Cochrane Library

Cochrane Database of Systematic Reviews

Physical environmental designs in residential care to improve quality of life of older people (Review)

Harrison SL, Dyer SM, Laver KE, Milte RK, Fleming R, Crotty M

Harrison SL, Dyer SM, Laver KE, Milte RK, Fleming R, Crotty M.
Physical environmental designs in residential care to improve quality of life of older people.
Cochrane Database of Systematic Reviews 2022, Issue 3. Art. No.: CD012892.
DOI: 10.1002/14651858.CD012892.pub2.

www.cochranelibrary.com

WILEY

TABLE OF CONTENTS

[Intervention Review]

Physical environmental designs in residential care to improve quality of life of older people

Stephanie L Harrison[1,2,3], Suzanne M Dyer[1], Kate E Laver[1], Rachel K Milte[4], Richard Fleming[5], Maria Crotty[1]

[1]Flinders Health and Medical Research Institute, College of Medicine and Public Health, Flinders University, Adelaide, Australia. [2]Registry of Senior Australians, South Australian Health and Medical Research Institute, Adelaide, Australia. [3]Liverpool Centre for Cardiovascular Science, University of Liverpool, Liverpool, UK. [4]Caring futures institute, Flinders University, Adelaide, Australia. [5]School of Science Medicine and Health, University of Wollongong, Wollongong, Australia

Contact: Stephanie L Harrison, stephanie.harrison@liverpool.ac.uk.

Editorial group: Cochrane Effective Practice and Organisation of Care Group.
Publication status and date: New, published in Issue 3, 2022.

Citation: Harrison SL, Dyer SM, Laver KE, Milte RK, Fleming R, Crotty M.Physical environmental designs in residential care to improve quality of life of older people. *Cochrane Database of Systematic Reviews* 2022, Issue 3. Art. No.: CD012892. DOI: 10.1002/14651858.CD012892.pub2.

ABSTRACT

Background

The demand for residential aged care is increasing due to the ageing population. Optimising the design or adapting the physical environment of residential aged care facilities has the potential to influence quality of life, mood and function.

Objectives

To assess the effects of changes to the physical environment, which include alternative models of residential aged care such as a 'home-like' model of care (where residents live in small living units) on quality of life, behaviour, mood and depression and function in older people living in residential aged care.

Search methods

CENTRAL, MEDLINE, Embase, six other databases and two trial registries were searched on 11 February 2021. Reference lists and grey literature sources were also searched.

Selection criteria

Non-randomised trials, repeated measures or interrupted time series studies and controlled before-after studies with a comparison group were included. Interventions which had modified the physical design of a care home or built a care home with an alternative model of residential aged care (including design alterations) in order to enhance the environment to promote independence and well-being were included. Studies which examined quality of life or outcomes related to quality of life were included. Two reviewers independently assessed the abstracts identified in the search and the full texts of all retrieved studies.

Data collection and analysis

Two reviewers independently extracted data, assessed the risk of bias in each included study and evaluated the certainty of evidence according to GRADE criteria. Where possible, data were represented in forest plots and pooled.

Main results

Twenty studies were included with 77,265 participants, although one large study included the majority of participants (n = 74,449). The main comparison was home-like models of care incorporating changes to the scale of the building which limit the capacity of the living units to smaller numbers of residents and encourage the participation of residents with domestic activities and a person-centred care approach,

compared to traditional designs which may include larger-scale buildings with a larger number of residents, hospital-like features such as nurses' stations, traditional hierarchical organisational structures and design which prioritises safety.

Six controlled before-after studies compared the home-like model and the traditional environment (75,074 participants), but one controlled before-after study included 74,449 of the participants (estimated on weighting). It is uncertain whether home-like models improve health-related quality of life, behaviour, mood and depression, function or serious adverse effects compared to traditional designs because the certainty of the evidence is very low. The certainty of the evidence was downgraded from low-certainty to very low-certainty for all outcomes due to very serious concerns due to risk of bias, and also serious concerns due to imprecision for outcomes with more than 400 participants. One controlled before-after study examined the effect of home-like models on quality of life. The author stated "No statistically significant differences were observed between the intervention and control groups." Three studies reported on global behaviour (N = 257). One study found little or no difference in global behaviour change at six months using the Neuropsychiatric Inventory where lower scores indicate fewer behavioural symptoms (mean difference (MD) -0.04 (95% confidence interval (CI) -0.13 to 0.04, n = 164)), and two additional studies (N = 93) examined global behaviour, but these were unsuitable for determining a summary effect estimate. Two controlled before-after studies examined the effect of home-like models of care compared to traditional design on depression. After 18 months, one study (n = 242) reported an increase in the rate of depressive symptoms (rate ratio 1.15 (95% CI 1.02 to 1.29)), but the effect of home-like models of care on the probability of no depressive symptoms was uncertain (odds ratio 0.36 (95% CI 0.12 to 1.07)). One study (n = 164) reported little or no difference in depressive symptoms at six months using the Revised Memory and Behaviour Problems Checklist where lower scores indicate fewer depressive symptoms (MD 0.01 (95% CI -0.12 to 0.14)). Four controlled before-after studies examined function. One study (n = 242) reported little or no difference in function over 18 months using the Activities of Daily Living long-form scale where lower scores indicate better function (MD -0.09 (95% CI -0.46 to 0.28)), and one study (n = 164) reported better function scores at six months using the Interview for the Deterioration of Daily Living activities in Dementia where lower scores indicate better function (MD -4.37 (95% CI -7.06 to -1.69)). Two additional studies measured function but could not be included in the quantitative analysis. One study examined serious adverse effects (physical restraints), and reported a slight reduction in the important outcome of physical restraint use in a home-like model of care compared to a traditional design (MD between the home-like model of care and traditional design -0.3% (95% CI -0.5% to -0.1%), estimate weighted n = 74,449 participants at enrolment).

The remaining studies examined smaller design interventions including refurbishment without changes to the scale of the building, special care units for people with dementia, group living corridors compared to a non-corridor design, lighting interventions, dining area redesign and a garden vignette.

Authors' conclusions

There is currently insufficient evidence on which to draw conclusions about the impact of physical environment design changes for older people living in residential aged care. Outcomes directly associated with the design of the built environment in a supported setting are difficult to isolate from other influences such as health changes of the residents, changes to care practices over time or different staff providing care across shifts. Cluster-randomised trials may be feasible for studies of refurbishment or specific design components within residential aged care. Studies which use a non-randomised design or cluster-randomised trials should consider approaches to reduce risk of bias to improve the certainty of evidence.

PLAIN LANGUAGE SUMMARY

Physical environmental designs in residential care to improve quality of life of older people

What is the aim of the review?

There is an increasing older population worldwide and an increase in the numbers of people living with dementia. It has been suggested that improving lived area designs may improve quality of life, mood, and ability to perform daily living activities of aged care residents. The aim of this Cochrane review was to examine the effects of different physical environmental design changes in residential aged care to determine the effect on quality of life for the residents. The review authors collected and analysed all relevant studies to answer this question and found 20 studies.

Key messages

We are uncertain of the effects of design changes in residential aged care to improve quality of life for residents because more high-quality studies are needed.

What was studied in the review?

The review studied changes to physical environmental design in residential aged care, referring to any changes to the environment in which residents live, in an aim to improve their quality of life. These may be large-scale or small-scale changes. Large-scale changes can be changes to the design of residential care such as changing from the currently used lived-area designs to home-like designs with smaller numbers of residents living together. Small-scale changes may involve refurbishing the lived area or changing a single part of the lived area such as lighting. We included studies which compared different large-scale or small design changes in residential aged care, or compared design changes to currently used lived-area designs and examined the effect of design changes on quality of life, behaviour and daily living

activities for the residents. There is no one definition of quality of life agreed upon, but most definitions include multiple aspects of a person's expectations for their life, such as physical, mental, and emotional health, social activity and life situation.

What are the main results of the review?

The review authors found 20 relevant studies that took place in nine different countries (Australia, Canada, Germany, Italy, the Netherlands, Spain, Sweden, the UK and the USA). The main design change which was investigated was the effect of creating a 'home-like' model of care which usually involved creating small-scale living units for residents and changes to care practices such as changes to staffing or choices residents had on daily routines.

Six studies examined changes to the size of the building to limit the number of residents per living unit ranging between six and fifteen residents per living unit, in addition to changing care practices, for example, changes to staffing, or changes to the choices residents had for their daily routines. One study examined quality of life, but there was insufficient information presented to draw conclusions. Three studies examined behaviour; one study found little or no difference in behaviour and two studies provided insufficient information to draw conclusions. Two studies examined depression and reported little or no difference in depressive symptoms or the effect was uncertain. Four studies examined daily living activities; one study reported improvement in daily living activities, one study reported little or no difference in daily living activities, and two studies provided insufficient information to draw conclusions. One study reported a reduction in serious adverse effects (the use of physical restraints). We are uncertain of the effects of home-like models of care on quality of life, behaviour, depression, daily living activities or serious adverse effects because the certainty (confidence) of the studies was determined to be very low due to issues with study design.

The other fourteen studies examined smaller design interventions such as refurbishment without changes to the scale of the building, special care units for people with dementia, different corridor designs, bright lighting, redesign of the dining room and an indoor garden.

How up-to-date is this review?

The review authors searched for studies up to February 2021.

SUMMARY OF FINDINGS

Summary of findings 1. Whole-facility changes: Home-like models compared to traditional environment for older people living in long-term residential care

Whole-facility changes: Home-like models compared to traditional environment for older people living in long-term residential care

Patient or population: older adults living in long-term residential care including, but not limited to, dementia-specific care settings
Settings: long-term residential care
Intervention: home-like models (features of home-like models may include buildings which limit the capacity of the living units to small numbers of residents, designs to encourage the participation of residents with domestic activities and a person-centred care approach)
Comparison: traditional design (traditional design may include larger-scale buildings with a larger number of residents, hospital-like features such as nurses' stations, traditional hierarchical organisational structures and design which prioritises safety)

Outcomes	Illustrative comparative risks (95% CI)		Relative effect (95% CI) Follow-up time	No of Participants (studies)	Certainty of the evidence (GRADE)	Comments
	Assumed risk Traditional design	Corresponding risk Home-like model				
Health-related quality of life Dementia-specific quality of life measure (QUALIDEM) (higher scores = better)	N/a	N/a	Not estimable 6 months and 12 months	33 (1 controlled before-after-study)	⊕⊖⊖⊖ **very low**[1]	2 domains (feeling at home and care relationship) were examined in an analysis adjusted for baseline differences between the groups; 7 other domains were unadjusted. The author stated "No statistically significant differences were observed between the intervention and control groups."
Global behaviour	N/a	N/a	Not estimable 6 months	257	⊕⊖⊖⊖ **very low**[2]	One study found little or no difference in global behaviour change at 6 months using the NPI (N = 164; MD -0.04 (95% CI -0.13 to 0.04)); two

