the shared emotional connection score and total score. No other significant differences from pretest to post-test were found	O
	Grier et al.[49]	1. Willingness to try fruit and vegetables[69] 2. Self-efficacy for eating fruit and vegetables[70] 3. Self-efficacy for asking for fruit and vegetables[71] 4. Nutritional guidelines knowledge (MyPlate categories)[49]	1. No significant effects on willingness to try fruit and vegetables 2. No significant effects on self-efficacy for eating fruit and vegetables 3. Significant improvements were found for self-efficacy for asking for fruit and vegetables 4. Significant improvement on knowledge of nutritional guidelines post intervention	O
	Martin et al.[54]	1. Quantities of food groups (in g/day per person)[72] 2. Expenditure for food (V/day per person)[72]	1. Gardeners had significantly more produce in their food supplies than non-gardeners, this remained significant when just fruit and vegetables were considered 2. Gardeners spent significantly more money on food than the non-gardening group	O
Care Farming				
Poultry Husbandry				
	Marquis et al.[53]	1. End-line diet quality (minimum dietary diversity)[53] 2. End-line nutritional status (weight for age, length-for-age, height-for-age, weight-for-length, weight-for-height)[73]	1. Compared with infants in the control group, infants in the intervention group met minimum diet diversity and a higher length-for-age, height-for-age and weight-for-age 2. No group difference in weight-for-length or weight-for-height	Y
	Dallmann et al.[46]	1. End-line diet quality (minimum dietary diversity)[53] 2. Egg consumption (in the past 24 h) 3. End-line nutritional status (weight for age, length-for-age, height-for-age, weight-for-length, weight-for-height)[73]	1. Participation level was not associated with meeting the minimum diet diversity 2. Compared with children in the control category, those in the intervention whose mothers had a high participation level were twice as likely to have consumed eggs the previous day 3. High and medium participation levels were associated with a similar increase in linear growth	G

(Continued)

Table 3 (Continued)

Intervention category	Publication	Primary outcome(s)	Key finding(s)	Overall effect
Agriculture training				
	Blakstad et al.[42]	1. Dietary diversity (Food Frequency Questionnaire)[74] 2. Food security (Household Food Insecurity Assessment Scale)[75]	1. Intervention group consumed significantly more food groups per day than the control group (at 12 months post intervention). The proportion of participants consuming at least 3/5 food groups per day was significantly greater in the intervention group and intervention participants were more likely to consume vitamin A-rich dark green vegetables, and beans or peas when compared with controls 2. No statistical differences in household food insecurity score between intervention or control groups post intervention	Y
Wilderness Arts & Crafts				
Sustainable building project				
	Davies et al.[47]	1. Mental Health (The Patient Health Questionnaire)[76] 2. Resilience (The Brief Resilience Scale)[77] 3. Wellbeing (Short Warwick and Edinburgh Mental Well-being Scale)[61] 4. Social connectedness (Inclusion of Community in the Self Scale)[78]	(1–4) No significant within-subject changes over time when data from all participants, regardless of baseline score, were analysed Statistical differences reported when the analysis was limited to participants that had baseline scores falling at or below the cut-off threshold for depression (large effect), anxiety (large effect) and resilience (medium to large effect) Note: study 1 and study 2 data pooled together for analysis	O
Green Exercise				
Park-based classes				
	Booth et al.[43]	1. Duration of moderate to vigorous physical activity (total minutes per day, Fitbit)[43] 2. Total step counts per day (Fitbit)[43]	1. Significantly higher moderate–vigorous physical activity minutes per day on days when participants did versus did not attend the intervention 2. Significantly higher mean total step counts on days when participants did versus did not attend the intervention	G
	Cohen et al.[45]	1. Park-based energy expenditure and number of park users (System for Observing Play and Recreation in Communities)[79] 2. Park use, physical activity, awareness of and participation in park-sponsored activities (surveys including questions from Minnesota Hearth Health Programme)[80]	1 and 2. Over time, park use increased but there were no overall differences between the control and treatment arms	R

(Continued)

Table 3 (Continued)

