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Review Article

Indoor Nature Interventions for Health and Wellbeing of Older Adults in Residential Settings: A Systematic Review

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Abstract

Background and Objectives: Having contact with nature can be beneficial for health and wellbeing, but many older adults face barriers with getting outdoors. We conducted a systematic review of quantitative studies on health and wellbeing impacts of indoor forms of nature (both real and simulated/artificial), for older adults in residential settings.

Research Design and Methods: Search terms relating to older adults and indoor nature were run in 13 scientific databases (MEDLINE, CINAHL, AgeLine, Environment Complete, AMED, PsychINFO, EMBASE, HMIC, PsychARTICLES, Global Health, Web of Knowledge, Dissertations and Theses Global, and ASSIA). We also pursued grey literature, global clinical trials registries, and a range of supplementary methods.

Results: Of 6,131 articles screened against eligibility criteria, 26 studies were accepted into the review, and were quality-appraised using the Effective Public Health Practice Project (EPHPP) tool. The participants were 930 adults aged over 60. Nature interventions and health/wellbeing outcomes were heterogeneous, which necessitated a narrative synthesis. The evidence base was generally weak, with 18 of 26 studies having a high risk of bias. However, several higher-quality studies found indoor gardening and horticulture programs were effective for cognition, psychological wellbeing, social outcomes, and life satisfaction.

Discussion and Implications: There is inconsistent evidence that indoor nature exposures are beneficial for older care residents. We expect that successful interventions were, at least partly, facilitating social interaction, supporting feelings of autonomy/control, and promoting skill development, that is, factors not necessarily associated with nature per se. Higher-quality studies with improved reporting standards are needed to further elucidate these mechanisms.

Keywords: Nature, Intervention studies, Residential care, Wellbeing, Indoor environment

Background and Objectives

In the United Kingdom in 2018, around 421,000 adults aged 65+ were living in residential homes (Age UK, 2017). Despite the benefits of 24-hr access to professional staff and presence of a network of other residents, transitioning into and living well within long-term care can present significant challenges for some residents; with greater risk of dissatisfaction, loneliness, hopelessness, and depression accompanying declines in physical and cognitive health as people age (NICE, 2013).

One way to support residents' wellbeing, and help "buffer" them against changes to their routines and health conditions, could be through facilitating contact with nature. A high proportion of older adults reports that contact with nature is important to them (Finlay, Franke, McKay, & Sims-Gould, 2015; Orr, Wagstaffe, Briscoe, & Garside, 2016; Reynolds, 2016). Moreover, growing evidence indicates that living near to and/or visiting natural environments (e.g., green spaces such as parks, woodland, and blue spaces like the coast, lakes, and rivers) can have a wide range of health and wellbeing benefits (Gascon et al., 2015; Gascon, Zijlema, Vert, White, & Nieuwenhuijsen, 2017; Mitchell & Popham, 2008; White, Pahl, Wheeler, Depledge, & Fleming, 2017). Though this evidence usually draws on the wider general population; benefits have also been reported in residential care settings. For example, time spent in "nearby nature"—usually the home's garden—has been associated with improved concentration (Ottosson & Grahn, 2005), reduced agitation (Whear et al., 2014), supported feelings of competence (Rappe & Topo, 2007), and increased quality of life (QoL) for residents (Raske, 2010), including for those with dementia (Whear et al., 2014).

Despite these findings, various barriers, such as physical mobility issues, staff shortages, and concerns for residents' safety, can make access to nature difficult for long-term care residents (Hernandez, 2007; Kearney & Winterbottom, 2006; Morgan & Stewart, 1999; Reynolds, 2016; Rodiek, 2006). Lack of contact with nature has been associated with chronic stress and poor mental health among the world's increasingly urban populations (McSweeney, Rainham, Johnson, Sherry, & Singleton, 2015). Therefore, it is conceivable that concomitant detachment from nature could exacerbate the potential mental health problems faced by long-term care residents. Finding ways to connect residents with nature might help maintain or improve wellbeing and reduce negative symptoms.

One way to enable nature contact for residents for whom outdoor access is infrequent or impossible, could be to simulate aspects of nature indoors. A 2014 literature review that included adults across the whole life span, explored impacts of real and simulated indoor forms of nature, ranging from permanent installations (e.g., building design features, nature art, indoor gardens), to more interim exposures (e.g., photographs and films). Improvements were found in a range of wellbeing outcomes including cognition, physiological stress/restoration, mood/affect, QoL, and reductions in physical pain (McSweeney et al., 2015). Although encouraging, none of the studies in this review focused on older adults, including those living in long-term care. We anticipated that the circumstances of these individuals, not least their ability to interact with nature autonomously, may be markedly different than the general adult population. Consequently, the current systematic review aimed to fill this evidence gap by synthesizing the health impacts of indoor nature exposure for older people in residential settings. Both real and simulated forms of nature were included. The review question was: "is exposure to indoor nature beneficial for the health and wellbeing of older adults in residential settings?"

Methods

The review was conducted according to Centre for Reviews and Dissemination (CRD) guidelines (Centre for Reviews and Dissemination, 2009), and the protocol was registered with PROSPERO (CRD42017056750).

Study Eligibility

The PICOS method was used to define eligibility criteria as follows; **P**opulation: Adults aged 60+ (or where the median sample age is 60+) living in any residential setting (including assisted and independent living complexes); **I**ntervention: any form of real or simulated indoor nature exposure (excluding window views of outdoor nature, and animal-assisted therapy); **C**ontrol/comparator: non-nature interventions (e.g., music groups) or no-intervention (i.e., "usual care") control groups. We also accepted single group before-after-after ("pre/post") studies; **O**utcome: any health or wellbeing outcome; **S**tudy design: any quantitative design. A more thorough description, detailing inclusion, and exclusion criteria, is available in Table 1.

Database Search

A Master Search was developed iteratively in the MEDLINE database in consultation with an information specialist. The final list of search terms is available in Supplementary Appendix 1; terms related to older adults or residential care were combined using the "AND" operator, with terms related to indoor nature interventions. Free-text searching was used together with relevant MeSH subject headings. The Master Search was adapted in 12 databases: CINAHL, AgeLine, Environment Complete, AMED, PsychINFO, EMBASE, HMIC, PsychARTICLES, Global Health, Web of Knowledge, Dissertations and Theses Global, and ASSIA. The search identified 24 papers when it was originally performed in March 2017 and 2 further papers when it was rerun September 2018.

Grey Literature

OpenGrey, The British Library Catalogue and two global clinical trials registries (clinicaltrials.gov and www.who.int/trialsearch) were searched for grey literature.

Supplementary Search

This included forwards and backwards citation chasing, hand-searching nonindexed journals, searching authors'

Table 1. Study Eligibility Criteria

	Population	Intervention	Comparator/ Control	Outcomes	Study design	Setting
Inclusion criteria	Adults aged 60+ (or where the median age was 60+, or the majority of participants were aged 60+)	Exposure to any form of indoor real, artificial or virtual/simulated nature including but not limited to: indoor gardening/ horticulture programs, indoor gardens/plants, nature art/imagery, videos, and Virtual Reality.	Non-nature interventions (e.g., music groups, receiving visitors) No-intervention controls (i.e., "usual care") Noncontrolled studies	Any health or wellbeing outcome(s). Health was based on the WHO definition, encompassing physical psychological and social aspects. Wellbeing was considered as more holistic, encompassing functional and behavioral aspects, feelings, emotions and moods.	Any quantitative design. Mixed methods were accepted if the quantitative aspect could be separated.	Residential settings: defined as anywhere participants were currently living and primarily considered "residents," i.e., not "patients," "inmates," or "workers"
Exclusion criteria	Average age across sample was under 60	Nature exposure wholly or partially experienced outdoors Window views, e.g., onto countryside and gardens Studies where it was not possible to distinguish the impact of nature from other aspects of multicomponent interventions Studies on pet or animal-assisted therapy Studies about impact of sunlight or UV exposure		Health and/or wellbeing outcomes were not reported	There was no quantitative data Quantitative data could not be separated from qualitative data in mixed methods studies.	Anywhere where the ultimate aim was discharge from the facility, such as hospitals and rehabilitation centers. Prisons Vacation or respite settings Work-based settings
Additional requirements	Written in English Presented within academic journals, dissertations, or theses The full-text of the article had to be available/retrievable where abstracts alone did not provide sufficient information to apply quality appraisal criteria There were no restrictions according to publication status or dates					

Note: Studies were required to meet all of the inclusion and exclusion criteria, and several additional requirements, to be eligible for inclusion in the systematic review.

publication lists, examining key literature reviews (Bossen, 2010; Bringslimark, Hartig, & Patil, 2009; Gonzalez & Kirkevold, 2014; McSweeney et al., 2015; Wang & MacMillan, 2013), and contacting a range of relevant local, national, and international organizations.