Neuropsychiatric Inventory (NPI), Neuropsychiatric Inventory-Nursing Home version (NPI-NH) and Nurses Observations Scale for Geriatric Patients (NOSGER) (lower scores = better)				(3 controlled before-after studies)		additional studies (N = 93) reported global behaviour endpoint data, but the data were unsuitable for determining a summary effect estimate.
Depression Revised Memory and Behaviour Problems Checklist (RMBPC) and Mood Scale Score (MSS) (lower scores = better)	N/a	N/a	Not estimable 6 months and 18 months	406 (2 controlled before-after studies)	⊕⊖⊖⊖ **very low**[3]	Depressive symptoms 18-month change using the MSS (1 study, N = 242; RR 1.15 (95% CI 1.02 to 1.29)) Probability no depressive symptoms 18 months using the MSS (1 study, N = 242; OR 0.36 (95% CI 0.12 to 1.07)) Depressive symptoms 6-month endpoint using the RMBPC (1 study, N = 164; MD 0.01 (95% CI -0.12 to 0.14))
Function Activities of daily living (ADL) long-form scale (lower scores = better), Interview for the Deterioration of Daily Living activities in Dementia (IDDD) (lower scores = better)	N/a	N/a	Not estimable 6 months and 18 months	499 (4 controlled before-after studies)	⊕⊖⊖⊖ **very low**[4]	Function 18-month change using the ADL long-form scale (1 study, N = 242; MD -0.09 (95% CI -0.46 to 0.28)) Function 6-month endpoint using the IDDD (1 study, N = 164; MD -4.37 (95% CI -7.06 to -1.69)) Two additional studies: measured function with the Barthel Index but were not included in the quantitative analysis:

Or Barthel Index (higher scores = better)						• One study (data were insufficient): authors stated: "interactions between settings and development over time could not be proved". • One study (results were not adjusted for differences in baseline characteristics): authors stated function declined in both the intervention and control groups but "more sharply" in control group.
Serious adverse effects Physical restraints, reported as percentage points (lower = better)	23 per 1000*	20 per 1000**	MD -0.3% (-0.5% to -0.1%) Follow-up: Unclear	Unclear (weighted estimate 74,449 participants at enrolment) (1 study)	⊕⊖⊖⊖ **very low**[5]	No further adverse effects were examined. Unclear length of follow-up (reported as up to 5 years)

CI: Confidence interval; **MD**: Mean difference;**OR**: Odds Ratio; **RR:** Risk ratio

GRADE Working Group grades of evidence
High quality: Further research is very unlikely to change our confidence in the estimate of effect.
Moderate quality: Further research is likely to have an important impact on our confidence in the estimate of effect and may change the estimate.
Low quality: Further research is very likely to have an important impact on our confidence in the estimate of effect and is likely to change the estimate.
Very low quality: We are very uncertain about the estimate.

[1] The certainty of evidence was downgraded two levels for risk of bias (high risk of bias on six items including high risk of selection bias, performance bias, detection bias, attrition bias, and other (differences in baseline characteristics and potential residual confounding)) and two levels for imprecision (only 33 participants).
[2]The certainty of evidence was downgraded two levels for risk of bias (all studies at high risk of bias on at least six items) and one level for imprecision (< 400 participants).
[3]The certainty of evidence was downgraded two levels for risk of bias (all studies at high risk of bias on six items).
[4]The certainty of evidence was downgraded two levels for risk of bias (high risk of bias on at least six items) and one level for imprecision (499 participants in total across outcomes but reported across different measures).
[5]The certainty of evidence was downgraded two levels for risk of bias (high risk of bias on five items including high risk of selection bias, performance bias, detection bias and other (method of selection of facilities unclear, potential residual confounding, significant differences in baseline characteristics and significant differences for many baseline outcome measures)).
*Assumed risk for the control group was derived from the study reporting this outcome (2.3%).
**Corresponding risk based on a difference of 0.3%.

BACKGROUND

Description of the condition

The population is ageing worldwide. Life expectancy has increased and people are living longer in older age, particularly in high-income countries (WHO 2015). There were 901 million people aged 60 years and older worldwide in 2015 and, by 2050. this figure is projected to more than double to nearly 2.1 billion (UN 2015). Although information regarding population ageing is well established, the patterns of health and quality of life for older people remain unclear (WHO 2015).

Many older adults experience physical and/or cognitive impairment as they age which may result in the need for care and support from others in order to manage activities of daily living. A significant decline in function may result in the need for long-term care. With an increasing number of people living to an older age, there will be an increase in the proportion of the population who will require accommodation in residential aged care (WHO 2015). A large proportion of those who reside in residential aged care (also called care facilities, care homes, nursing homes, residential homes, skilled-nursing facilities or assisted-living facilities) are living with dementia, and the number of people living with dementia globally is expected to increase. There are currently 46.8 million people living with dementia and this figure is expected to double every 20 years, to 131.5 million people by 2050 (ADI 2015). An ageing population and an increasing number of people living with dementia is likely to increase demand for residential aged care. Therefore, it will be increasingly important to ensure that these facilities provide an environment which ensures that quality of life is optimised in advancing age.

Quality of life for residents in residential aged care has been referred to as the degree to which the well-being of an individual is maintained, including social activity, physical activity and health, and whether or not this meets their expectations (Post 2014). Maintaining quality of life in advancing age is important, both for those living in the community and those living in residential aged care. However, people who live in residential aged care are more likely to experience a reduced quality of life compared to those living in the community (Kane 2003). Moving from the community to living in residential aged care is often associated with a decline in quality of life that may be due to loss of independence and purpose (Bradshaw 2012; Olsen 2016). Interventions to maximise quality of life for people who live in residential aged care should be prioritised. Implementing interventions which may improve quality of life for people living in care facilities also has the potential to positively impact the residents, staff and families of the resident. Many factors may impact quality of life for people living in residential aged care and people with dementia, including health status, availability of activities, social participation, standard of care provided and the physical environment. The impact of therapies such as music therapy, art therapy and functional analysis-based interventions for people living with dementia on factors related to quality of life, such as behaviour, have been examined in previous Cochrane reviews (Deshmukh 2018; Moniz Cook 2012; Van der Steen 2018).

Description of the intervention

Maximising quality of life for people living in residential aged care includes providing models of care that encourage engagement in meaningful activities and care which fosters ongoing independence (Tolson 2011). Changing the physical environment refers to changing features of the care facility which are constantly available to the resident, rather than temporary approaches. The physical environment of care facilities can be altered in an attempt to improve the quality of life of the residents. Deciding how the physical environment of residential aged care may be best enhanced to benefit the residents is an emerging area of research (Fleming 2010).

Traditionally, care facilities adopted a medicalised model of care, meaning that facilities were designed and operated similarly to hospitals, rather than homes for the residents (WHO 2015). More recently, care facilities are being encouraged to offer different models of care, which are designed to improve quality of life for the residents by adapting the facilities to create a more stimulating environment, which encourages individuals to maintain independence for longer (Ausserhofer 2016). However, the ability to offer different models of care may be impacted by factors such as the varied funding models for residential aged care in different countries.

This 'person-centred' approach may involve redesigning or building new facilities to create a more home-like environment where residents live in small groups and which have been specifically designed to look and feel more like a domestic home (Chenoweth 2014). These home-like models of care have been developed in different countries including Australia (Dyer 2018), Germany (Wolf-Ostermann 2012), Japan (Funaki 2005), the Netherlands (Te Boekhorst 2009) and the USA (Afendulis 2016, Zimmerman 2016). These models may offer different components regarding how they are designed and operated, but the underlying concept of providing a home-like environment to improve quality of life is consistent.

In the USA, the Green House model is gaining popularity. These facilities promote person-centred care for older people by offering small houses where a home-like environment is maintained, meaningful activities are accessible and teams of certified nursing assistants are available (Zimmerman 2016). The Eden Alternative was also originally established in the USA and has since been implemented in Europe, Asia and Australia (Brownie 2011). The Eden Alternative has some similarities to the Green House model of care as it also aims to create a home-like environment to enrich the lives of the residents, but rather than purpose-built small houses, the Eden Alternative aims to improve the existing environment, using methods such as the introduction of animals and plants (Coleman 2002).

Other small-scale home-like environments specifically designed for people with dementia have been adopted in various countries in Europe, North America and Australia, but are often implemented in different ways (Verbeek 2014).

Changes to the physical environment do not always involve large-scale changes. Instead, the environmental changes may be small, such as tailored lighting designed to improve sleep quality and behaviour (Figueiro 2014), or improved access to outdoor spaces and gardens to improve well-being (Whear 2014). Previous studies have suggested that techniques to enhance the physical environment of care facilities may improve activities of daily living function, quality of life, and mood, as well as lowering hospital admissions (Ausserhofer 2016; Chenoweth 2014;

Zimmerman 2016). However, the evidence for the impact of small-scale or large-scale whole-facility changes to the model of care on the quality of life of residents remains unclear.

How the intervention might work

Studies have shown that staff of care facilities are responsive to the idea of enhancing the physical environment of their facilities. Many facilities have reported implementing small environmental changes (Tesh 2002), but fewer residential aged care facilities have adopted large-scale environmental interventions such as changing from more traditional models of residential aged care to smaller home-like environments (Doty 2007).

As there are a wide range of interventions that can be implemented to improve the physical environment, there will be different ways in which the interventions might work. For example, increased access to outdoor spaces may improve mood and levels of physical activity. Increased lighting during the day may help to improve circadian rhythm, improve sleep patterns for residents and affect mood (Joseph 2015). Improvements in these types of outcomes have been associated with improved quality of life amongst older adults (Livingston 2014). Interventions such as 'dementia-enabling environments' have been designed to encourage residents with dementia to maintain independence for longer and increase opportunity for engagement in meaningful activities, with the aim of improving quality of life for the residents by helping them to feel valued and purposeful (DEEP 2015).

Older adults prefer greater choice of living accommodation and higher quality of services (Brownie 2013). Moving to residential aged care can be daunting, as it is a major change from the family home, and can result in declines in psychological health (Ellis 2010). Improving the physical environment could help the residents to maintain normality and establish routine. As a large proportion of people moving to residential aged care have dementia, it is important to recognise that the unmet needs of these individuals can lead to changed behaviours, or behavioural and psychological symptoms of dementia (BPSD) (Lyketsos 2000). Although most previous research has focused on therapies for the individual experiencing changed behaviours or the staff caring for them, environmental interventions may also have positive effects on behaviour.

Why it is important to do this review

Previous reviews have been conducted in relation to the physical environment of care facilities and various outcomes. However, these reviews generally do not evaluate the quality of the included studies and do not undertake a quantitative analysis of the study findings. Current available reviews suggest that certain environmental changes can improve outcomes for residents and staff of facilities (Ausserhofer 2016; Joseph 2015; Marquardt 2014; Soril 2014).

The majority of the research summarised in previous reviews suggests that studies which have examined environmental changes to residential aged care facilities have focused on specific component interventions, such as outdoor gardens, reduced facility size and changes to lighting (Joseph 2015). Other reviews, including only studies of people with dementia, have found a broad range of interventions to improve the built environment, but provide inconsistent evidence to suggest which interventions are more favourable for certain outcomes, such as behaviour (Soril 2014).

Similarly, a recent scoping review of home-like environments in care facilities concluded that although some studies showed positive improvements in certain outcomes, further evidence is needed in order to determine the effectiveness of home-like models of residential aged care compared to traditional models on quality of life (Ausserhofer 2016). However, a different review examining the built environment for people with dementia concluded that design interventions are largely beneficial for many outcomes for people with dementia including behaviour, activities of daily living function, well-being, social abilities, orientation and care outcomes, but the evidence for cognitive function was inconsistent (Marquardt 2014).

It is important to consider risk management of the environmental interventions, as there may also be adverse effects from some environmental modifications, in particular falls. Falls in residential aged care for older adults are common and can have serious consequences, including fractures, reduced independence and death (Cameron 2018). Changes to the physical environment, particularly with regard to floor surfaces, furnishings or accessibility to spaces, may increase falls. Therefore, consideration of the evidence for both the benefits and harms of physical environmental changes are important in order to establish recommendations. Redesign of the built environment may also specifically be introduced to reduce the risk of falls in residential aged care, and these have been examined in a previous Cochrane review (Cameron 2018).