Intervention category	Publication	Primary outcome(s)	Key finding(s)	Overall effect
	Han et al.[50]	1. Number of park users (System for Observing Play and Recreation in Communities)[79] 2. Intensity of physical activity (Metabolic Equivalents)[81]	1. Within-park comparison: Average METs per park user increased from 2.58 to 2.75 due to the exercise classes 2. Between-park comparison: during classes the study park had a higher number of parks users and METs than 95% of all other similar condition parks 3. Between-park comparison: No statistically significant differences observed during all other non-class times	G
	Kling et al.[51]	1. Body mass index (kg per m^2)[82] 2. Systolic blood pressure (SBP), diastolic blood pressure (DBP) and heart beats per minute[82] 3. Fitness performance (arm strength, chair stands, mobility)[83]	1. Adjusted models found no significant differences for BMI 2. Adjusted models found improvements in SBP and DBP across each time point (baseline to post intervention). No significant differences were observed for heart beats per minute 3. Adjusted models found improvements in arm strength, chair stands and mobility across each time point (baseline to post intervention)	Y
Park prescriptions				
	Razani et al.[55]	1. Stress (Perceived Stress Score)[59] 2. Park visits per week (participant recall) 3. Physiological stress (salivary cortisol levels)[55] 4. Loneliness (modified UCLA Loneliness Score)[84] 5. Physical activity (self-report and monitoring of pedometer)[85] 6. Nature affinity (self-report scale).[86] 7. Neighbourhood social support (self-report scale)[87]	1. The change in perceived stress did not significantly differ between the intervention and comparison conditions (supported and independent park prescription groups) at the 1-month or 3-month follow-ups 2. The comparison condition (independent park prescription group) had a statistically significant increase of in park visits per week compared to the supported park prescription group 3–7. No significant group difference over time	O
	South et al.[56]	1. Time in greenspace (total minutes and number of visits measured using smartphone GPS data)[56] 2. Postpartum depression (Edinburgh Postnatal Depression Scale).[88]	1. When restricted to the participants that received the intervention (as treated), the intervention was significantly associated with a three times higher rate of visits to nature compared to the control group 2. No significant differences were found in post-partum depression scores	Y
	Wexler et al.[57]	1. Perceptions of park services, recalled park visit frequency and park-based physical activity duration (Survey of Parks, Leisure-time Activity and Self-reported Health)[57]	1. Statistically significant treatment effect when controlling for a full set of covariates	G

BMI: body mass index; GPS: global positioning system; UCLA: University of California, Los Angeles.
Overall effect key:
G = overall positive effect; Y = mostly positive effects (over half of outcomes); O = some positive effects (less than half of outcomes), R = no overall positive effect.

applicable. Due to the characteristics of NBIs, none of the reviewed studies were able to blind participants to the intervention. While a lack of intervention blinding may have been unavoidable, it is important to consider the potential for bias such as participant expectancy effects and the impact that this may have on study results.

Overview of studies

For this review, individual studies were grouped based on the category of NBI utilised (see table 3).

Therapeutic horticulture

Seven of the included studies (39%) evaluated the effectiveness of therapeutic horticulture interventions in the form of home gardening ($n=4$) and community gardening ($n=3$) projects in the local community or neighbourhood. These interventions provided gardening training and resources for individuals to utilise in their own personal garden at home or within a community setting (see Supplemental material 4).

Physical health and wellbeing

When evaluating physical health changes, the reviewed studies reported no significant improvements in body mass index, blood pressure, waist circumference[52] or physical activity levels.[44] Statistically significant increases were, however, observed in vegetable consumption,[40,41] fruit and vegetable asking self-efficacy and awareness of nutritional guidelines.[49]

Four of the reviewed studies explored the impact of therapeutic horticulture on personal wellbeing with mixed results. There was evidence of significant reductions in perceived and physiological measures of stress,[44] a significant increase in quality of life[52] and a significant increase in shared emotional connection postintervention.[48] In contrast, there was also evidence of a significant increase in perceived stress scores,[52] and no significant difference in overall wellbeing.[44] One study also identified a significant reduction in participants' satisfaction with their health post-intervention.[48] In this study, older participants reported less satisfaction with their health than younger participants.