Screening

All hits were imported into Endnote X7 reference management software and de-duplicated. Title/abstract screening and subsequent full-text screening were performed by two independent reviewers. Where there were disagreements on eligibility, consensus was reached through discussion and, if unresolved, by consulting a third reviewer. A PRISMA flow chart overviewing the searching and screening processes is shown in Figure 1.

Data Extraction

Study data were independently extracted by two reviewers using a prepiloted template (see Supplementary Appendix 2). Discrepancies arising between reviewers were resolved through discussion and consulting a third reviewer if necessary.

Quality Appraisal

The Effective Public Health Practice Project (EPHPP) Quality Assessment Tool for Quantitative Studies

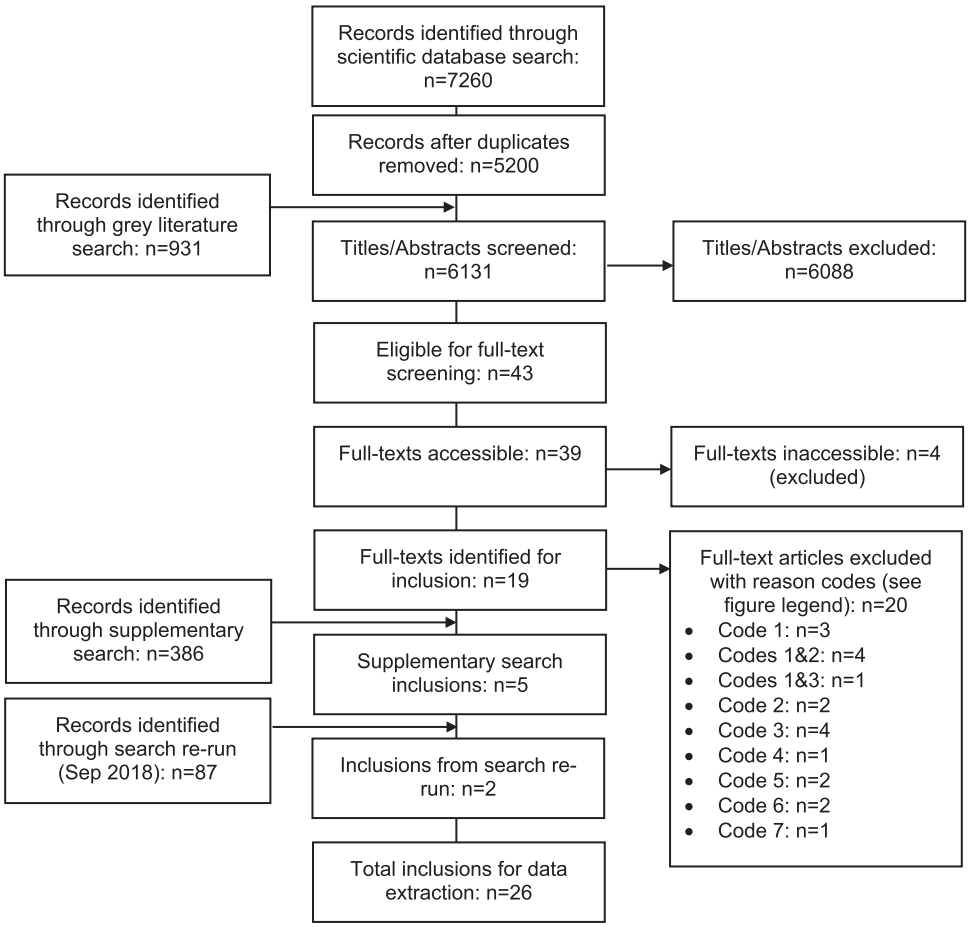

Figure 1. Study selection flowchart. *Note*: PRISMA flow diagram outlining study selection process. Exclusion codes: (1) study set in an environment where the participants were not living permanently; (2) the majority of participants were aged under 60; (3) nature exposure was wholly or partially experienced outdoors; (4) study did not use quantitative data; (5) not enough detail was available to apply the quality appraisal criteria; (6) study duplicates material from an already-included study; and (7) no nature intervention included.

(Thomas, Ciliska, Dobbins, & Micucci, 2004) was used by two independent reviewers to appraise study quality. The EPHPP was considered appropriate because it: (1) allows assessment of any quantitative study design, (2) was developed for health promotion interventions, (3) has been judged suitable to be used in systematic reviews of effectiveness, and (4) has adequate construct and content validity (Armijo-Olivo, Stiles, Hagen, Biondo, & Cummings, 2012; Thomas et al., 2004). The tool assesses six domains: (1) selection bias; (2) study design; (3) confounders; (4) blinding; (5) data collection method; and (6) withdrawals/dropouts. Each domain is rated as strong (one point), moderate (two points), or weak (three points) according to EPHPP guidance, and domain scores are averaged to provide a global score. Based on their global score, studies are assigned a quality rating reflecting risk of bias, of weak (2.51–3.00, i.e., high risk of bias), moderate (1.51–2.50, i.e., medium risk of bias) or strong (1.00–1.50, i.e., low risk of bias). We refer to study quality hereafter as "strong," "moderate," or "weak" as a form of shorthand, and to align with the EPHPP language. We did not exclude any studies based on quality.

Data Synthesis

The heterogeneous nature of the study designs and outcome measures precluded meta-analysis and so, we provide a narrative synthesis in the results and discussion sections, drawing on study findings (usually reported as difference in group means) with reference to study quality. Most studies did not confirm baseline equivalence, and as such we were unable to accurately calculate post-test effect sizes.

Results

Twenty-six papers were included in the review (see Figure 1).

Overview of Studies

Included studies were highly heterogeneous in terms of nature interventions, comparator groups, and health/wellbeing outcomes. An overview of all studies, grouped by intervention, is shown in Table 2, with full study details provided in Supplementary Appendix 3. Table 2 also indicates the significance of each study outcome, with full

results provided Supplementary Appendix 4, and discussed in the following sections.

Most studies took place after 2000 with the majority published in the last decade (n = 19), although four took place between 1979 and 1998. The studies were conducted in the United States (n = 15), Australia (n = 2), Canada (n = 1), Hong Kong (n = 1), Taiwan (n = 1), United Kingdom (n = 1), or an unspecified location (n = 5). Settings included nursing homes (n = 9), homes, wings, or units specialized to accommodate people with dementia (n = 6), residential, continuing care, or aged care homes (n = 7), assisted living accommodation (1), and independent living apartment complexes (n = 3).

A total of 930 participants (mean per study: 36; range per study: 10–85) were included in the 26 studies. Across the 18 studies which specified participant ages, mean/median age ranged from 61 to 89 years. Across the 23 studies which reported participant sex, a mean of 69% were female. Only one study recruited more men than women (Goto, Kamal, Puzio, Kobylarz, & Herrup, 2014).

The interventions, which are detailed more fully below, included indoor gardening and horticulture programs (which involved active participation by residents), indoor gardens (which residents visited, but were not actively involved in maintaining), indoor plants, nature installations, photographs, films, Virtual Reality, and fish tank aquariums.

Eighteen studies used control or comparison groups (three randomized controlled trials [RCT], four cluster RCT, eight controlled clinical trials [CCT], and three crossover studies) which included usual care, receiving social visits from the researchers or the home's staff, waiting list designs, music groups, and nonnature installations/photographs and films. The remaining eight studies were one-group designs.

A range of functional/physical, physiological, cognitive, behavioral, emotional, and social health and wellbeing outcomes were captured using self-report scales, researcher/carer observations, participant tests and tasks (e.g., for assessing cognition), and direct objective measurements (e.g., for physiological outcomes such as pulse rate). Each study reported between one and seven outcomes.