We are unaware of any high-quality systematic review that has examined the effectiveness of both small-scale and large-scale environmental changes to care facilities to improve quality of life of all residents (i.e. not limited to a subgroup). There are a wide-range of interventions that could come under the umbrella term of the 'physical environment', but largely this review refers to features of a care facility which have been specifically altered to improve quality of life for the residents. Furthermore, previous reviews have included uncontrolled before-after studies and cross-sectional studies which is discouraged by the Cochrane EPOC group because 'it is difficult, if not impossible to attribute causation from such studies' (EPOC 2016b). Similarly, many prior reviews include controlled before-after and cluster-randomised studies which have only a single site enrolled in one or more arms of the study, where outcomes are inherently confounded by site effects. A more detailed discussion of existing reviews is included in the Discussion. Investigating ways to improve the quality of life of residents not only benefits the residents themselves, but also benefits the staff in the facilities in which they reside and family members of the resident.

OBJECTIVES

The primary objective was to assess the effects of changes to the physical environment or alternative models of residential aged care that enhance the environment on the quality of life of the residents. The secondary objective was to assess whether the effects of changes to the physical environment or alternative models of residential aged care that enhance the environment have a different impact on quality of life according to whether the population are living with dementia.

METHODS

Criteria for considering studies for this review

Types of studies

We included randomised trials and cluster-randomised trials, as these are considered the 'gold standard' study design to assess the effectiveness of an intervention. However, due to the limited feasibility of implementing environmental design interventions in care facilities in randomised trials, we also included other study designs. We included non-randomised trials, controlled before-after studies, interrupted time series studies and repeated-measures studies that met the EPOC Group study design criteria (EPOC 2016b) and provided a comparison to traditional care facilities or alternative physical designs. Interrupted time series were required to measure observations at a minimum of three data points before and three data points after the intervention. Only controlled before-after and cluster-randomised studies which had more than one control and intervention site were included. Within the context of whole models of care, studies were considered as before-after studies if outcomes were reported on or before admission and at a minimum of one follow-up time point. We included full-text studies, conference abstracts and unpublished data obtained via correspondence with authors. We included studies irrespective of their publication status and language of publication.

Types of participants

We included studies of older adults residing in care facilities, requiring some level of nursing care beyond room and board. We included studies where ≥ 80% of the participants are aged 65 years and over (mean age ≥ 65 years).

Types of interventions

We included studies examining interventions which have modified the physical design of a residential aged care facility or built a facility with an alternative model of residential aged care in order to enhance the environment to promote independence and well-being. The included interventions were design features that have been specifically implemented to improve the quality of life of the residents. The list of included interventions below indicates many, but not all, possible interventions that were eligible for inclusion. We have generated this list from an examination of previous reviews and a review of a website which has been designed to show enabling environments in residential aged care facilities (DEEP 2015).

Cochrane EPOC recommendations for grouping interventions are based on four main themes (delivery arrangements, financial arrangements, governance arrangements, and implementation strategies) (EPOC 2016a). Within these groups are categories and subcategories; due to the nature of the review, all of the interventions fit within the 'delivery arrangements' group as described below. We have further categorised the potential interventions according to a previous review (Joseph 2015). They include structural and non-structural interventions as follows.

Delivery arrangements

Category: Where care is provided and changes to the healthcare environment.

Subcategory: environment (changes to the physical or sensory healthcare environment, by adding or altering equipment or layout, providing music, art).

- Whole-facility model
  - Home-like models of residential aged care, such as the Green House model (Zimmerman 2016). These interventions are multi-component and will include both changes to the physical environmental design and changes to the model of care provided. It is not possible to distinguish the influence of the design component of the intervention from other components of the intervention. Studies will be further categorised by whether the intervention is a facility built specifically to facilitate the proposed model of care, or refurbishment of existing facilities.
- Outdoor modifications
  - Access to and design of outdoor spaces (e.g. outdoor dining spaces, easy access to a safe enclosed environment, sensory gardens, Men's Shed).
- Building layout
  - Design of dining spaces.
  - Increase in helpful stimuli (way-finding cues, natural light, visibility of key amenities such as the toilet, use of contrast to highlight helpful features and fixtures).
- Furniture, fixtures and equipment
  - Home-like environments (e.g. variety of furniture to produce a non-institutionalised feel).
  - Inclusion of unobtrusive safety measures.
  - Paint colours.
  - Colour contrast of furniture.
  - Changes to lighting (e.g. flexible lighting, buildings designed to optimise natural light).
  - Improvements in visual access (legibility) of the internal spaces to enable residents to see their destination.
  - Reduction in unhelpful stimuli (e.g. noise, clutter, glare).
  - Introduction of familiar furniture, fittings, memorabilia.
- Indoor privacy/social interaction modifications
  - Non-shared rooms (single-resident rooms).
  - Designated quiet rooms.
  - Smaller intimate seating areas to promote socialisation.
  - Kitchen designs which promote opportunities for engagement.
  - Reminiscence rooms.
  - Improving facilities that encourage links with the community (better facilities for visitors, volunteers or children).
  - Increasing number of social rooms.

Subcategory: size of organisations (increasing or decreasing the size of health service provider units)

- Changes in scale of the building.
- Reduction in number of residents living together.

Exclusions: Studies which examined temporary interventions applied as a management/treatment tool at an individual resident level, such as light therapy, music therapy or sensory therapy (e.g. Snoezelen) were excluded.

The comparison for this review was:

- usual care (any residential aged care facility design which meets the national accreditation standards for residential aged care, but without specific enhancements, as described above); or
- alternative physical environmental designs.

Types of outcome measures

Studies were only included if they reported the primary or secondary outcomes of interest, including quality of life and other outcomes considered likely to impact quality of life for residents. This is because this review was focused on interventions aimed at improving quality of life and outcomes related to quality of life, not interventions aimed at improving safety. Only outcomes measured at the same time points were synthesised in meta-analyses; outcomes measured at different time points were synthesised separately. Outcomes measured using different scales or with different assessors could be included in the same data synthesis if the outcome of interest was the same.

Primary outcomes

- Health-related quality of life (as measured on internationally recognised scales such as the EuroQol (EQ5D); 36-Item Short Form Health Survey (SF-36); Health Utilities Index (HUI); and Adult Social Care Outcomes Toolkit (ASCOT) instruments).
- Behaviour, mood and depression (as measured on recognised quantitative scales, e.g. global measures with the Challenging Behaviour Scale, agitation measured with Cohen-Mansfield Agitation Inventory (CMAI)). Different sub-domains of behaviour, mood and depression were assessed separately.
- Function
  - Basic function (as measured by activities of daily living (ADL) as measured on recognised scales such as the Barthel Index, or individual quantitative measures of basic self-care activities (i.e. ability to dress independently)).
  - Instrumental function (as measured by ADL-recognised scales such as the Lawton's instrumental ADL scale, or individual measures of instrumental function (e.g. independence in shopping, using the telephone)).

Secondary outcomes

- Global cognitive functioning
  - Measured with any validated measure, e.g. Alzheimer's Disease Assessment Scale cognitive subscale (ADAS-cog); Mini Mental State Examination (MMSE); Repeatable Battery for the Assessment of Neuropsychological Status (RBANS); Cambridge Cognition Examination (CAMCOG).
- Quality of care
  - Number of bedfast residents, catheter use, pressure ulcers and hospital readmissions.
- Serious adverse effects
  - Including falls and the use of physical restraints.
- Outcomes for carers including mood/depression, quality of life and burden
  - Measured with any established tool, e.g. carer mood or depression measured with Geriatric Depression Scale; Hospital Anxiety and Depression Scale; Centre Epidemiological Studies-Depression Scale; Montgomery–Åsberg Depression Rating Scale; General Well-Being Scale; carer quality of life measured with SF-36; EQ5D; World Health Organization Quality of Life Questionnaire (WHOQOL-BREF); and carer burden measured with Zarit Burden Inventory; Perceived Stress Scale; Family Caregiving Burden Inventory.
- Outcomes for staff including staff knowledge, attitude, self-efficacy, quality of life, stress (or burnout), and work satisfaction
  - Measured with any established tool, e.g. Satisfaction in Nursing Care and Work Scale, Caregiver Stress Scale (CSS), Strains in Nursing Care Scale, Maslach Burnout Inventory (MBI), Staff Attitude Questionnaire (SAQ), and the Quality of Work Life Questionnaire

In the protocol, we reported that secondary outcomes would include "dementia-specific measures (e.g. global behaviour measures with the Neuropsychiatric Inventory, depression as measured with the Cornell Scale for Depression in Dementia)". However, it is considered that these measures should not be examined separately to behaviour as some measures including the Neuropsychiatric Inventory may be used for people not living with dementia and all depression measures should also be considered as one outcome. Therefore, we removed "dementia-specific measures" as a secondary outcome. As 'behaviour, mood and depression' is a broad category, we did not think it was appropriate to combine measures of different behavioural outcomes, therefore, these were analysed separately. Only the two behavioural outcomes considered most informative are included in the Summary of findings tables. These included global behaviour measures, as global behaviour scales incorporate questions about a range of behaviours and depression, as this is a common and important negative mood symptom in residents of aged care homes. In the Summary of findings tables, we also grouped the outcomes 'measures of basic function' and 'measures of instrumental function' under one outcome 'function'.

Search methods for identification of studies

The authors of this review developed a search strategy in collaboration with the Cochrane Effective Practice and Organisation of Care (EPOC) Information Specialist.

Electronic searches

We undertook a comprehensive search of the Cochrane Database of Systematic Reviews for related systematic reviews.

We searched the following databases for primary studies, from inception to 11 February 2021.

- MEDLINE Ovid (1946 onwards);
- Embase Ovid (1974 onwards);
- Cochrane Central Register of Controlled Trials, (CENTRAL; 2021, Issue 2) in the Cochrane Library;
- CINAHL PLUS (Cumulative Index to Nursing and Allied Health Literature), EbscoHost (1982 onwards);
- PsycINFO EBSCO (1967 onwards);
- Dissertations and Theses, ProQuest;
- Science Citation Index Expanded, Web of Science, Clarivate (1945 onwards);
- Conference Proceedings Citation Index – Science, Web of Science, Clarivate (1990 onwards);
- Social Care Online (www.scie-socialcareonline.org.uk).

Search strategies are comprised of synonyms for different potential environmental design interventions and different terms for care

facilities in both natural language and controlled vocabulary terms. We did not apply any limits on language. All search strategies are available in Appendix 1.

We used filters to limit retrieval to appropriate study designs.

Searching other resources

Trial registries

- WHO ICTRP (World Health Organisation International Clinical Trials Registry Platform; www.who.int/ictrp; to 30 November 2017). This was not available at the time of the updated search on 11 February 2021 and therefore, was not included.
- US National Institutes of Health Ongoing Trials Register (www.ClinicalTrials.gov; to 11 February 2021).
- ANZCTR (www.anzctr.org.au; to 11 February 2021).

The search strategies for the trial registers are also provided in Appendix 1.

Grey literature

We conducted a grey literature search to identify studies not indexed in the databases listed above. We searched the following websites on 11 February 2021 for terms including nursing home OR residential OR long term care AND architecture OR design OR environment:

- OpenGrey (www.opengrey.eu);
- Agency for Healthcare Research and Quality (AHRQ; www.ahrq.gov), first ten pages returned;
- National Institute for Health and Clinical Excellence (NICE; www.nice.org.uk);
- NHS Evidence (www.evidence.nhs.uk).