Produce and cost savings

In terms of cost savings, one study identified a statistically significant rise in the share of women selling vegetables at markets,[41] and there was also evidence that community gardeners yielded a statistically significant greater quantity of fruit or vegetable produce than controls.[54] One study reported similar cost savings per month for both community and home gardeners,[40] while another study found evidence to suggest that community gardeners spent significantly more money on food than a non-gardening sample.[54] It is necessary to highlight that both studies may be influenced by confounding demographic factors as they identified between-groups differences in baseline income,[40] and significant differences in the number of stores used when purchasing food.[54]

Care farming or wilderness arts and crafts

Three (17%) of the reviewed publications evaluated the effectiveness of care farming interventions. In two studies, participants received poultry husbandry training. In one study, participants received training on a range of topics including fertiliser management, agronomical practices, pest management, crop harvesting, marketing vegetables, farm processes and nutrition counselling. Only one (6%) of the reviewed publications evaluated a wilderness arts and crafts intervention in which participants engaged in a sustainable building project where they developed construction and outdoor skills.

Diet and food insecurity

Benefits of agriculture training interventions included significant improvements in dietary diversity,[42,53] consumption of nutrient rich foods[42] and likelihood of egg consumption.[46] One study also reported a non-significant reduction in likelihood of experiencing moderate-to-severe food insecurity for participants involved in the intervention when compared with controls.[42]

Anthropometric changes

Two of the reviewed studies also reported improvements in anthropometric outcomes for the children of mothers who had participated in an agriculture training intervention.[46,53] These infants were observed to have higher length-for-age, height-for-age and weight-for-age than those in the control sample,[53] and benefits were greater for children whose mothers had engaged most with the intervention.[46]

Resilience, anxiety and depression

Davies et al.[47] reported significant improvements in resilience scores following the outdoor sustainable project. However, this difference was only observed when the analysis was restricted to participants who fell at or below a predefined clinical threshold at the baseline assessment. Davies et al.[47] also measured changes in anxiety and depression levels before and after the intervention and found a statistically significant improvement in anxiety and depression outcomes for participants who had elevated scores at baseline.

Green exercise

Seven (39%) of the reviewed studies evaluated the effectiveness of green exercise in the form of park prescriptions and park-based fitness classes.

Park visits and time in nature

Three studies identified a statistically significant increase in number of nature or park visits post intervention[55–57] with greater benefits for participants who received a supported rather than unsupported park-prescription intervention.[55] There was also evidence that participants who received a park-prescription intervention reported higher rate of visits to nature than controls[56] and that intervention parks, which offered free exercise classes, had a greater number of park users than control parks.[50]

In contrast, Cohen et al.[45] reported no significant differences in park use for participants who engaged in park-based fitness classes compared with controls and identified an association between participants' perception of park safety and visits to the park, length of stay and engagement with the exercise classes.

Physical activity and health

Three studies identified a significant increase in physical activity[43,50] and park-based activities[57] for participants attending green exercise interventions. One study observed a statistically significant negative interaction between age and the treatment effect.[57] In contrast, Cohen et al.[45] found no differences in physical activity between the green exercise intervention or control groups.

One study reported significant improvements in arm strength, mobility and blood pressure for older adults attending park-based fitness classes.[51] In this study, differences in physical health outcomes were observed between ethnic groups and greater improvements in blood pressure outcomes were identified among younger participants living in low poverty (compared to older participants in higher poverty).

Stress and depression

Two of the reviewed publications evaluated the effect of park prescriptions on mental health outcomes. South et al.[56] found no significant improvements in post-partum depression scores for new mothers after the intervention. Razani et al.[55] reported a significant decrease in perceived and physiological stress levels for participants in supported and unsupported park prescriptions when data for both groups were analysed together. However, no statistically significant differences were observed between groups. In this study, male gender (for parents) was significantly associated with reduced stress over the course of the study. In addition, an increase in number of park visits was significantly positively associated with decreased stress.

DISCUSSION

KEY POINTS

1. The reviewed studies evaluated the effectiveness of therapeutic horticulture, care farming, green exercise and wilderness arts and crafts interventions on a range of economic, environmental, health and social outcomes.
2. Results were mixed and a broad range of outcome measures were used within the literature limiting the ability for direct comparisons.
3. Therapeutic horticulture interventions benefitted the production, consumption and marketing of vegetables. Care farming interventions improved diet diversity, food security and anthropometric outcomes. Wilderness arts and crafts improved anxiety and depression outcomes. Green exercise interventions enhanced nature visits, physical activity and physical health.
4. Age, gender, ethnicity, level of engagement and perception of environment safety influenced the effectiveness of the interventions.