Study Quality

A summary of the quality appraisal is shown in Table 3. Eighteen of the 26 studies received weak ratings, 7 were moderate (Barnicle & Midden, 2003; Edwards, Beck, & Lim, 2014; Lee & Kim, 2008; Martin, 2011; Reynolds, Rodiek, Lininger, & McCulley, 2018; Scott, Masser, & Pachana, 2014; Tse, 2010) and 1 was strong (D'Andrea, Batavia, & Sasson, 2008). The strongest components across all studies were: (1) study design (i.e., likelihood of bias resulting from allocation processes was minimized, and, where applicable, a method of randomization was described and justified) and (2) withdrawals/dropouts (i.e., dropout rates were reported, and a high proportion of participants completed the study), with 62% of studies receiving a "strong" rating on each of these. The weakest components overall were: (1) confounders (i.e., authors did not indicate whether groups were equivalent at baseline, or did not explain whether/how additional variables were controlled for in the analysis) with 69% receiving a "weak" rating and (2) blinding (i.e., authors did not state whether outcome assessors and participants were blind to participant intervention status) with 50% receiving a "weak" rating.

Interventions

The interventions can be divided broadly into two categories: (1) "active" nature interventions, which involved intentional, direct, and tactile interaction with real forms of nature or Virtual Reality and (2) "passive" nature interventions, in which participants could observe forms of real nature (e.g., indoor plants, fish aquariums) or simulated nature (e.g., photo walls, nature videos), but were not able to influence or manipulate them.

Active Nature Studies

Nine out of the 10 active nature programs involved interaction with real forms of nature through "indoor gardening" (Brown, Allen, Dwozan, Mercer, & Warren, 2004; Lee & Kim, 2008; Powell, Felce, Jenkins, & Lunt, 1979; Tse, 2010); "horticulture activities" (Barnicle & Midden, 2003; Collins & O'Callaghan, 2008; Masuya, Ota, & Mashida, 2014); or "Horticulture Therapy" (D'Andrea et al., 2008; Yao & Chen, 2017) programs. The distinction between these subtypes was unclear; all involved instructor-led activities related to cultivating plants, and most included group discussion. There were generally one or two sessions (totaling 30–120 min) per week, for 4–10 weeks. Some programs had specific lessons/plans each week; others were more informal. The other active nature study used a form of Virtual Reality, consisting of a large immersive wall-mounted TV screen depicting a forest scene (Moyle, Jones, Dwan, & Petrovich, 2018). Video game technology allowed participants to interact with and influence the forest elements by moving their hands and arms. Seven of the 10 active nature studies included a control group—most often this was "usual care" (n = 5). Six of the 10 studies were rated as weak quality, three as moderate, and one as strong.

Passive Nature Studies

These 16 studies used indoor plants (Kiyota, 2009; Webster, 2015), an indoor garden (Goto et al., 2014), nature corridor enhancements (Cohen-Mansfield & Werner, 1998; Martin, 2011; Scott et al., 2014), aquariums (DeSchriver & Riddick, 1990; Edwards & Beck, 2002, 2013; Edwards et al., 2014;

Table 2. Individual Study Information and Outcomes

First author, year, country	Study design (quality score)	Sample	Residence type	Intervention(s)	Comparator(s) / control(s)	Frequency/ duration	Outcome(s)	W[a]	B[b]
Indoor gardening and horticulture programs									
D'Andrea et al., 2008, United States	RCT (Strong)	40 (AZD)	Nursing home	Horticulture therapy program	Various regular scheduled activities, e.g., music sessions, reminiscence discussions, socialising	2× 30–45 min sessions per week for 12 weeks	1. Cognition	-	✓
Brown et al., 2004, United States	Cluster RCT (Weak)	66	Nursing home	Indoor gardening program	20-min visits from care staff	1× session[c] per week for 5 weeks	1. ADL		
							2. Socialization	-	-
							3. Loneliness	-	-
Tse, 2010, Hong Kong	Cluster RCT (Moderate)	53	Nursing home	Indoor gardening program	Usual care	1× session[c] per week for 8 weeks	1. ADL	-	-
							2. Socialization	✓	✓
							3. Loneliness	✓	✓
							4. Life Satisfaction	✓	✓
Powell et al., 1979, United Kingdom	CCT (Weak)	32 (physically frail)	Residential home	Gardening days	Nongardening days (usual care)	1× session[c] per week for 10 weeks	1. Engagement		✓
Barnicle & Midden, 2003, United States	CCT (Moderate)	62	Residential home	Horticulture activity program	Usual care (waiting list)	1× 1 hr session per week for 7 weeks	1. Affect	-	✓
Masuya et al., 2014, not specified	CCT (Weak)	18	Nursing home	Horticultural activity program	Usual care	1× 30–40 min session per week for 6 weeks	1. Cognition		
							2. Depression	✓	✓
							3. ADL	-	-
							4. QoL	-	-
Yao & Chen, 2017, Taiwan	CCT (Weak)	85	Nursing home	Horticulture therapy program	Usual care (waiting list)	1× 1-hr session per week for 8 weeks	1. ADL	✓	✓
							2. Happiness	✓	✓
							3. Meaning of life	-	-
							4. Interpersonal intimacy	✓	✓
Collins & O'Callaghan, 2008, United States	One-group pre/ post (Weak)	18	Assisted living facility	Horticulture activity program	N/A	1× 2 hr session per week for 4 weeks	1. Mastery	✓	
							2. SR health	✓	
							3. SR happiness	✓	
Lee & Kim, 2008, not specified	One-group pre/ post (Moderate)	23 (mild to severe dementia)	"Institution"	Indoor gardening program	N/A	2× 1-hr sessions per day, every day for 28 days; participants could also access their plants whenever they wanted	1. Agitation	✓	
							2. Cognition	✓	
							3. Sleep	✓	

Table 2. *Continued*

First author, year, country	Study design (quality score)	Sample	Residence type	Intervention(s)	Comparator(s) / control(s)	Frequency/ duration	Outcome(s)	W[a]	B[b]
		Indoor gardens and plants							
Kiyota, 2009, Canada	Three-group cluster RCT (Weak)	30	Small houses within elderly care complex	(1) Indoor plants: active group (2) Indoor plants: passive group 1)	No plants	Plants placed in the living room for 6 weeks. Cared for by participants (active) or staff (passive)	1. Perceived restoration	-	✓
							2. Depression	-	-
Goto et al., 2014, United States	CCT (Weak)	36 (late stage dementia)	Nursing home	Indoor Japanese garden	(1) Snoezelen room (2) control space (participant's bedroom)	2 × 15 min sessions per week for 3 weeks	1. Physiological stress (pulse rate)		
							2. Behavior		✓
Webster, 2015, United States	One-group ABABB (Weak)	11 (dementia)	Memory care wing of continuing care facility	Indoor plants	N/A	Plants installed on day 1, removed on day 6, replaced on day 8 and	1. Cognition 2. Behavior		
		Indoor nature installations							
Scott et al., 2014, Australia	Three-group cluster RCT (Moderate)	33	Residential aged care facility	Biophilia installation	(1) Reminiscence installation (2) No installation	4 weeks	1. Anxiety	-	-
							2. Depression	-	-
							3. Social engagement	✓	✓
							4. Satisfaction with living environment	-	-
							5. Satisfaction with opportunities for keeping occupied	-	-
Martin, 2011, United States	Cluster-randomized crossover (Moderate)	22 (AZD)	Nursing home	Nature slide show looped corridor projection (180 photos)	Nursing home interiors slide show looped corridor projection (180 photos)	Projections looped for 5 days between 09:00 and 17:00	1. Agitation	-	-
Cohen-Mansfield & Werner, 1998, not specified	Quasi-crossover (Weak)	27 (residents who pace frequently; 92.6% had dementia)	Nursing home	Nature corridor enhancement	"Home" corridor enhancement	4 weeks each	1. Agitation	-	-
							2. Dementia-related behaviors	-	-
							3. Mood	-	-
		Nature photographs, films and immersive virtual nature experiences							