Although not originally planned, we also decided to search the following websites because we identified them as potentially relevant for this review after publication of the protocol. The following websites were also searched on 11 February 2021:

- Housing Learning and Improvement Network (Housing LIN; www.housinglin.org.uk);
- Dementia Training Australia (www.dta.com.au);
- Google Advanced Search (www.google.co.uk/advanced_search), first ten pages returned.

We also reviewed reference lists of all included studies and relevant systematic reviews of alternative models of residential care to identify additional potentially eligible primary studies. We conducted cited reference searches for included studies which examined whole-facility models in Science Citation Index, Web of Science, Clarivate on 22 June 2018.

Data collection and analysis

Selection of studies

We downloaded all titles and abstracts retrieved by electronic searching to a reference management database (Endnote) and removed duplicates. SLH screened all titles and abstracts for inclusion and a second reviewer (SMD, RKM, KEL or staff listed in the acknowledgements section) also independently screened titles and abstracts for inclusion. We retrieved the full-text study reports/publications and two review authors (SLH and SMD, RKM or KEL) independently screened the full texts, identified studies for inclusion and identified and recorded reasons for exclusion of the ineligible studies using Covidence. We resolved any disagreement through discussion. We collated multiple reports of the same study so that each study, rather than each report, was the unit of interest in the review. We recorded the selection process in sufficient detail to complete a PRISMA flow diagram (Liberati 2009).

Data extraction and management

We used Covidence software to complete data collection. Two review authors (SLH and SMD, KEL or RKM) independently extracted the following study characteristics from the included studies.

- Methods: study design, number of study centres and location, study setting, withdrawals, date of study, follow-up;
- Participants: number, mean age, age range, gender, severity of condition, diagnostic criteria, ethnicity, country, inclusion criteria, exclusion criteria, other relevant characteristics;
- Interventions: intervention components, comparison, fidelity assessment;
- Outcomes: main and other outcomes specified and collected, time points reported;
- Notes: funding for trial, conflicts of interest, ethical approval.

We resolved disagreements by consensus. We contacted authors of included studies/reviews to seek unpublished results/data or clarify study reports. We entered the extracted data into Review Manager 5 (Review Manager 2014). The most important time points for outcomes were considered to be in the range 3 to 6 months as this allows adequate time for an intervention to have an effect, but is not such an extended follow-up that it will be against a background of large functional or cognitive decline or increased mortality in residents.

Assessment of risk of bias in included studies

Two review authors (SLH and KEL, RKM or SMD) independently assessed risk of bias for each study using the criteria outlined in the *Cochrane Handbook for Systematic Reviews of Interventions* (Higgins 2011), and the guidance from the EPOC group (EPOC 2017a). Any disagreement was resolved by discussion. We assessed the risk of bias according to the following domains.

- Random sequence generation
- Allocation concealment
- Blinding of participants and personnel
- Blinding of outcome assessment
- Incomplete outcome data
- Selective outcome reporting
- Other bias: baseline outcome measurements similar, baseline characteristics similar, protection against contamination

For interrupted time series studies, we assessed the risk of bias according to the following domains.

- Allocation concealment
- Incomplete outcome data
- Selective outcome reporting
- Intervention independent of other events
- Shape of the intervention effect prespecified

- Affect/influence of intervention on data collection
- Other bias: any additional potential sources of bias identified

We judged each potential source of bias as 'high', 'low', or 'unclear' and provided a justification for our judgement in the risk of bias tables including a quote from the study where appropriate. We assigned an overall low risk of bias if we judged all domains to have a low risk of bias, an overall high risk of bias if we judged one or more domains to have a high risk of bias, and an overall unclear risk of bias if we judged one or more domains to have an unclear risk of bias (i.e. not clearly reported). We summarised the risk of bias judgements across different studies for each of the domains listed. We did not exclude studies on the grounds of their risk of bias. We contacted study authors to clarify risk of bias for 'unclear' items for studies providing quantitative outcomes suitable for pooling.

When considering treatment effects, we took the risk of bias into account for the studies that contributed to that outcome and incorporated it into our grading of the certainty of the evidence.

We conducted the review according to the published protocol and reported any deviations from it in the Differences between protocol and review.

Measures of treatment effect

We estimated the effect of the intervention using risk ratio/risk difference, rate ratio or odds ratio (as appropriate) for dichotomous data, and mean difference or standardised mean difference for continuous data, together with the 95% confidence interval. We ensured that an increase in scores for continuous outcomes could be interpreted in the same way for each outcome, explained the direction to the reader, and reported where the directions were reversed, if this was necessary.

For randomised trials, we used study endpoints in preference to change from baseline data, if possible, as recommended in Chapter 7 of the *Cochrane Handbook for Systematic Reviews of Interventions* (Higgins 2011). For interrupted time series studies, we planned to abstract the difference in slope and the difference in level pre- to post-intervention. We planned to report the post- versus pre-intervention difference (adjusted for trends) at specific time points. If the differences were not available in the primary reports, we planned to attempt re-analysis using data from graphs or tables based on the EPOC-specific guidance for analysis of interrupted time series studies.

Unit of analysis issues

For cluster-randomised trials, where possible, we extracted data which took the effect of clustering into account. When clustering was not taken into account, we planned to attempt to account for the effect of clustering by dividing the original sample size by the design effect, as described in Chapter 16.3 of the *Cochrane Handbook for Systematic Reviews of Interventions* (Higgins 2011).

Dealing with missing data

We contacted investigators in order to obtain missing outcome data. If a standard deviation needed to determine a mean difference was not available, the standard deviation was obtained from other available data such as a standard error, confidence intervals, t statistic or P value that related to a difference between means in two groups, in line with the *Cochrane Handbook for Systematic Reviews of Interventions* (Higgins 2011). However, if the studies were non-randomised and the reported means were unadjusted for potential confounding factors, we did not attempt to produce an effect estimate. If the study was a repeated measures study or interrupted time series and a statistical comparison of time trends before and after the intervention were not provided; we re-analysed the results as recommended in EPOC 2017c.

Assessment of heterogeneity

We examined heterogeneity using the I^2 statistic which quantifies the percentage of the total variation across studies that is due to heterogeneity rather than chance (Higgins 2003). We used Cochrane guidance to interpret the I^2 statistic (0% to 40% might not be important; 30% to 60% may represent moderate heterogeneity; 50% to 90% may represent substantial heterogeneity; and 75% to 100% may represent very substantial ('considerable') heterogeneity) (Higgins 2011).

Assessment of reporting biases

We attempted to contact study authors, asking them to provide missing outcome data where applicable. If no response was received, and the missing data were thought to introduce serious bias, we planned to explore the impact of including such studies in the overall assessment of results. If we were able to pool more than 10 trials, we planned to create and examine a funnel plot to explore possible publication biases, interpreting the results with caution (Sterne 2011). We did not assess reporting biases using a funnel plot as there were too few studies for each comparison and outcome.

Data synthesis

We undertook meta-analyses only where this was meaningful, i.e. if the treatments, participants, and the underlying clinical question were similar enough for pooling to make clinical sense. Fixed-effects models were used, but random effects would be considered if we were concerned about the influence of small-study effects on the results of a meta-analysis in which there was evidence of between-study heterogeneity ($I^2 > 0$) as described in Chapter 10 of the *Cochrane Handbook for Systematic Reviews of Interventions* (Higgins 2011). Where multiple trial arms were reported in a single trial, we included only the relevant arms. For non-randomised studies, only studies which reported results adjusted for potential confounding factors were planned to be reported in forest plots using the "estimate from the model that adjusted for the maximum number of covariates" as recommended in Chapter 13 of the *Cochrane Handbook for Systematic Reviews of Interventions* (Higgins 2011). For repeated measures studies, if the authors did not conduct a statistical comparison of time trends before and after the intervention, we re-analysed the results as recommended in EPOC 2017c. We statistically compared time trends using a segmented regression model which included the time elapsed since the start of the study, a dummy variable indicating the pre-intervention period or the post-intervention period, and an interaction term between the time elapsed and the dummy variable as predictors and the mean scores as the outcome variable.

Where pooling of outcomes was not appropriate, we completed a structured synthesis of the results. We provided structured tabulations of results across studies grouped by the intervention examined (e.g. all studies which examined a whole-facility 'home-like' model of care were grouped together) and further grouped by the outcome category (e.g. health-related quality of life). Forest

plots were included when more than one study examined the same intervention and outcome, and data were available for presentation in a forest plot.

Subgroup analysis and investigation of heterogeneity

We planned to carry out the following subgroup analyses, but there were insufficient data to perform these.

- Level of nursing care provided by the facility (high/intermediate/mixed). The levels of care of the facilities reflect the levels of dependence of the participants. (Cameron 2018).
- Cognitive status (i.e. dementia versus no dementia/mixed population)

Sensitivity analysis

We planned to perform sensitivity analyses defined a priori to assess the robustness of our conclusions and explore their impact on effect sizes, but there were insufficient data to perform these.

- restricting the analysis to published studies; and
- restricting the analysis to studies with a low risk of bias.

Summary of findings and assessment of the certainty of the evidence

We created a Summary of findings table for the main intervention comparison (whole-facility 'home-like' model compared to usual care or alternative designs) and included main outcomes — primary effectiveness outcomes of health-related quality of life; measures of behaviour, mood and depression; measures of function; plus serious adverse effects. Only the main intervention comparison was included in a Summary of findings table as this is the largest scale design change which captures a variety of different design alterations and is considered the most important comparison. "Behaviour, mood and depression" is a primary outcome. As this outcome encompasses a large range of possible outcomes and measures, only the two considered most informative were included in the Summary of findings table. These are: global behaviour measures (as these capture a range of these outcomes) and depression as this is a common and important negative mood symptom in residents of aged care homes. As described in the Data extraction and management section, the most important time points for outcomes were considered to be in the range 3 to 6 months. Therefore, outcomes within this range were reported in the Summary of findings table, where available.

Two review authors (SLH and SMD or KEL) independently assessed the certainty of the evidence (high, moderate, low, and very low) using the five GRADE considerations (risk of bias, consistency of effect, imprecision, indirectness, and publication bias) (Guyatt 2008). We used methods and recommendations described in Section 8.5 and Chapter 12 of the *Cochrane Handbook for Systematic Reviews of Interventions* (Higgins 2011), and the EPOC worksheets (EPOC 2017b), and used GRADEpro GDT software (GRADEpro GDT 2015). Randomised trials start at high certainty of evidence and non-randomised trials start at low certainty of evidence before the five GRADE considerations are assessed. We resolved disagreements on certainty ratings by discussion and provided justification for decisions to down or upgrade the ratings using footnotes to the table with comments to aid readers' understanding of the review, where necessary.