The objective of this review was to explore the benefits of NBIs in socio-economically deprived communities. This review identified a broad range of interventions that have been evaluated to date, including therapeutic horticulture, care farming, green exercise and wilderness arts and craft. A range of economic, environmental, health and social co-benefits were observed.

Summary of results

Physical health outcomes for therapeutic horticulture interventions were mixed, with evidence of increased nutritional awareness[49] and vegetable consumption,[40,41] but no changes in anthropometric measures[52] or physical activity.[44] Similarly, mental health outcomes were mixed with evidence of reduced[44] and increased stress;[52] and both increased quality of life[52] and reduced satisfaction in life post intervention.[48] Previous research in general population samples has also revealed mixed results for community gardening interventions on health outcomes,[89] although therapeutic horticultural interventions on the whole have been observed to have positive impact on both physical and mental health.[33,90]

This review also identified economic benefits of home and community gardening interventions with a significant increase in quantities of produce yielded[54] and marketing of produce.[41] In addition, agriculture training interventions were found to significantly improve diet diversity[42,53] and anthropometric outcomes.[46,53] There was also evidence of non-significant improvements in food security.[42] These findings may be particularly important when considering the evidence that domains of financial health are associated with both physical and mental health,[91] and highlights the value of considering interactions between co-benefits of NBIs.

Within this review, a sustainable building project intervention improved resilience, anxiety and depression outcomes for individuals who presented with poorer mental health at baseline.[47] Considering the evidence that individuals living in socio-economically deprived communities are at greater risk of mental health difficulties,[8] this finding is of particular importance. Moreover, encouraging people to engage with their local parks also demonstrated benefits. Park-based fitness classes and park-prescription interventions were found to improve the number of nature visits,[55–57] physical activity[43,50,57] and physical health for participants,[51] although improvements in depression outcomes were not observed.[56] There was also evidence of stress reduction for participants in supported and unsupported park prescriptions. These findings echo that of the study by Corazan et al.[92] who reviewed NBIs in a broad sample of general population studies (in which the study by Razani et al.[55] was the only low-income population study); suggesting that accessing local parks may act as a vehicle for improved physical health for both those who are from socio-economically deprived communities and the general population.

Implications

Clinical implications

Socio-economic health inequalities are well understood with clear evidence of increased mortality,[4] disease[5] and overall compromised mental and physical health[7,8] for individuals living in socio-economic deprivation. It is also well established that the social determinants of health (individual living condition and wider systemic structures) have an important influence on health inequities,[93] and that health and illness follow a social gradient, thus those in a lower socio-economic position experience worse health.[12,94] This review has demonstrated how NBIs may serve to address health inequalities, promoting improved physical, mental and financial health, thus levelling up the social gradient. Based on this evidence, future public health initiatives should continue to incorporate NBIs into health and social care planning for socio-economically deprived populations, both on an individual and community level.

This review identified broad mental health benefits of NBIs,[44,47,48,52,55] and that NBIs may be of particular benefit for individuals in socio-economically deprived communities who experience mental health-related difficulties.[47] NBIs are increasingly being used within health services in the form of nature prescriptions with evidence to suggest positive effects of nature prescriptions on depression and anxiety.[95] Given the potential benefits of NBIs on mental health outcomes, future research and public health initiatives should endeavour to evaluate the benefits of NBIs in contrast to current treatment options for individuals from socio-economically deprived communities who experience mental health-related difficulties.

Urban planning

This review identified that an individuals' perception of the safety of an environment may impact the benefits observed;[45] a barrier that has widely been reported within the field of green space literature.[96–99] Perceived environmental safety and fear of crime is a particular concern for those of older age,[100] and for racialised individuals.[99] While recorded crime rates are substantially greater in the most socio-economically deprived areas,[101] research has shown that access to nature and NBIs can have a mitigating impact on violence.[102] As such urban planning initiatives should consider the two-way interaction between perceived environmental safety and NBI engagement for socio-economically deprived communities.