Table 2. *Continued*

First author, year, country	Study design (quality score)	Sample	Residence type	Intervention(s)	Comparator(s) / control(s)	Frequency/ duration	Outcome(s)	W[a]	B[b]
Aslakson, 2010, United States	RCT (Weak)	40 (dementia)	Nursing home	Nature videos	Music therapy	3 × 30–40 min sessions over 1 week	1. Agitation 2. Engagement 3. Functional behavior	- x -	- x -
Eggert et al., 2015, not specified	Two group pre/ post (Weak)	13 (dementia)	Memory care unit of assisted living facility	Preferred nature images (photographs)	Preferred music	1× 90-min session per week for 4 weeks	1. Cognition 2. Engagement 3. Agitation		
Reynolds et al., 2018, not specified	Quasi-Crossover (Moderate)	14 (mild to severe dementia)	Memory unit of assisted living facility	Immersive nature experience, including film on 65-inch TV,	Generational movie on 65-inch TV	3× trials involving 10 min exposure to each condition. 1 day washout between	1. Observed emotions 2. Agitation 3. Heart rate	- - ✓	- - ✓
Moyle et al., 2018, Australia	One-group pre/ post (Weak)	10 (dementia)	Residential aged care facility	Virtual Reality Forest (Large interactive wall-mounted 2D screen)	NA	1× session of 8–12 min duration.	1. Observed emotions 2. Apathy 3. Engagement	✓	
Chung et al., 2016, United States	One-group pre/ post (Weak)	23 (dementia)	Nursing home	Nature media presentations (DVDs)	N/A	1× 7–10 min session, 3× per week for 2–4 weeks	1. Agitation	-	
Kieffer, 2014, United States	Cross-sectional (Weak)	20	Private senior independent living community	Representational elements of nature (photographs)	N/A	1× 25 min interview	1. Perceived wellbeing		
Aquariums									
DeSchriver & Riddick, 1990, United States	RCT (Weak)	27	Publicly-subsidized housing unit	Fish aquarium	1) Fish videos[d] 2) Videos of static	1× 8 min session per week for 3 weeks	1. Cardio-vascular activity (proxy for physiological stress)	-	-
Edwards& Beck, 2002, United States	CCT (Weak)	62 (AZD)	Dementia-specific unit	Fish aquarium	Scenic ocean picture[d] (waiting list)	Aquarium for 8 weeks; scenic ocean picture for	1. Nutritional Intake 2. Body weight	✓	
Riddick, 1984, United States	Three-groups CCT (Weak)	24	Publicly-subsidized apartments	Fish aquarium plus researcher visits	(1) Researcher visits only (2) Control (no aquarium, no researcher visits)	10× 20–40 min visits once per fortnight	1. Diastolic blood pressure 2. Systolic blood pressure 3. Happiness 4. Anxiety 5. Loneliness 6. Leisure satisfaction	✓ - - - - -	
Edwards & Beck, 2013, United States	One-group pre/ post (Weak)	70 (dementia)	Specialized dementia unit	Fish aquarium	N/A	8 weeks, visible at mealtimes	1. Food Intake 2. Body weight	✓ ✓	

Table 2. *Continued*

First author, year, country	Study design (quality score)	Sample	Residence type	Intervention(s)	Comparator(s) / control(s)	Frequency/ duration	Outcome(s)	W[a]	B[b]
Edwards et al., 2014, United States	One-group pre/ post (Moderate)	71 (dementia)	Specialized dementia unit	Fish aquarium	N/A	8 weeks, visible at mealtimes	1. Behavior	✓	

Note: AZD = Alzheimer's disease; CCT = Controlled clinical trial; N/A = Not applicable; QoL = Quality of Life; RCT = Randomized controlled trial; SR = Self-reported.
[a]Within-group changes; [b]between-group changes; [c]duration of sessions not indicated; [d]condition was a control group in the individual study but is considered as an intervention for the current review. In the W column, green (✓) indicates the intervention group (but not the control/comparator group, if included) was significantly effective over time; yellow (-) indicates the intervention group had no significant effect over time; red (X) indicates the control/comparator group (but not the intervention group) was significantly effective over time. In B column, green (✓) indicates a significant difference favoring intervention; yellow (-) indicates no between-group differences; red (X) indicates a significant difference favoring control/comparator. In either W or B column, no color/symbol means results were inconsistent/mixed, direction of effect(s) were unclear, some results were not reported, the study only reported descriptive statistics, or the test was not performed or not applicable.

Riddick, 1984), or media such as nature photos or videos (Aslakson, 2010; Chung, Choi, & Kim, 2016; Eggert et al., 2015; Kieffer, 2014; Reynolds et al., 2018). The duration of the interventions ranged from a 25-min photo viewing session (Kieffer, 2014), up to a 6-month longitudinal study involving an aquarium intervention (Riddick, 1984), but most interventions ran for 2–8 weeks. Sample sizes tended to be smaller in the passive (mean n = 33, range 11–71) than the active (mean n = 41, range 10–85) nature studies, and quality was marginally lower, with 12 of 16 studies being weak, and 4 being moderate. Eleven studies included control groups, but other designs were less robust, including one cross-sectional study (Kieffer, 2014). A greater proportion of the passive nature studies (11 of 16), compared with active nature studies (3 of 10), specifically recruited people with dementia, who lived in specialized dementia units, memory care units, or nursing homes. The remaining five passive nature studies all took place in independent living facilities.

Outcomes

The results of each study are indicated in Table 2, detailed fully in Supplementary Appendix 4, and discussed in the sections below.

Dementia-Related Outcomes

Twelve studies measured impacts of indoor nature on dementia-related outcomes such as cognition and agitation. Effects were inconsistent, with nature interventions often proving no more effective than comparators such as music therapy (Aslakson, 2010), "home-like" corridor installations (Cohen-Mansfield & Werner, 1998; Martin, 2011) or a generational movie (Reynolds et al., 2018). Agitation and cognitive decline were significantly lower in higher-quality gardening studies (D'Andrea et al., 2008; Lee & Kim, 2008), but not in a lower quality horticulture study (Masuya et al., 2014). Other dementia-related behaviors were more often targeted using passive interventions in weaker quality studies (Cohen-Mansfield & Werner, 1998; Goto et al., 2014; Webster, 2015), and results and reporting standards were mixed.

Psychological Wellbeing Outcomes

Twelve studies measured impacts on psychological wellbeing, with outcomes ranging from emotional states such as mood and affect, to clinically-relevant indicators of anxiety and depression. Reporting tended to be better and sample sizes larger for psychological wellbeing than dementia-related outcomes. Nevertheless 8 of 12 studies received weak ratings despite 6 of these having included control groups. Weak ratings were usually due to problems with researcher–participant blinding (an understandable challenge in a care home setting), and/or failure to account for potential confounders.

Table 3. Quality Appraisal/Risk of Bias

Lead Author	EPHPP subcategory						
	Selection bias	Study design	Confounders	Blinding	Data collection method	Withdrawals and dropouts	Global rating
Aslakson	M	S	S	S	W	W	Weak
Barnicle	M	S	S	W	S	S	Moderate
Brown	M	S	S	W	S	W	Weak
Chung	M	M	W	W	W	S	Weak
Cohen-Mansfield	M	S	W	M	W	W	Weak
Collins	M	M	W	W	S	S	Weak
D'Andrea	M	S	M	M	S	S	Strong
DeSchriver	W	S	W	W	S	S	Weak
Edwards and Beck (2002)	M	S	W	M	W	S	Weak
Edwards and Beck (2013)	M	M	W	M	W	S	Weak
Edwards and colleagues (2014)	M	M	W	M	S	S	Moderate
Eggert	W	M	W	M	S	M	Weak
Goto	M	S	W	M	W	W	Weak
Kieffer	M	W	W	W	W	W	Weak
Kiyota	W	S	W	M	S	S	Weak
Lee	M	M	W	M	M	S	Moderate
Martin	M	S	S	W	S	S	Moderate
Masuya	M	S	W	W	S	S	Weak
Moyle	M	M	W	W	S	W	Weak
Powell	M	S	W	M	W	W	Weak
Reynolds	M	W	S	M	S	M	Moderate
Riddick	W	S	W	W	S	S	Weak
Scott	M	S	S	M	W	M	Moderate
Tse	M	S	S	W	S	S	Moderate
Webster	M	M	W	W	W	S	Weak
Yao	M	S	W	W	S	S	Weak

Note: Quality appraisal was performed according to EPHPP criteria. The subcategories were scored as being weak (W), moderate (M), or strong (S). The subcategories were then averaged to calculate the global rating.