RESULTS

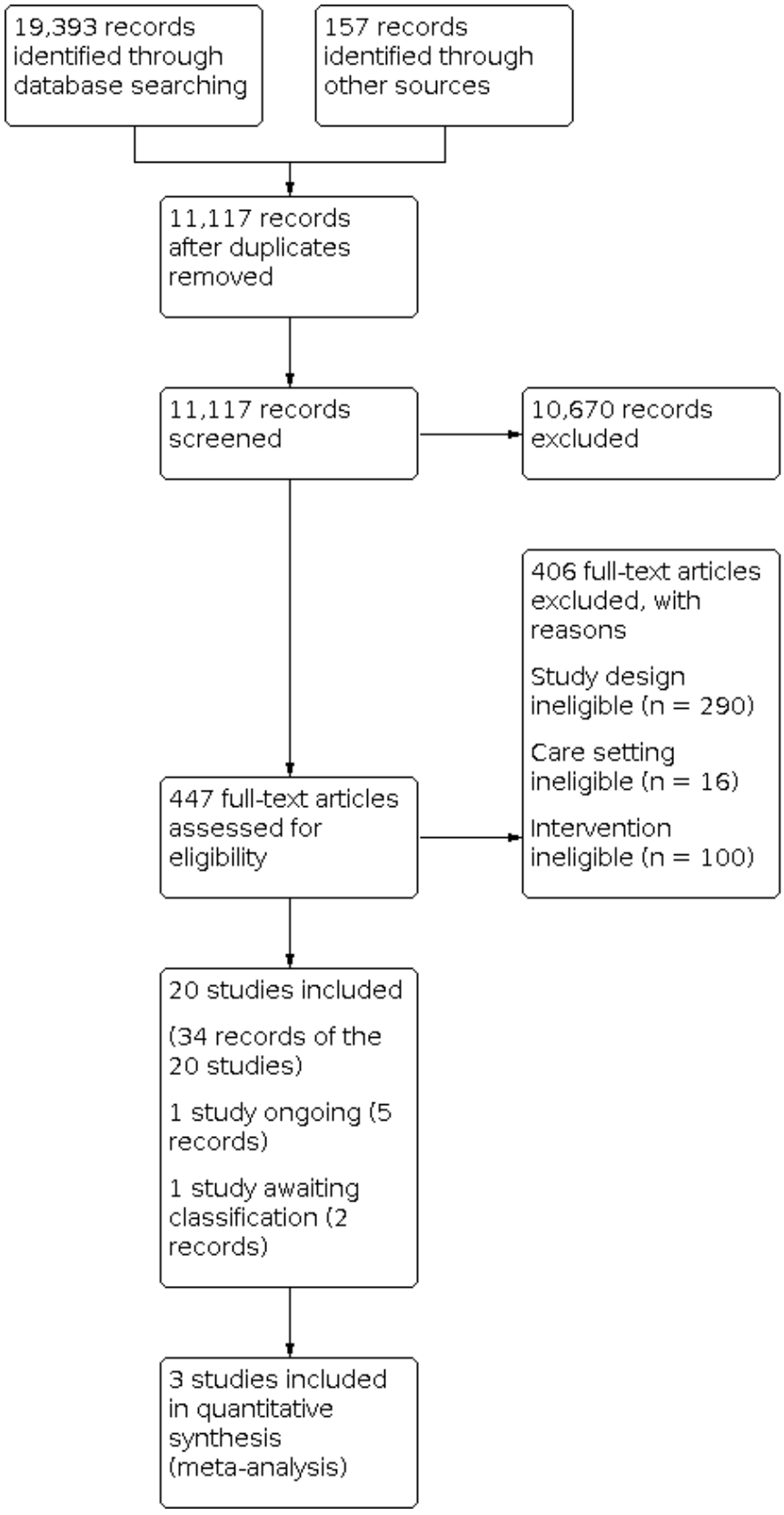
Description of studies

Twenty randomised controlled, before-after or repeated measures studies of large- or small-scale changes to the environmental design of aged care facilities were included in this review. The comparison groups varied, but included comparison to any alternative environmental design. Details of the interventions and comparisons are provided in the Included studies section.

Results of the search

The electronic search returned 19,393 records, and 157 records (grey literature or reference lists of studies) were identified from other sources. After removal of duplicates, 11,117 unique records were screened, and 10,670 citations were excluded based on titles and abstracts. We assessed the full-text for 447 records and identified 20 completed studies eligible for inclusion in this review (reported in 34 records). One ongoing study was identified and one study awaiting classification. Figure 1 shows the study selection process.

Figure 1.



Included studies

See Characteristics of included studies.

Study design and country

Of the 20 included studies, five were randomised trials (Chenoweth 2014; Galik 2021; Mathey 2001; Nijs 2006; Riemersma-vanDerLek 2008), two were randomised cross-over trials (Figueiro 2019; Hopkins 2017), 12 were controlled before-after studies (Afendulis 2016; Annerstedt 1993; Burack 2012; Dettbarn-Reggentin 2005; Diaz-Veiga 2014; Elmstahl 1997; Frisoni 1998; Kenkmann 2010; Te Boekhorst 2009; Wolf-Ostermann 2012; Wylie 2001; Yoon 2015), and one was a repeated measures study (Marcy-Edwards 2011). All of the randomised trials were cluster-randomised as the facilities were randomised to receive the intervention (Chenoweth 2014; Galik 2021; Mathey 2001; Nijs 2006; Riemersma-vanDerLek 2008). Hopkins 2017 and Figueiro 2019 did not specifically state the studies were cluster randomised, but as the intervention (lighting) was installed in communal living areas in both of these studies, it is assumed these studies are also cluster randomised. The studies were conducted in nine different countries including the USA (n = 6, Afendulis 2016; Burack 2012; Figueiro 2019; Galik 2021; Wylie 2001; Yoon 2015), The Netherlands (n=4 Mathey 2001; Nijs 2006; Riemersma-vanDerLek 2008; Te Boekhorst 2009), the UK (n=2 Hopkins 2017; Kenkmann 2010), Sweden (n = 2, Annerstedt 1993; Elmstahl 1997), Germany (n = 2, Dettbarn-Reggentin 2005; Wolf-Ostermann 2012) and single studies from Australia (Chenoweth 2014), Spain (Diaz-Veiga 2014), Italy (Frisoni 1998) and Canada (Marcy-Edwards 2011).

All studies except five reported sources of funding (Burack 2012; Dettbarn-Reggentin 2005; Diaz-Veiga 2014; Mathey 2001; Wylie 2001). The funding sources for the majority of studies were research or city councils, charitable organisations, government health organisations, universities or a mixture of these. Riemersma-vanDerLek 2008 reported that Philips Lighting BV, Braun, and Cambridge Neurotechnology supplied material for the study at reduced cost. Figueiro 2019 reported that the following manufacturers provided in-kind lighting products: GE Current, a Daintree company; OSRAM Sylvania; Ketra; and Sharp Corporation. Ten studies reported no conflicts of interest and eight studies did not report conflicts of interest. One study (Hopkins 2017) stated no financial, personal, potential conflicts of interest in the conduct of the study or in the manuscript development. The authors stated that although Philips Lighting supplied the light fitments, they had no part in the design of the protocol nor in the analysis of the data. They stated two co-authors were co-directors of Stockgrand Ltd and one co-author had in the past received research grant support from Philips. One co-author was an employee of Philips Research. Nine studies did not report ethical approval and eleven studies reported ethical approval details. One further study (Figueiro 2019) stated neither the funding agency nor the in-kind contributors had any role in the design, methods, data analysis, or preparation of the manuscript. Four co-authors received research grant support from the National Institutes of Health, Office of Naval Research, the United States General Services Administration, and industry (Acuity Brands; Axis Lighting; GE Current, a Daintree company; OSRAM Sylvania; Ketra; USAI Lighting; Armstrong Ceilings and Walls; Philips Lighting; Cree; View Glass; Marriott International).

Participants

The 20 studies included 77,265 participants. There was one very large study which was unclear on the number of participants included in the analyses used in this review, but weighted sample percentages indicate an estimated 74,449 participants at enrolment (Afendulis 2016). The remaining 18 studies included 2816 participants and sample sizes ranged from 34 (Marcy-Edwards 2011) to 601 (Chenoweth 2014). Two studies did not report mean participant age (Afendulis 2016; Wylie 2001) and most studies reported mean age by group allocation (intervention and control). Reported mean participant age in studies which did report this ranged from 75 (Nijs 2006) to 87.7 years (Kenkmann 2010) in the intervention or control groups. Thirteen studies reported the proportion of participants with dementia (range 0% to 100%). One study included only participants without dementia (Nijs 2006) and nine studies included only participants with dementia (Chenoweth 2014; Diaz-Veiga 2014; Elmstahl 1997; Figueiro 2019; Mathey 2001; Riemersma-vanDerLek 2008; Te Boekhorst 2009; Wolf-Ostermann 2012; Wylie 2001). Overall, 68% of participants were women and 32% were men, in the 14 studies for which this information was available (Annerstedt 1993; Chenoweth 2014; Dettbarn-Reggentin 2005; Diaz-Veiga 2014; Figueiro 2019; Frisoni 1998; Galik 2021; Marcy-Edwards 2011; Mathey 2001; Nijs 2006; Riemersma-vanDerLek 2008; Te Boekhorst 2009; Wolf-Ostermann 2012; Yoon 2015).

Description of the interventions

Whole-facility model

Home-like models of care

Eleven studies (two randomised trials, nine controlled before-after studies) reported on changes to the physical environment in conjunction with changes to the whole model of care (e.g. changes to staffing such as more consistent staffing and residents having more choice and control over daily routines and activities) in comparison to traditional design and care (Afendulis 2016; Annerstedt 1993; Burack 2012; Chenoweth 2014; Dettbarn-Reggentin 2005; Diaz-Veiga 2014; Galik 2021; Te Boekhorst 2009; Wolf-Ostermann 2012; Wylie 2001; Yoon 2015). The 'traditional design' comparators included: settings which had not adopted a 'small house model' (Afendulis 2016), large long-term care hospitals (Annerstedt 1993), settings with a 'typical nursing home organisational structure and standard administrative and departmental hierarchy of care' (Burack 2012), 'nursing home typical organisational structures' (Dettbarn-Reggentin 2005), settings which has 'provision of public health services in accordance with the health needs of the residents, the formal registration of care tasks and activities, and the prioritisation of safety both in the design of the spaces and the organisation' (Diaz-Veiga 2014), larger-scale settings (Te Boekhorst 2009), special care units for people with dementia (Wolf-Ostermann 2012), 'traditional nursing homes' (Wylie 2001), traditional large scale nursing homes, with hospital-like features and traditional hierarchical organisational structures (Yoon 2015), or residential aged care settings which did not receive a refurbishment intervention (Chenoweth 2014, Galik 2021).

Of these, six controlled before-after studies incorporated changes to the scale of the building which limited the capacity of the living units to small numbers of residents (this ranged from six to 15 residents assigned per living unit) (Afendulis 2016; Annerstedt 1993;

Dettbarn-Reggentin 2005; Te Boekhorst 2009; Wolf-Ostermann 2012; Yoon 2015). These interventions usually involved design changes to areas which both the residents and staff would use (e.g. kitchen and laundry room).

Nine studies (five randomised trials, three controlled before-after studies, one repeated measures study) reported interventions which did not incorporate changes to the whole model of care (Elmstahl 1997; Figueiro 2019; Frisoni 1998; Hopkins 2017; Kenkmann 2010; Marcy-Edwards 2011; Mathey 2001; Nijs 2006; Riemersma-vanDerLek 2008).