This review also highlighted that participants' level of engagement with an intervention was positively related to the overall impact of the intervention.[46] Previous research has demonstrated that co-created interventions can lead to more sustained outcomes and greater participation.[103,104] As such, it can be suggested that all stakeholders involved in the design of NBIs and green-space planning should collaborate with the communities they aim to serve to address pre-existing safety concerns and other potential barriers. Such collaboration may promote enhanced engagement with the intervention.

Future directions

Heterogeneity in measures

The reviewed studies evaluated a range of health, social, economic and environmental outcomes. Measures utilised included self-report surveys (e.g. mental wellbeing, physical activity, vegetable production); physiological measurements (e.g. cortisol levels, blood pressure); anthropometric measurements (e.g. height, weight); GPS trackers (e.g. Fitbit, mobile phone application) and observational methods (e.g. park use observations). While the broad range of outcome measures highlights the many co-benefits of NBIs, it also illustrates complexities observed in this review in drawing direct comparisons between NBI research. Future research should work towards developing a standardised measure or package of outcome measures to support comparisons of intervention effectiveness. Recent progress in this area includes the development of the 'BIO-WELL scale', which was established to empirically measure wellbeing and health effects following interactions with biodiversity.[105] While this new measure may offer a more comprehensive tool within the field of NBIs, it does not address the full range of co-benefits (health, economic, social and environmental) that are observed with NBIs, thus further research within this field is essential to allow better generalisability across studies examining a broader range of co-benefits. A recent systematic review protocol has been designed to evaluate health, wellbeing, social and environmental outcome measures for community gardening interventions.[106] The results of this review will be beneficial in supporting the development of standardised measurements and should be replicated with a broader range of NBIs.

Research design

The studies included in this review were of a moderate to high quality. Most of the reviewed studies ($n = 12$) evaluated between-group differences, but only six studies utilised a randomised approach to condition allocation. The randomised controlled trial design is traditionally regarded as the 'gold standard' for experimental research, as through the balancing of participant characteristics the overall potential for bias is reduced.[107] Moreover, only 8 (44%) of the included studies utilised a control comparison condition. From a public health perspective, such designs are advantageous as they allow conclusions to be drawn regarding the benefits of treatment interventions over standard care. As such, future research in this field should endeavour to incorporate control comparison conditions and utilise a randomised approach to condition allocation where possible.

Moreover, reporting of participant characteristics was identified as a weakness in much of the reviewed literature and almost half ($n = 8$, 44%) of the included studies did not report on participant ethnicity. It is well established that ethnic minority groups are disproportionately affected by socio-economic deprivation,[108] and that the effect of living in a deprived area impacts on ethnic minorities more disadvantageously.[109] As such, it is imperative that future NBI research and

initiatives consider the interaction between socio-economic deprivation and ethnicity. An intersectional approach to future research would facilitate greater understanding of how people are exposed to, and experience combinations of inequalities differently.[110] Future research should therefore aim to go beyond the 'what works' question and draw on a realist evaluation approach to seek to answer the questions of 'what works for whom in which circumstances'.[111]

Strengths and limitations

The reviewed literature was limited to publications in English language and, therefore, may not fully represent the global body of research. In addition, while a strength of this review is the broad representation of different cultures and settings (8 different countries represented in 18 studies), attention must be paid to the unique context of the reviewed research and caution must be applied when evaluating the evidence together and the conclusions that can be drawn from these diverse set of studies.

Moreover, the heterogeneity in interventions across the reviewed studies limits the ability to fully understand which interventions, and more specifically which elements of these interventions, are responsible for the benefits observed. This is a common challenge faced when reviewing quantitative NBI research.[112,113] As such, further reviews incorporating qualitative data may be valuable to better understand participants experiences of NBIs. Such data may also provide insight into the individual, contextual and interpersonal factors that enhance or reduce the benefits of NBIs in socio-economically deprived communities. While it is evident from this review that there are substantial benefits of a range of NBIs in socio-economically deprived communities, much remains to be done before these overall benefits are fully understood.

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SUPPLEMENTAL MATERIAL

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