Active interventions were associated with significant improvements across weak (Masuya et al., 2014; Moyle et al., 2018; Yao & Chen, 2017) and moderate (Barnicle & Midden, 2003; Tse, 2010) studies measuring depression (Masuya et al., 2014), happiness (Yao & Chen, 2017), affect (Barnicle & Midden, 2003), and loneliness (Tse, 2010). Significant improvements occurred more frequently where the control group was "usual care." By contrast, comparator groups, for example, receiving social visits (Brown et al., 2004), were just as effective as active nature-based interventions, for psychological wellbeing. Other studies found improvements in apathy during exposure to a Virtual Reality forest (Moyle et al., 2018), and in happiness and feelings of mastery following a horticulture activity program (Collins & O'Callaghan, 2008), but both were based on small samples and lacked control groups.

Effects of passive interventions were inconsistent, but generally more effective for interim outcomes such as pleasure (Cohen-Mansfield & Werner, 1998; Reynolds et al., 2018), and perceived restoration (Kiyota, 2009), than clinical ones like anxiety or depression (Kiyota, 2009; Reynolds et al., 2018; Scott et al., 2014), which may reflect that the interventions had relatively short time frames. Happiness scores improved for participants who received a home aquarium plus researcher visits, relative to a visits-only group, or no-intervention controls (Riddick, 1984), but as between-groups inferential analyses were not conducted; the statistical significance of these effects was unclear.

Social Outcomes

Social engagement and interpersonal intimacy significantly improved in weak (Yao & Chen, 2017) and moderate (Tse, 2010) studies that compared gardening/horticulture programs against "usual care." However, there were no significant improvements over alternative types of interventions including 20-min social visits (Brown et al., 2004) or a "reminiscence" installation (Scott et al., 2014) in weak- and moderate-quality studies, respectively.

Functional and Physical Outcomes

Seven studies measured functional or physical health and wellbeing, in terms of Activities of Daily Living (ADL) (Brown et al., 2004; Masuya et al., 2014; Tse, 2010; Yao & Chen, 2017), sleep (Lee & Kim, 2008), and nutritional intake and body weight (Edwards & Beck, 2002, 2013). Of one moderate (Tse, 2010) and three weak (Brown et al., 2004; Masuya et al., 2014; Yao & Chen, 2017) studies that measured ADL before and after completion of controlled indoor gardening/horticulture programs lasting 5–8 weeks, only one weak-quality study found significant positive effects (Yao & Chen, 2017). There were indications that indoor gardening and fish aquariums were able to improve the quality and quantity of sleep (Lee & Kim, 2008) and nutritional intake/body weight (Edwards & Beck, 2013), respectively, for people with dementia, but these studies lacked control groups for comparison.

Physiological Outcomes

One moderate-quality and three weak-quality studies investigated whether passive nature interventions (a nature film (Reynolds et al., 2018), fish aquariums (DeSchriver & Riddick, 1990; Riddick, 1984), or an indoor garden (Goto et al., 2014)) could alter indicators of physiological stress, such as pulse rate and blood pressure. A moderate-quality crossover study reported that average heart rate significantly decreased for people with dementia when they watched a nature film, but not when they watched a generational movie (Reynolds et al., 2018). Although the other studies also used controlled designs; all suffered from poor reporting, with no between-group comparisons made in two (Goto et al., 2014; Riddick, 1984) and mismatches between tabulated data and study conclusions in the other (DeSchriver & Riddick, 1990).

General Health, Wellbeing, and Satisfaction

The remaining outcomes comprised various measures of satisfaction (Riddick, 1984; Scott et al., 2014; Tse, 2010), engagement (Aslakson, 2010; Eggert et al., 2015; Moyle et al., 2018; Powell et al., 1979) and self-perceived health, wellbeing, and QoL (Collins & O'Callaghan, 2008; Kieffer, 2014; Masuya et al., 2014; Yao & Chen, 2017). At least some significant improvements were reported in all five studies which employed gardening/horticulture programs (Collins & O'Callaghan, 2008; Masuya et al., 2014; Powell et al., 1979; Tse, 2010; Yao & Chen, 2017). Increases in engagement occurred only with gardening (Powell et al., 1979), and not with photos (Eggert et al., 2015) or videos (Aslakson, 2010). None of the studies using passive nature reported any positive effects. In fact, the reverse was true in a moderate-quality RCT of a biophilia installation, where outcomes instead favored the "reminiscence" installation and no-installation comparator groups (Scott et al., 2014).

Discussion and Implications

Key Findings

This systematic review aimed to evaluate the evidence that indoor nature interventions might improve the health and wellbeing of older adults in residential settings. On the whole, there was little robust evidence of improvements with most studies receiving a weak-quality rating, indicating a high risk of potential bias (18 of 26) using the EPHPP criteria.

Nevertheless, interventions involving physical interaction with real forms of nature, such as indoor gardening programs, appeared to be more effective than passive interventions such as nature installations or photographs. The strongest study (i.e., with low risk of bias) reported significantly less cognitive decline for people with Alzheimer's Disease, following a Horticulture Therapy program (D'Andrea et al., 2008). In addition, two controlled gardening studies, both of moderate quality, reported improvements in affect balance (Collins & O'Callaghan, 2008), and loneliness, social engagement, and life satisfaction (Tse, 2010). Of the seven gardening/horticulture studies that included control/comparator groups, six reported significant between-group differences favoring nature in at least one measured health/wellbeing outcome (Barnicle & Midden, 2003; D'Andrea et al., 2008; Masuya et al., 2014; Powell et al., 1979; Tse, 2010; Yao & Chen, 2017). This was the case for only four (Goto et al., 2014; Kiyota, 2009; Reynolds et al., 2018; Scott et al., 2014) of the 11 controlled passive nature studies. These findings align with seminal works which describe incremental wellbeing benefits with increasing nature engagement, from "indirect" (i.e., passive viewing), up to "intentional" (i.e., active) participation in nature (Keniger, Gaston, Irvine, & Fuller, 2013; Pretty, 2004).

In terms of outcomes, significant positive effects were reported for psychological and social wellbeing, engagement, life satisfaction, and QoL indicators across several controlled studies of both weak (Kiyota, 2009; Masuya et al., 2014; Powell et al., 1979; Yao & Chen, 2017) and moderate (Barnicle & Midden, 2003; Reynolds et al., 2018; Scott et al., 2014; Tse, 2010) quality. This reflects a growing evidence base arguing that contact with nature can: (1) support mental health/wellbeing (Bragg & Atkins, 2016) and (2) bring people together, increasing social capital/cohesion, reducing loneliness, and creating a sense of community (Maas, van Dillen, Verheij, & Groenewegen, 2009; de Vries, van Dillen, Groenewegen, & Spreeuwenberg, 2013). Effects on functional/physical, physiological, and dementia-related outcomes were more mixed, with some positive effects of gardening and horticulture programs (D'Andrea et al., 2008; Yao & Chen, 2017), fish aquariums (Edwards & Beck, 2002; Riddick, 1984), nature films (Reynolds et al., 2018), and Virtual Reality (Moyle et al., 2018).

Effects of Interventions for People With Dementia

More than half of the studies (14 of 26) specifically stated recruitment of individuals with dementia, but only eight of these included control groups. Of these, four studies reported significant improvements in outcomes ranging from cognition (D'Andrea et al., 2008) and heart rate (Reynolds et al., 2018) in strong and moderate studies, to behavior (Goto et al., 2014) and nutritional intake (Edwards & Beck, 2002) in weaker studies. On the whole, these interventions were structured activities that specifically required participants to attend, and all involved the researcher or staff staying in the room with the participants during their nature exposure. Most aimed to engage residents frequently, with the majority being accessible either every day (Edwards & Beck, 2002) or twice per week (D'Andrea et al., 2008; Goto et al., 2014). The diversity of the successful interventions, spanning Horticulture Therapy, an indoor garden, a fish aquarium and an Immersive Virtual Nature Experience, suggests that a variety of active and passive indoor nature mechanisms may be beneficial in supporting the health of older adults with dementia. However, further, high-quality research is needed to substantiate this given the small number of robust studies.