Refurbishment

Five of the studies (two randomised trials, three controlled before-after studies) which examined physical design changes in conjunction with changes to the whole model of care did not incorporate changes to the number of residents living in a unit but were smaller refurbishments and design changes of the existing home (Burack 2012; Chenoweth 2014; Diaz-Veiga 2014; Galik 2021; Wylie 2001). Burack 2012 included changes to the bedrooms and common living areas including encouraging the use of personal items for the residents to individualise their bedrooms and design changes to the common areas to create a "calm, peaceful environment" (e.g. table cloths and centrepieces, artwork for walls and painted murals) in conjunction with changes to person-centred care such as consistent staffing, meaningful activities, community structure changes and family involvement. Chenoweth 2014 examined changes to the physical environment with or without changes to the whole model of care (person-centred care). The authors stated that changes to the environment involved using the Environment Audit Tool (EAT) to "identify features of the home that could be improved" (Fleming 2011). The recommended environmental changes included altering the safety, accessibility and utility of outdoor spaces, a greater variety of social spaces and changes to colour and addition of objects with an aim to improve way finding and familiarity with a budget of AUD$10,000 per home. However, the authors have reported that there were difficulties in implementation of some design features at some facilities within the time frame of the study. Facilities which also received changes to person-centred care had experts in person-centred care train five staff from each of the facilities over 32 hours off-site (Chenoweth 2014). Diaz-Veiga 2014 examined the Etxean Ondo model which includes design of physical-organisational environments similar to domestic settings, favouring personal privacy as well as opportunities for choice, participation in daily life activities and social interaction, set apart by the creation of domestic environments, the development of important activities and organisational processes based on the daily life and the resources of residents, families and professionals. Galik 2021 examined a Function and Behavior Focused Care (FBFC) model which included an examination of opportunities for physical activity and engaging in functional tasks as well as barriers to these activities. Based on these assessments, modifications in policy and the environment were made. Wylie 2001 examined the Eden Alternative which incorporates pets, plants and children to daily life and provides daily opportunities to give as well as receive care by promoting resident participation in the daily routine of activities.

Special-care units for people with dementia

One controlled before-after study examined a special care unit for people with dementia in comparison to traditional nursing homes (Frisoni 1998). This intervention incorporated the following components: ten two-bed rooms, a large wandering area, a dining room, and a separate area for structured activity (physical and occupational therapy); exit doors were secured by magnetic locks opening with a digital code, noxious stimuli were minimised, wall colours were made neutral, and way-finding cues were used to help residents identify different areas.

Group living corridors

One controlled before-after study examined a comparison between different building layouts within a group living unit (Elmstahl 1997). Group living units were built for six to eight residents with dementia and incorporated a specifically designed community area comprising a living room, laundry, kitchen and dining room shared by residents and staff. A corridor design to the group living units was compared to a non-corridor design (L-shaped, H-shaped or square design).

Alternative physical environmental design (without whole-facility changes)

Lighting

Three randomised trials examined lighting interventions (Figueiro 2019; Hopkins 2017; Riemersma-vanDerLek 2008). One study compared high colour temperature (17000 K) blue-enriched white-light in communal areas compared to low colour temperature (4000 K) white light (Hopkins 2017); the higher the degrees Kelvin the brighter the lights will appear. One study installed a large number of fluorescent tubes in the common living room and lights were on between 9 am and 6 pm and increased light intensity between 10 am and 6 pm, whereas the control facilities had half the number of tubes with concealed band-stop filters and were installed at a greater distance from the eye (Riemersma-vanDerLek 2008). The third study examined lighting designed to provide high circadian stimulus (Figueiro 2019). Custom-built floor luminaires, light boxes and light tables were used, timers activated lights according to wake times, and lights were placed in the person's bedrooms or in common area until 6 pm. The control lighting provided low circadian stimulus with the light delivery method varying depending on where the participant spent most of his/her day.

Dining area redesign

Three studies (two randomised trials, one controlled before-after study) examined changes to the dining room to create a family-style, restaurant-style or improved ambiance environment (Kenkmann 2010; Mathey 2001; Nijs 2006). Nijs 2006 examined a family-style dining intervention which included changes to the design components of the dining room (table cloths, plates and glasses, full cutlery, flower arrangements) and changes to the dining service (cooked meals served on tables, greater choice of meals, resident choice for timing of meals compared to meals served on a pre-plated tray with none of the design features described in the intervention). The second study which examined a restaurant-style dining intervention also included table cloths and flower arrangements in addition to food displayed for residents to see, fewer tables in the dining room, white crockery with side plates, drinks machine available at all times and snacks available anytime (Kenkmann 2010). This intervention also included increased choice of meals and increased choice in timing of meals by opening the dining area for 90 minutes with several sittings. Mathey 2001 examined an 'improved meal ambiance' intervention which included changes to the design of

the environment: plant or flowers placed on every table, sufficient lighting, background music chosen by the residents, table cloths and trays and covers removed from the table. Further changes were also employed including increasing the number of nurses during meal times and distinguishing meal times from other activities, e.g. medications handed out before the start of the meal and no cleaning activities in the dining room during meal consumption.

Garden vignette

One repeated measures study with no control group examined a garden vignette (Marcy-Edwards 2011) which involved the creation of a designated area that contained clusters of gardening and nature-related objects, positioned in a highly visible, high traffic space. The vignette included all objects required to accomplish the activity of gardening: a garden centre table; soil, plastic pots, garden seeds, light plastic garden tools, and a plastic watering can; scented, colourful and edible plants, glossy gardening magazines with engaging pictures; and large artificial flowers to attract attention. When the garden vignette was in place, all residents had unobstructed exposure and access, 24 hours per day.

Comparators

For changes to the whole model of care, the comparators were 'traditional nursing homes' (Wylie 2001, Yoon 2015), 'psychogeriatric nursing homes' (Te Boekhorst 2009), nursing homes with 'typical organisational structure' (Burack 2012, Dettbarn-Reggentin 2005) long-term care hospitals (Annerstedt 1993), special care units for people with dementia (Wolf-Ostermann 2012), facilities which have 'prioritisation of safety in design and organisation' (Diaz-Veiga 2014) or matched non Green House model facilities (Afendulis 2016). Chenoweth 2014 compared the adoption of the person-centred environment to regular monitoring of any unplanned changes to the environment. Elmstahl 1997 compared a corridor design to a non-corridor design. The studies of lighting comparators were low colour temperature white light (Hopkins 2017) or half the number of fluorescent tubes installed in the intervention group with concealed band-stop filters that were installed at a greater distance from the eye (Riemersma-vanDerLek 2008). For the dining interventions, the comparator was usual care (Kenkmann 2010; Mathey 2001; Nijs 2006). The special care units were compared to traditional environments (Frisoni 1998). The garden vignette intervention did not have a comparator group as this was a repeated measures study (Marcy-Edwards 2011).

Fidelity assessment

One of the studies carried out a fidelity assessment (Galik 2021). Galik 2021 reported evidence of fidelity in terms of delivery of the intervention (583 staff educated, completion of environment and policy assessments, development of care-plans and ongoing mentoring and motivating of the staff). There was also evidence of knowledge of the intervention (98% correct on the Knowledge Test for the intervention). There was evidence of adoption of the intervention in the intervention facilities. This was based on improvements in environments and policies to improve function and physical activity (environment assessment increased from 13.5 (SD 2.07) to 15.12 (SD 0.99), and policy changes increased from 8.50 (SD 3.85) to 10.87 (SD 2.41)). There was also an increase reported in the number of care activities. Chenoweth 2014 reported difficulties in implementing changes to the physical environment within the time frame of the study (Chenoweth 2014). Of the facilities that were randomised to receive the environment intervention, the authors reported that only 47% at post-intervention and 54% at eight months follow-up had implemented the environment intervention, and of the facilities that had been randomised to receive the environment intervention with person-centred care training, only 14% and 27% had implemented the environment intervention, respectively. Reported difficulties in implementing the environment intervention included: a) delays in finding contractors to complete the design changes within the study timeframe, b) management at facilities implementing changes which differed from the recommended changes or management at facilities not happy to implement the suggested changes (e.g. a plan to make the outside area more accessible involved losing a bedroom which the home was not prepared to do), c) quotations for the interventions being beyond the budget of the project or the home, d) changes to management in the home during the study period, e) safety issues for residents with the proposed changes or f) feasibility of the intervention in relation to complying with building codes. In some instances, where the management of the home were not happy with the proposed changes or the cost of the changes was above budget, the project team were able to work with the home to adapt the proposed changes to fit within budget and the study time frame, but this was not always feasible. Furthermore, facilities that were not randomised to receive the intervention may have initiated design improvements during the study period which could not be controlled for. One other study examining implementation of the Eden Alternative reported one of the facilities which received the intervention discontinued its implementation and was then evaluated as part of the control group, but reasons for discontinuation of the intervention were not detailed in the study (Wylie 2001).

Outcomes

Primary outcomes

Health-related quality of life

Seven studies were included that reported health-related quality of life (Chenoweth 2014; Diaz-Veiga 2014; Mathey 2001; Nijs 2006; Te Boekhorst 2009; Wolf-Ostermann 2012; Wylie 2001). Twelve studies were included that did not report health-related quality of life, but reported other, related, secondary outcomes (Afendulis 2016; Annerstedt 1993; Burack 2012; Dettbarn-Reggentin 2005; Elmstahl 1997; Frisoni 1998; Galik 2021; Hopkins 2017; Kenkmann 2010; Marcy-Edwards 2011; Riemersma-vanDerLek 2008; Yoon 2015). Health-related quality of life was measured using the following assessments in single studies: Dementia Quality of Life (DEMQOL) Proxy (Chenoweth 2014), QUALIDEM: a dementia-specific quality of life measure (Wolf-Ostermann 2012), Life Satisfaction Index (LSI) (Wylie 2001) and Dutch Quality of Life of Somatic Nursing Home Residents questionnaire (Nijs 2006). The quality of life in late-stage dementia (QUALID) and FUMAT were used in Diaz-Veiga 2014 and the Sickness Impact Profile (SIP) and Philadelphia Geriatric Centre Morale Scale (PGCMS) were used in Mathey 2001. Quality of life was reported at six months (Nijs 2006), eight months (Chenoweth 2014), up to 12 months (Diaz-Veiga 2014; Mathey 2001; Wolf-Ostermann 2012) and up to 18 months (Wylie 2001) follow-up. Although Te Boekhorst 2009 did include Dementia Quality of Life (DQoL) and QUALIDEM measures in their study, these findings were not included in the review because only results at six months were reported without baseline results or change in quality of life over time.

Behaviour, mood and depression

Fifteen studies reported on behaviour, mood or depression (Annerstedt 1993; Burack 2012; Chenoweth 2014; Dettbarn-Reggentin 2005; Elmstahl 1997; Figueiro 2019; Frisoni 1998; Galik 2021; Hopkins 2017; Kenkmann 2010; Marcy-Edwards 2011; Riemersma-vanDerLek 2008; Te Boekhorst 2009; Wolf-Ostermann 2012; Yoon 2015). Behaviour, mood or depression was measured by the Neuropsychiatric Inventory (NPI) in five studies, where three studies used the standard version (Frisoni 1998; Marcy-Edwards 2011; Te Boekhorst 2009), one study used the nursing home version (Wolf-Ostermann 2012) and one study used the questionnaire format (Riemersma-vanDerLek 2008). The Cohen-Mansfield Agitation Inventory (CMAI) was also used in seven studies (Burack 2012; Chenoweth 2014; Figueiro 2019; Frisoni 1998; Galik 2021; Riemersma-vanDerLek 2008; Wolf-Ostermann 2012), the Organic Brain Syndrome (OBS) scale was used in two studies (Annerstedt 1993; Elmstahl 1997) and the Philadelphia Geriatric Centre Affect Rating Scale (PGCARS) in one study (Riemersma-vanDerLek 2008). The Hospital Anxiety and Depression (HAD scale) was used in three studies, in two studies (Kenkmann 2010; Riemersma-vanDerLek 2008) specifically to measure anxiety and in one to measure depression (Hopkins 2017). Depression was measured using the Cornell Depression Scale in four studies (Figueiro 2019; Frisoni 1998; Galik 2021; Riemersma-vanDerLek 2008), the Revised Memory and Behaviour Checklist (RMBPC) in one study (Te Boekhorst 2009) and the Mood Scale Score (MSS) in one study (Yoon 2015). The Index of Social Engagement (ISE) and Revised ISE (RISE) were used to measure social engagement in Te Boekhorst 2009 and Yoon 2015, respectively. Resistiveness to care was measured using the Resistiveness to Care Scale in one study (Galik 2021).