Links With Theory

Most studies identified a theoretical basis for their research but this was usually limited to paper introductions and rarely elaborated in their discussions. The most frequently referenced theories concerned wellbeing impacts of nature rooted in evolutionary psychology. For example, four studies (Edwards & Beck, 2013; Martin, 2011; Scott et al., 2014; Webster, 2015) mentioned the Biophilia Hypothesis, which posits that because humans evolved in nature; we retain an innate connection with living things (Wilson, 1984). Ten studies made direct or indirect reference to one or both of two classic theories which argue that the content and structure of natural settings can promote psychologically restorative experiences, allowing for recovery of attentional processes (Attention Restoration Theory [Kaplan & Kaplan, 1989]) and/or recovery from psycho-physiological stress (Psychological Stress Reduction Theory [Ulrich, 1981]). However, only half of these studies included outcomes directly relating to attention (Chung et al., 2016; D'Andrea et al., 2008), stress (Reynolds et al., 2018), or restoration (Kiyota, 2009; Webster, 2015).

Others specified broader environmental theories, proposing that wellbeing of people with dementia improves when care homes' physical environments are altered in order to provide enrichment (Edwards et al., 2014), reduce vulnerability (Aslakson, 2010), and reduce inappropriate stimulation (Cohen-Mansfield & Werner, 1998). However, these studies did not necessarily stipulate a special or unique role for nature in these processes. Others worked within wider theoretical contexts, including health promotion (Brown et al., 2004), physical activity (Lee & Kim, 2008), and Theory of Personhood (Masuya et al., 2014), and here nature seemed to be coincidental to the intervention's goal, rather than its central focus.

Although many studies acknowledged theories, it was rarely apparent that they used them to inform their study's design or measures. Moreover, there was little attempt to work across/integrate different theories, or to develop conceptual models of anticipated mechanisms/pathways/contextual factors linking nature-based interventions to wellbeing outcomes, in care settings. Future work in this area would benefit from a Complex Interventions-based approach (Craig et al., 2008) that attempts to unpick which kinds of interventions generate the most beneficial impacts, for which outcomes, for whom, and in what circumstances.

Identifying Key Features of Stronger Interventions

We analyzed the 18 controlled studies from several perspectives (e.g., sample size, intervention duration/frequency, setting, dementia diagnosis, data collection procedure) to try and identify factors that may moderate or mediate effective indoor nature interventions. Though the majority of results were inconsistent, we found that larger proportions of the studies lasting more than 5 weeks (7 of 9), and those set in nursing homes (7 of 10), reported significant findings, compared with those lasting 5 weeks or less (3 of 9), or based in other settings (3 of 8). A smaller proportion of the studies specifically recruiting people with dementia reported any significant results (4 of 8), compared with those recruiting more widely (7 of 10). The proportions of findings which were statistically significant were similar regardless of whether the staff/researcher (37.5%) or resident themselves (40%) completed the outcome measure.

By cross-referencing Tables 1–3, we identified features which tended to persist across studies reporting significant positive effects. We observed that, regardless of whether or not they involved gardening/horticulture activities, interventions were more likely to be effective when they afforded: (1) shared/group experiences; (2) acquiring knowledge and learning skills; and/or (3) opportunities to have control/autonomy, provide care, or be responsible for nature. Each of these factors: social interaction (Bassuk, Glass, & Berkman, 1999; Graney, 1975; Mendes de Leon, Glass, & Berkman, 2003), lifelong learning (Narushima, Liu, & Diestelkamp, 2013, 2018), and having responsibility/autonomy (Kloos, Trompetter, Bohlmeijer, & Westerhof, 2018; Langer & Rodin, 1976), have been reported to benefit older adults' wellbeing, in terms of ADL (Mendes de Leon et al., 2003), happiness (Graney, 1975), cognition (Bassuk et al., 1999), depression (Kloos et al., 2018), general psychological wellbeing (Kloos et al., 2018; Narushima

et al., 2013), general overall health (Langer & Rodin, 1976), and life satisfaction (Kloos et al., 2018), i.e., similar outcomes to those reported in this review. Horticulture Therapy is similarly modeled as providing a diverse range of emotional, physical, intellectual and social mechanisms (Relf, 2006); we expect therefore, that the success of the gardening and horticulture programs in particular was due in part to provision of these experiences, rather than through fostering interaction with nature per se.

Strengths of the Systematic Review Process

As far as we are aware, this is the first systematic review to evaluate the evidence of indoor nature interventions on the health and wellbeing of older adults in residential settings. Our search strategy used an extensive keyword list, represented diverse disciplines, and included unpublished literature. Despite being unable to perform meta-analyses, we attempted to assimilate studies through narrative and tabulation. Finally, we only included studies which took place in residential environments, allowing a degree of confidence in the external validity of the findings.

Strengths of the Included Studies

Through the quality appraisal process, we found that participants did not tend to withdraw from "opt-in" interventions. This was particularly the case with gardening programs, for which six of nine programs reported 100% completion rates, indicating that they appear to be largely acceptable/enjoyable. In addition, most studies included a control group(s), and outcome measures often had clinically meaningful thresholds or interpretations. Many studies avoided an ethical dilemma by ensuring that no residents "missed out" on the experiencing the intervention (e.g., by employing waiting list or crossover designs), and this inclusivity was noted to make the studies more acceptable to carers and residents' families. Finally, some papers noted that care staff also benefited from the interventions. Although further investigation was not within the scope of this review, wellbeing impacts of outdoor nature for residential care staff have been discussed as part of a previous review (Whear et al., 2014).

Limitations of the Review Process

We recognize some key limitations of the review process. First, we opted to use the EPHPP because it was the only validated, reliable quality appraisal tool that could be used with a wide range of quantitative studies, but we also recognize some issues in its use. For example, the EPHPP tool's scoring instructions are unbalanced, so that a study receiving two weak and four strong subcategory scores receives the same weak overall global score, as another study receiving six weak subcategory scores. Furthermore, global scores are based on a nonweighted summation of the subcategories, which overlooks that some risks may be more important than others. Second, by only including quantitative studies, the review perhaps lacked an in-depth exploration of the relationships between interventions and outcomes that may have been afforded by including qualitative data. We may also have missed some studies by including only English language papers.

Limitations of the Included Studies

Several issues affected the majority of studies, including: (1) small sample sizes, which conceivably meant most studies were under-powered to detect significant between-group effects; (2) lack of random allocation procedures, or else failure to account for basic demographic factors (age, sex) in the analyses, either of which risks introducing confounding; and (3) a lack of researcher–participant blinding. In addition, a smaller number of studies did not report between-groups analyses for some (Goto et al., 2014) or any (Brown et al., 2004; Cohen-Mansfield & Werner, 1998; Edwards & Beck, 2002; Eggert et al., 2015; Riddick, 1984) of their outcomes, meaning the relative effects of their nature intervention arm(s) could not be evaluated. Furthermore, as most studies did not confirm baseline equivalency; we could not accurately calculate the magnitude of their effects.

In addition, these kinds of field intervention studies are naturally susceptible to uncontrollable biases. For example, selection effects might have been introduced if residents opting take part in gardening were particularly "green-fingered" (and thus not necessarily representative of the general care population). Observer-expectancy effects are also possible, for example, if some residents felt the need to please the researchers in order to maintain social interaction with them (i.e., social desirability bias). The latter is particularly pertinent in this review considering (1) widespread positive impacts on social wellbeing were observed and (2) social interaction is often limited in these settings.

Though the above issues reduced our confidence in the findings, we accept that researchers in this field often face multiple challenges with recruiting large samples and that avoiding experimenter effects is near-impossible. We understand also, that there may be ethical concerns in including control groups, which effectively deny half of a care home sample access to an intervention which may benefit them. However, one area we feel could be improved is data reporting—as basic demographic information, summary statistics, and/or study means/medians were sometimes missing (Aslakson, 2010; Brown et al., 2004; Chung et al., 2016; Edwards & Beck, 2002; Goto et al., 2014; Moyle et al., 2018; Powell et al., 1979). In addition, very few papers stated the proportion of their sample who were living with dementia or health conditions, which may have important implications for recruitment, retention, and outcome effects.

Conclusions

The impact of indoor nature on older residents' wellbeing is currently unclear. Though several higher-quality studies indicated improvements in dementia-related, social, and psychological wellbeing outcomes; the vast majority of studies were of weak quality, which made it difficult to present a comprehensive overview. Nevertheless, there is some suggestion that active involvement, for example, through indoor gardening programs, has greater potential to provide benefits than more passive exposures such as nature corridor installations. Mechanisms underlying these interactions may include provision of opportunities for social stimulation, development of skills, and/or having responsibility to care for nature, but further research is needed to fully elucidate these associations.