Behaviour was reported at six months follow-up (Te Boekhorst 2009), six and 12 months follow-up (Annerstedt 1993; Wolf-Ostermann 2012) and agitation at eight months follow-up (Chenoweth 2014). Burack 2012 reported on verbal agitation, forceful behaviours and physical agitation at two years follow-up. Marcy-Edwards 2011 also reported behaviour in a repeated measures study over five phases of 14 days each; the measurements were repeated multiple times in the 14-day period and the mean measurements for days, evenings and nights were presented. Six studies reported behaviour and depression at four weeks follow-up (Figueiro 2019; Hopkins 2017), three months follow-up (Frisoni 1998) and 12 months follow-up (Elmstahl 1997; Galik 2021; Kenkmann 2010). Yoon 2015 reported depressive symptoms at 18 months follow-up. Riemersma-vanDerLek 2008 reported behaviour and function at multiple time points (six weeks, six months, 12 months, 18 months and 24 months follow-up). Yoon 2015 and Te Boekhorst 2009 reported social engagement at 6 months (Te Boekhorst 2009) and over 18 months (Yoon 2015). Dettbarn-Reggentin 2005 reported social behaviour at 12 months.

Function

Nine studies reported on function (Chenoweth 2014; Dettbarn-Reggentin 2005; Figueiro 2019; Frisoni 1998; Nijs 2006; Te Boekhorst 2009; Wolf-Ostermann 2012; Yoon 2015). Function was measured by the Barthel Index in four studies (Dettbarn-Reggentin 2005; Frisoni 1998; Galik 2021; Wolf-Ostermann 2012), the Interview for the Deterioration of Daily Living activities in Dementia (IDDD) in one study (Te Boekhorst 2009), the Bedford Alzheimer's nursing severity scale in one study (Frisoni 1998), the Nursing Home physical performance test in one study (Dettbarn-Reggentin 2005), and Activities of Daily Living (ADLs) in three studies; the ADL long-form scale was used in one study (Yoon 2015); the Minimum Data Set Activities of Daily Living Scale (MDS-ADL) was used in one study (Figueiro 2019), and the Nurse-informant adaptation of the scale by Katz and colleagues was used in one study (Riemersma-vanDerLek 2008).

Function was reported at three months (Frisoni 1998), six months (Nijs 2006; Te Boekhorst 2009), eight months (Chenoweth 2014), six and 12 months (Dettbarn-Reggentin 2005; Wolf-Ostermann 2012), four and 12 months (Galik 2021) and 18 months (Yoon 2015) follow-up. Figueiro 2019 was a cross-over trial with a 14-week protocol which comprised of two 1-week baseline measurement periods and two 4-week lighting intervention/control periods, separated by a 4-week washout period. Data were collected during the baseline measurement weeks (weeks 1 and 10) prior to each 4-week intervention/control period and once again during the final week of each intervention/control period (weeks 5 and 14).

Secondary outcomes

Global cognitive functioning

Seven studies reported on global cognitive functioning (Dettbarn-Reggentin 2005; Frisoni 1998; Kenkmann 2010; Riemersma-vanDerLek 2008; Te Boekhorst 2009; Wolf-Ostermann 2012; Yoon 2015). Global cognitive functioning was measured with the Mini Mental State Examination (MMSE) in six studies (Dettbarn-Reggentin 2005; Frisoni 1998; Kenkmann 2010; Riemersma-vanDerLek 2008; Te Boekhorst 2009; Wolf-Ostermann 2012), the Clinical Dementia Rating in one study (Frisoni 1998) and the Cognitive Performance Scale (CPS) in one study (Yoon 2015). Global cognitive function was reported at three months (Frisoni 1998), six months (Kenkmann 2010; Wolf-Ostermann 2012), 12 months (Dettbarn-Reggentin 2005; Te Boekhorst 2009; Wolf-Ostermann 2012) and 18 months (Yoon 2015). Riemersma-vanDerLek 2008 also reported cognitive function at multiple time points.

Quality of care

Two studies reported on quality of care (Afendulis 2016; Chenoweth 2014). Chenoweth 2014 used the Quality of Interactions Schedule (QUIS) to measure quality of care and Afendulis 2016 used number of bedfast residents, catheter use, low-risk and high-risk pressure ulcers, rehospitalisations and avoidable rehospitalisations as quality of care measures.

Afendulis 2016 reported these outcomes at up to 5-year follow-up and Chenoweth 2014 reported these at post-intervention at four months and eight months follow-up.

Serious adverse effects

Three studies reported on serious adverse effects (Afendulis 2016; Frisoni 1998; Kenkmann 2010). Afendulis 2016 and Frisoni 1998 reported use of physical restraints over five years and three months respectively. Frisoni 1998 reported frequency of falls in three months and Kenkmann 2010 reported number of falls in 12 months.

Outcomes for carers

No included studies reported outcomes for carers.

Outcomes for staff

No included studies reported outcomes for staff.

Ongoing studies

One ongoing study was identified (see Characteristics of ongoing studies for details). This ongoing national cross-sectional monitoring study is examining quality of life, quality of care and staff outcomes in different styles of aged care facilities every two to three years in The Netherlands. Between 47 and 144 facilities have participated in the four cycles conducted so far (Willemse 2011). The study aimed to compare "traditional large scale nursing homes, nursing home wards in a home for the aged, large nursing home where group living home care is provided, group living homes nearby the mother facility and stand-alone group living homes in the community" (Willemse 2011). Whilst all the potentially relevant analyses identified from the study thus far have been cross-sectional, future publications will be monitored for studies that meet the inclusion criteria for this review.

Studies awaiting classification

One study was identified which is awaiting classification. Kolberg 2020 is a cluster-randomised trial examining a lighting intervention in common living areas in eight aged care facilities. A conference abstract and thesis have been published showing the results of the study. There is insufficient information in the conference abstract and thesis to determine if the study should be included.

Excluded studies

We excluded 406 studies following full-text review; 290 were excluded due to ineligible study design, such as the study only had one intervention and control site or was a longitudinal study but did not have a measure before the intervention, i.e. before admission to a facility; 100 were excluded because the intervention was ineligible such as temporary therapies or changes to care practices without any changes to the environmental design of the facilities; and 16 were excluded because the care setting was ineligible such as living in an assisted living setting with no nursing care required. The Characteristics of excluded studies section details the reason for exclusion of studies which might be expected to be included in this review to explain why they are excluded.

Risk of bias in included studies

See Figure 2 and Figure 3.

Figure 2. Risk of bias graph: review authors' judgements about each risk of bias item presented as percentages across all included studies.

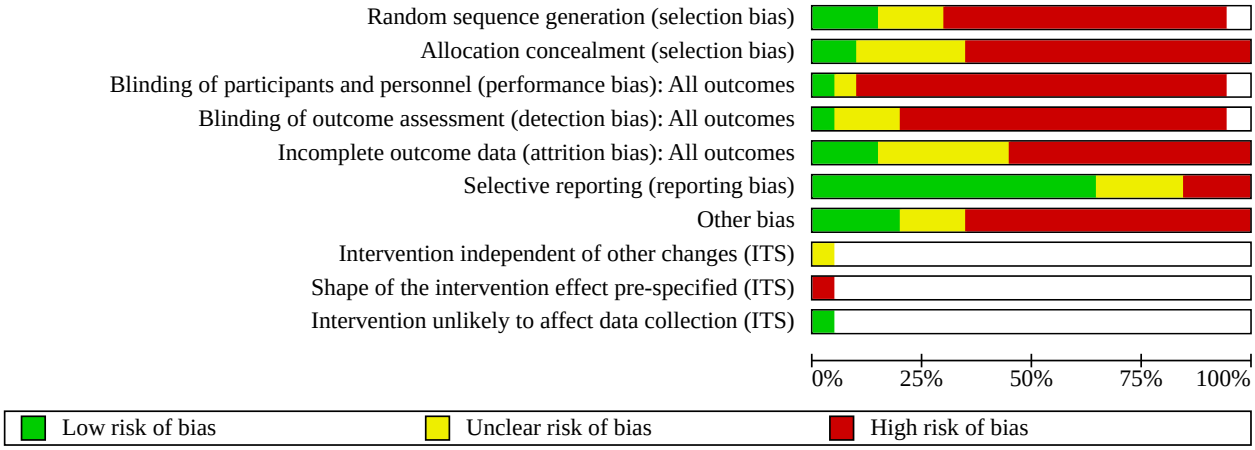
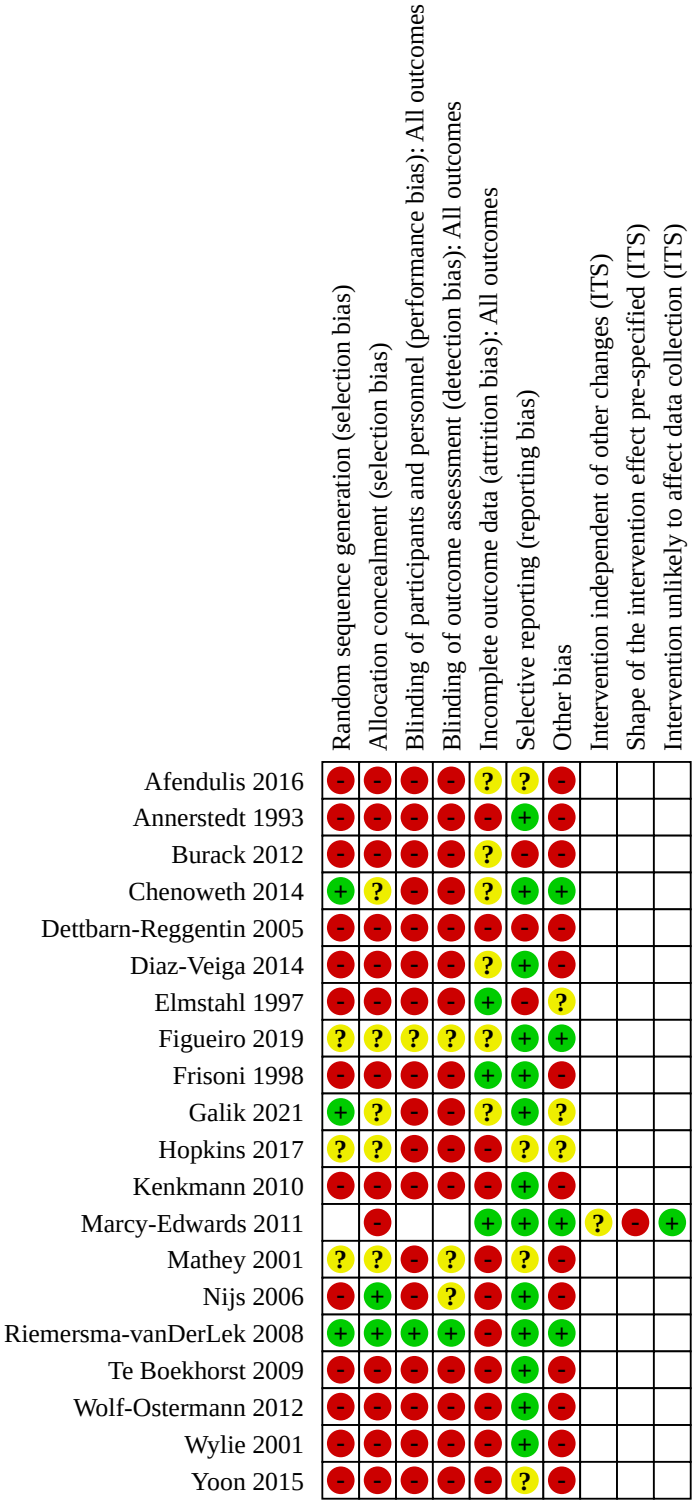


Figure 3. Risk of bias summary: review authors' judgements about each risk of bias item for each included study.