Recommendations for Practice and Future Research

Despite the mixed findings of this systematic review, the gardening and horticulture programs were, on the whole, more effective than passive forms of nature. The current evidence does not allow us to recommend indoor nature interventions over other types of intervention or activities. However, in the event that practitioners are looking to utilize indoor forms of nature, we tentatively suggest facilitation of direct and active nature contact may be more effective for wellbeing, than more passive forms. In addition, interventions seem more likely to benefit residents' health and wellbeing where there is coprovision of opportunities for social stimulation, skills development, decision making, and/or the chance to take responsibility or care for nature.

This review identified several research gaps for consideration. First, most studies only measured outcomes before-and-after; it would be valuable to conduct longitudinal studies which collect data throughout or following the intervention, to allow for interrogation of some of the more implicit, purported nature-wellbeing mechanisms, for example, do the social interactions noted in this review develop into lasting friendships? Second, we suggest that future research works within the Complex Interventions framework to elucidate more clearly the mechanisms and pathways involved in generating wellbeing impacts from nature-based interventions in care settings. Third, we would like to see cocreation of nature-based interventions alongside the residents, to determine whether this increases beneficial wellbeing effects. Finally, though most of the passive nature conditions in this review produced few effects, it is conceivable that their lower cost, maintenance, time, and space requirements mean they are more routinely implemented than active interventions. It would be interesting to see whether emerging technologies, such as low-cost mobile head-mounted Virtual Reality, are able to produce a "compromise," by combining together the interactive elements of active interventions, with the scenic quality and modifiability of passive interventions, to provide highly immersive indoor nature experiences.

Supplementary Data

Supplementary data are available at *The Gerontologist* online.

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Conflict of Interest

None reported.

References

Age UK. (2017). *Later life in the United Kingdom*. Retrieved February 13, 2019, from https://www.ageuk.org.uk/globalassets/age-uk/documents/reports-and-publications/later_life_uk_factsheet.pdf

Armijo-Olivo, S., Stiles, C. R., Hagen, N. A., Biondo, P. D., & Cummings, G. G. (2012). Assessment of study quality for systematic reviews: A comparison of the Cochrane collaboration risk of bias tool and the effective public health practice project quality assessment tool: Methodological research. *Journal of Evaluation in Clinical Practice*, **18**, 12–18. doi:10.1111/j.1365-2753.2010.01516.x

Aslakson. (2010). *The effects of a music therapy intervention on agitation in people with dementia*. (Doctor of Philosophy, University of Wisconsin-Milwaukee).

Barnicle, T., & Midden, K. (2003). The effects of a horticulture activity program on the psychological well-being of older people in long-term care facility. *Horttechnology*, **13**, 81–85. doi: 10.21273/HORTTECH.13.1.0081

Bassuk, S. S., Glass, T. A., & Berkman, L. F. (1999). Social disengagement and incident cognitive decline in community-dwelling elderly persons. *Annals of Internal Medicine*, **131**, 165–173. doi:10.7326/0003-4819-131-3-199908030-00002

Bossen, A. (2010). The importance of getting back to nature for people with dementia. *Journal of Gerontological Nursing*, **36**, 17–22. doi:10.3928/00989134-20100111-01

Bragg, R., & Atkins, G. (2016). *A review of nature-based interventions for mental health care*. Natural England Commissioned Report NERC204. Retrieved February 13, 2019, from http://publications.naturalengland.org.uk/publication/4513819616346112

Bringslimark, T., Hartig, T., & Patil, G. G. (2009). The psychological benefits of indoor plants: A critical review of the experimental literature. *Journal of Environmental Psychology*, **29**, 422–433. doi:10.1016/j.jenvp.2009.05.001

Brown, V. M., Allen, A. C., Dwozan, M., Mercer, I., & Warren, K. (2004). Indoor gardening older adults: Effects on socialization, activities of daily living, and loneliness. *Journal of Gerontological Nursing*, **30**, 34–42. doi:10.3928/0098-9134-20041001-10

Centre for Reviews and Dissemination. (2009). *Systematic reviews* (3rd ed.). York: CRD.

Chung, J., Choi, S. I., & Kim, J. (2016). Experience of media presentations for the alleviation of agitation and emotional distress among dementia patients in a long-term nursing facility. *Dementia (London, England)*, **15**, 1021–1033. doi:10.1177/1471301214550660

Cohen-Mansfield, J., & Werner, P. (1998). The effects of an enhanced environment on nursing home residents who pace. *The Gerontologist*, **38**, 199–208. doi:10.1093/geront/38.2.199

Collins, C. C., & O'Callaghan, A. M. (2008). The impact on health of horticultural responsibility indicators and quality of life in assisted living. *HortTechnology*, **18**, 611–618. doi:10.21273/HORTTECH.18.4.611

Craig, P., Dieppe, P., Macintyre, S., Michie, S., Nazareth, I., & Petticrew, M.; Medical Research Council Guidance. (2008). Developing and evaluating complex interventions: The new Medical Research Council guidance. *BMJ (Clinical research ed.)*, **337**, a1655. doi:10.1136/bmj.a1655

D'Andrea, S., Batavia, M., & Sasson, N. (2008). Effect of horticultural therapy on preventing the decline of mental abilities of patients with Alzheimer's type dementia. *Journal of Therapeutic Horticulture*, **18**, 8–17.

DeSchriver, M. M., & Riddick, C. C. (1990). Effects of watching aquariums on elders' stress. *Anthrozoös*, **4**, 44–48. doi:10.2752/089279391787057396

Edwards, N. E., & Beck, A. M. (2002). Animal-assisted therapy and nutrition in Alzheimer's disease. *Western Journal of Nursing Research*, **24**, 697–712. doi:10.1177/019394502320555430

Edwards, N. E., & Beck, A. M. (2013). The influence of aquariums on weight in individuals with dementia. *Alzheimer Disease and Associated Disorders*, **27**, 379–383. doi:10.1097/WAD.0b013e3182769b34

Edwards, N. E., Beck, A. M., & Lim, E. (2014). Influence of aquariums on resident behavior and staff satisfaction in dementia units. *Western Journal of Nursing Research*, **36**, 1309–1322. doi:10.1177/0193945914526647

Eggert, J., Dye, C. J., Vincent, E., Parker, V., Daily, S. B., Pham, H.,… Roy, T. (2015). Effects of viewing a preferred nature image and hearing preferred music on engagement, agitation, and mental status in persons with dementia. *SAGE Open Medicine*, **3**, 2050312115602579. doi:10.1177/2050312115602579

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

Gascon, M., Triguero-Mas, M., Martínez, D., Dadvand, P., Forns, J., Plasència, A., & Nieuwenhuijsen, M. J. (2015). Mental health benefits of long-term exposure to residential green and blue spaces: A systematic review. *International Journal of Environmental Research and Public Health*, **12**, 4354–4379. doi:10.3390/ijerph120404354

Gascon, M., Zijlema, W., Vert, C., White, M. P., & Nieuwenhuijsen, M. J. (2017). Outdoor blue spaces, human health and well-being: A systematic review of quantitative studies. *International Journal of Hygiene and Environmental Health*, **220**, 1207–1221. doi:10.1016/j.ijheh.2017.08.004

Gonzalez, M. T., & Kirkevold, M. (2014). Benefits of sensory garden and horticultural activities in dementia care: A modified scoping review. *Journal of Clinical Nursing*, **23**, 2698–2715. doi:10.1111/jocn.12388

Goto, S., Kamal, N., Puzio, H., Kobylarz, F., & Herrup, K. (2014). Differential responses of individuals with late-stage dementia to two novel environments: A multimedia room and an interior garden. *Journal of Alzheimer's disease*, **42**, 985–998. doi:10.3233/JAD-131379

Graney, M. J. (1975). Happiness and social participation in aging. *Journal of Gerontology*, **30**, 701–706. doi:10.1093/geronj/30.6.701

Hernandez, R. O. (2007). Effects of therapeutic gardens in special care units for people with dementia. *Journal of Housing for the Elderly*, **21**, 117–152. doi:10.1300/J081v21n01_07

Kaplan, R., & Kaplan, S. (1989). *The experience of nature. A psychological perspective*. Cambridge: Cambridge University Press.

Kearney, A. R., & Winterbottom, D. (2006). Nearby nature and long-term care facility residents. *Journal of Housing For the Elderly*, **19**, 7–28. doi:10.1300/J081v19n03_02

Keniger, L. E., Gaston, K. J., Irvine, K. N., & Fuller, R. A. (2013). What are the benefits of interacting with nature? *International Journal of Environmental Research and Public Health*, **10**, 913–935. doi:10.3390/ijerph10030913

Kieffer, S. (2014). *Representational elements of nature's effect on seniors' self-perceived well-being*. (Master of Science, University of Minnesota).

Kiyota, E. (2009). *People-nature interactions: The therapeutic role of nature in elderly residents' everyday experience in a long term care facility*. Milwaukee: University of Wisconsin.

Kloos, N., Trompetter, H., Bohlmeijer, E., & Westerhof, G. (2018). Longitudinal associations of autonomy, relatedness, and competence with the well-being of nursing home residents. *The Gerontologist*, 1–9. doi:10.1093/geront/gny005

Langer, E. J., & Rodin, J. (1976). The effects of choice and enhanced personal responsibility for the aged: A field experiment in an institutional setting. *Journal of Personality and Social Psychology*, **34**, 191–198. doi:10.1037/0022-3514.34.2.191

Lee, Y., & Kim, S. (2008). Effects of indoor gardening on sleep, agitation, and cognition in dementia patients—a pilot study. *International Journal of Geriatric Psychiatry*, **23**, 485–489. doi:10.1002/gps.1920

Maas, J., van Dillen, S. M. E., Verheij, R. A., & Groenewegen, P. P. (2009). Social contacts as a possible mechanism behind the relation between green space and health. *Health & Place*, **15**, 586–595. doi:10.1016/j.healthplace.2008.09.006

Martin, P. (2011). *A cross-over study to investigate the use of natural landscape photographs with particular content and pattern to reduce agitation in nursing home residents with Alzheimer's dementia*. (Doctor of Philosophy, University of Rochester).

Masuya, J., Ota, K., & Mashida, Y. (2014). The effect of a horticultural activities program on the psychologic, physical, cognitive function and quality of life of elderly people living in nursing homes. *International Journal of Nursing & Clinical Practices*, **1**, 1–4. doi:10.15344/2394–4978/2014/109

Mcsweeney, J., Rainham, D., Johnson, S. A., Sherry, S. B., & Singleton, J. (2015). Indoor nature exposure (INE): A health-promotion framework. *Health Promotion International*, **30**, 126–139. doi:10.1093/heapro/dau081

Mendes de Leon, C., Glass, T., & Berkman, L. (2003). Social engagement and disability in a community population of older adults: The New Haven EPESE. *American Journal of Epidemiology*, **157**, 633–42 doi:10.1093/aje/kwg028

Mitchell, R., & Popham, F. (2008). Effect of exposure to natural environment on health inequalities: An observational population study. *Lancet (London, England)*, **372**, 1655–1660. doi:10.1016/S0140-6736(08)61689-X

Morgan, D. G., & Stewart, N. J. (1999). The physical environment of special care units: Needs of residents with dementia from the perspective of staff and family caregivers. *Qualitative Health Research*, **9**, 105–118. doi:10.1177/104973299129121721

Moyle, W., Jones, C., Dwan, T., & Petrovich, T. (2018). Effectiveness of a virtual reality forest on people with dementia: A mixed methods pilot study. *The Gerontologist*, **58**, 478–487. doi:10.1093/geront/gnw270

Narushima, M., Liu, J., & Diestelkamp, N. (2013). The association between lifelong learning and psychological well-being among older adults: Implications for interdisciplinary health promotion in an aging society. *Activities, Adaptation & Aging*, **37**, 239–250. doi:10.1080/01924788.2013.816834

Narushima, M., Liu, J., & Diestelkamp, N. (2018). Lifelong learning in active ageing discourse: Its conserving effect on wellbeing, health and vulnerability. *Ageing and Society*, **38**, 651–675. doi:10.1017/S0144686X16001136

NICE. (2013). *Mental wellbeing of older people in care homes*. Quality Standard QS50. Retrieved February 13, 2019, from https://www.nice.org.uk/guidance/qs50

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

Ottosson, J., & Grahn, P. (2005). A comparison of leisure time spent in a garden with leisure time spent indoors: On measures of restoration in residents in geriatric care. *Landscape Research*, **30**, 23–55. doi:10.1080/0142639042000324758

Powell, L., Felce, D., Jenkins, J., & Lunt, B. (1979). Increasing engagement in a home for the elderly by providing an indoor gardening activity. *Behaviour Research and Therapy*, **17**, 127–135. doi:10.1016/0005-7967(79)90021–4

Pretty, J. (2004). How nature contributes to mental and physical health. *Spirituality and Health International*, **5**, 68–78. doi:10.1002/shi.220

Rappe, E., & Topo, P. (2007). Contact with outdoor greenery can support competence among people with dementia. *Journal of Housing for the Elderly*, **21**, 229–248. doi:10.1300/J081v21n03_12

Raske, M. (2010). Nursing home quality of life: Study of an enabling garden. *Journal of Gerontological Social Work*, **53**, 336–351. doi:10.1080/01634371003741482

Relf, P. D. (2006). Theoretical models for research and program development in agriculture and health care: Avoiding random acts of research. In J. A. N. Hassink & M. Van Dijk (Eds.), *Farming for health* (pp. 1–20). Dordrecht: Springer Netherlands.

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

Reynolds, L., Rodiek, S., Lininger, M., & McCulley, M. A. (2018). Can a virtual nature experience reduce anxiety and agitation in people with dementia? *Journal of Housing for the Elderly*, **32**, 176–193. doi:10.1080/02763893.2018.1431583

Riddick, C. (1984). Health, aquariums, and the non-institutionalized elderly. *Marriage and Family Review*, **88**, 163–173. doi:10.1300/J002v08n03_12

Rodiek, S. (2006). A missing link: Can enhanced outdoor space improve seniors housing? *Seniors Housing & Care Journal*, **14**, 3–19.

Scott, T. L., Masser, B. M., & Pachana, N. A. (2014). Multisensory installations in residential aged-care facilities: Increasing novelty and encouraging social engagement through modest environmental changes. *Journal of Gerontological Nursing*, **40**, 20–31; quiz 32. doi:10.3928/00989134-20140731-99

Thomas, B. H., Ciliska, D., Dobbins, M., & Micucci, S. (2004). A process for systematically reviewing the literature: Providing the research evidence for public health nursing interventions. *Worldviews on Evidence-Based Nursing*, **1**, 176–184. doi:10.1111/j.1524-475X.2004.04006.x

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

Ulrich, R. (1981). Natural versus urban scenes: Some psychophysiological effects. *Environment and Behavior*, **13**, 523–556. doi:10.1177/0013916581135001

de Vries, S., van Dillen, S. M., Groenewegen, P. P., & Spreeuwenberg, P. (2013). Streetscape greenery and health: Stress, social cohesion and physical activity as mediators. *Social Science & Medicine (1982)*, **94**, 26–33. doi:10.1016/j.socscimed.2013.06.030

Wang, D., & MacMillan, T. (2013). The benefits of gardening for older adults: A systematic review of the literature. *Activities, Adaptation & Aging*, **37**, 153–181. doi:10.1080/01924788.2013.784942

Webster, S. (2015). *The effects of living plants on cognitive and behavioral responses of persons with dementia*. (Master of Fine Arts, The University of North Carolina).

Whear, R., Coon, J. T., Bethel, A., Abbott, R., Stein, K., & Garside, R. (2014). What is the impact of using outdoor spaces such as gardens on the physical and mental well-being of those with dementia? A systematic review of quantitative and qualitative evidence. *Journal of the American Medical Directors Association*, **15**, 697–705. doi:10.1016/j.jamda.2014.05.013

White, M. P., Pahl, S., Wheeler, B. W., Depledge, M. H., & Fleming, L. E. (2017). Natural environments and subjective wellbeing: Different types of exposure are associated with different aspects of wellbeing. *Health & Place*, **45** (Supplement C), 77–84. doi:10.1016/j.healthplace.2017.03.008

Wilson, E. (1984). *Biophilia*. Cambridge: Harvard University Press.

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