Allocation

Random sequence generation

Thirteen studies were rated as having high risk of bias because randomisation was not applied (Afendulis 2016; Annerstedt 1993; Burack 2012; Dettbarn-Reggentin 2005; Diaz-Veiga 2014; Elmstahl 1997; Frisoni 1998; Kenkmann 2010; Te Boekhorst 2009; Wolf-Ostermann 2012; Wylie 2001; Yoon 2015) or a non-random component to sequence generation (including the first letter of the ward name) was used (Nijs 2006). Three studies (Chenoweth 2014; Galik 2021; Riemersma-vanDerLek 2008) were rated as having low risk of bias as they described an appropriate method of randomisation. Three studies (Figueiro 2019; Hopkins 2017; Mathey 2001) were rated as having unclear risk of bias because randomisation was stated, but no specific details were reported. Marcy-Edwards 2011 was a repeated measures study and therefore this was not applicable.

Allocation concealment

Thirteen studies were rated as having high risk of bias because randomisation was not applied (Afendulis 2016; Annerstedt 1993; Burack 2012; Dettbarn-Reggentin 2005; Diaz-Veiga 2014; Elmstahl 1997; Frisoni 1998; Kenkmann 2010; Marcy-Edwards 2011; Te Boekhorst 2009; Wolf-Ostermann 2012; Wylie 2001; Yoon 2015). Two studies were rated as having low risk of bias because adequate allocation concealment was reported (Nijs 2006; Riemersma-vanDerLek 2008). Five studies was rated at unclear risk of bias because allocation concealment details were not specified (Figueiro 2019; Galik 2021; Hopkins 2017; Mathey 2001) or it was unclear where the randomisation sequence was stored (Chenoweth 2014).

Blinding

Blinding of participants and personnel

One study was rated as having low risk of bias as blinding of outcome assessment and blinding of participants and personnel were both adequately described (Riemersma-vanDerLek 2008). Seventeen studies were rated at high risk of bias for blinding of participants and personnel as this was not feasible (e.g. where residents or staff who are aware of group allocation provided the data) (Afendulis 2016; Annerstedt 1993; Burack 2012; Chenoweth 2014; Dettbarn-Reggentin 2005; Diaz-Veiga 2014; Elmstahl 1997; Frisoni 1998; Galik 2021; Hopkins 2017; Kenkmann 2010; Mathey 2001; Nijs 2006; Te Boekhorst 2009; Wolf-Ostermann 2012; Wylie 2001; Yoon 2015). One study was rated as having unclear risk of bias as the study stated "facility staff were not informed of any differences between the lighting interventions", but it was unclear if any differences had been observed (Figueiro 2019). Marcy-Edwards 2011 was a repeated measures study and therefore this was not applicable.

Blinding of outcome assessment

Three studies were rated as having unclear risk of bias as none reported specific details of blinding (Figueiro 2019; Mathey 2001; Nijs 2006). One study was rated as having low risk of bias as adequate descriptions of blinding of the outcome assessment was provided (Riemersma-vanDerLek 2008). Fifteen studies used outcomes where blinding was not feasible (e.g. residents or staff who were aware of group allocation provided the data) (Afendulis 2016; Annerstedt 1993; Burack 2012; Chenoweth 2014; Dettbarn-Reggentin 2005; Diaz-Veiga 2014; Galik 2021; Te Boekhorst 2009; Wolf-Ostermann 2012; Wylie 2001; Yoon 2015) or outcome assessment was not blinded (Elmstahl 1997; Frisoni 1998; Hopkins 2017; Kenkmann 2010). Marcy-Edwards 2011 was a repeated measures study and therefore this was not applicable.

Incomplete outcome data

Eleven studies were rated as having high risk of bias as there was high loss to follow-up (> 20%) (Annerstedt 1993; Dettbarn-Reggentin 2005; Hopkins 2017; Kenkmann 2010; Mathey 2001; Nijs 2006; Riemersma-vanDerLek 2008; Te Boekhorst 2009; Wolf-Ostermann 2012; Wylie 2001; Yoon 2015). Eight studies were rated at unclear risk of bias due to information not being provided by group allocation (Burack 2012), or the reasons for dropout (Chenoweth 2014), did not report loss to follow-up over time (Afendulis 2016; Diaz-Veiga 2014; Figueiro 2019) or reported large loss to follow-up, 30% after randomisation, but it was unclear which randomised group the participants belonged to (Galik 2021). Three studies were rated at low risk of bias due to adequate (> 85%, Marcy-Edwards 2011 and > 90%, Elmstahl 1997) or no loss to follow-up (Frisoni 1998).

Selective reporting

Thirteen studies were rated as having low risk of bias as their results matched what was reported in a protocol, trial registration or methods section for non-randomised studies which did not have a protocol (Annerstedt 1993; Chenoweth 2014; Diaz-Veiga 2014; Figueiro 2019; Frisoni 1998; Galik 2021; Kenkmann 2010; Marcy-Edwards 2011; Nijs 2006; Riemersma-vanDerLek 2008; Te Boekhorst 2009; Wolf-Ostermann 2012; Wylie 2001). Three studies were rated at high risk of bias due to not reporting outcomes which were described in the methods (Burack 2012; Dettbarn-Reggentin 2005; Elmstahl 1997). Four studies were rated at unclear risk of bias because they did not have published protocols and were based on data from the Minimum DataSet (MDS) which included many fields from the MDS which were not reported; (Afendulis 2016; Yoon 2015) or were randomised trials that did not report details of a study protocol or trial registration (Hopkins 2017; Mathey 2001).

Other potential sources of bias

Thirteen studies were rated at high risk of bias (Afendulis 2016; Annerstedt 1993; Burack 2012; Dettbarn-Reggentin 2005; Diaz-Veiga 2014; Frisoni 1998; Kenkmann 2010; Mathey 2001; Nijs 2006; Te Boekhorst 2009; Wolf-Ostermann 2012; Wylie 2001; Yoon 2015). Reasons for being rated at high risk of bias included differences in baseline characteristics (Afendulis 2016, Annerstedt 1993, Burack 2012, Frisoni 1998, Kenkmann 2010, Mathey 2001, Nijs 2006, Te Boekhorst 2009; Wylie 2001, Wolf-Ostermann 2012, Yoon 2015), differences in baseline outcome measures (Afendulis 2016; Annerstedt 1993; Burack 2012; Dettbarn-Reggentin 2005; Diaz-Veiga 2014; Frisoni 1998) and potential for contamination (Mathey 2001; Wylie 2001). Twelve studies were non-randomised studies, therefore residual confounding was a potential source of bias (Afendulis 2016; Annerstedt 1993; Burack 2012; Dettbarn-Reggentin 2005; Diaz-Veiga 2014; Elmstahl 1997; Frisoni 1998; Kenkmann 2010; Te Boekhorst 2009; Wolf-Ostermann 2012; Wylie 2001; Yoon 2015). Three studies were rated at unclear risk of bias (Elmstahl 1997; Galik 2021; Hopkins 2017); two studies did not report baseline characteristics by group allocation (Elmstahl 1997; Hopkins 2017); one study reported outcome measures in little detail (Hopkins 2017); and in one study there appeared to be differences in one

of the outcomes but no statistical analysis was performed (Galik 2021). Four studies were rated at low risk of bias for having no statistically significant differences between groups at baseline, no statistically significant differences in outcome measures at baseline, having the intervention assigned at the level of the care facility and no other potential sources of bias identified (Chenoweth 2014; Figueiro 2019; Marcy-Edwards 2011; Riemersma-vanDerLek 2008).

Intervention independent of other changes

Marcy-Edwards 2011 was a repeated measures study and therefore the criteria for risk of bias also included 'intervention independent of other changes', and was rated as having unclear risk of bias as it was not reported that the intervention was not independent of other changes in time nor was there compelling evidence that the intervention was independent.

Shape of the intervention effect prespecified

Marcy-Edwards 2011 was also rated at high risk of bias for 'shape of the intervention effect prespecified' because the baseline data collection was spread over four weeks.

Intervention unlikely to affect data collection

Marcy-Edwards 2011 was rated at low risk of bias for 'intervention unlikely to affect data collection' as the sources and methods of data collection were the same before and after the intervention.

Effects of interventions

See: **Summary of findings 1** Whole-facility changes: Home-like models compared to traditional environment for older people living in long-term residential care

Whole-facility model

A summary of the evidence for home-like in comparison to traditional models of care is provided in Summary of findings 1.

Home-like model versus traditional environment

Six controlled before-after studies compared the home-like model and the traditional environment (136,419 participants) (Afendulis 2016; Annerstedt 1993; Dettbarn-Reggentin 2005; Te Boekhorst 2009; Wolf-Ostermann 2012; Yoon 2015). One controlled before-after study did not report participant numbers according to their exposure (Afendulis 2016).

Health-related quality of life

It is uncertain whether home-like models improved health-related quality of life because the certainty of the evidence is very low (1 study; 33 participants; very low-certainty evidence). No effect estimate could be derived because of the unavailability of the data. The certainty of the evidence was downgraded from low-certainty to very low-certainty because of very serious concerns due to risk of bias and imprecision.

One controlled-before after study examined quality of life (Wolf-Ostermann 2012). Outcomes were measured at baseline, six months and 12 months by examining multiple domains from the QUALIDEM, where high scores indicate better quality of life. Although 56 participants were included in the study, only 33 participants completed the follow-up and were included in the analysis. The authors examined nine domains of the QUALIDEM including care relationship, feeling at home, social relations, positive self-image, restless tense behaviour, having something to do, positive affect, negative affect and social isolation. Two domains (feeling at home and care relationship) were examined in analyses adjusted for baseline differences between the groups and the seven other domains were examined in unadjusted analyses. The author stated "no statistically significant differences were observed between the intervention and control groups." (Analysis 1.1).

Behaviour, mood and depression

It is uncertain whether home-like models improved behaviour, mood and depression because the certainty of the evidence is very low (3 studies for global behaviour; 257 participants; very low-certainty evidence, and two studies for depression; 406 participants; very low-certainty evidence). The certainty of the evidence was downgraded from low-certainty to very low-certainty because of very serious concerns due to risk of bias, and also serious concerns due to imprecision for global behaviour. Meta-analyses could not be completed because of differences in the outcomes reported.

Five controlled before-after studies compared the home-like model to a traditional environment (625 participants) and reported data for a home-like model versus traditional environment on behaviour, mood and depression outcomes (Annerstedt 1993; Dettbarn-Reggentin 2005; Wolf-Ostermann 2012; Yoon 2015; Te Boekhorst 2009). Two studies (Annerstedt 1993; Wolf-Ostermann 2012) reported results for sub-domains of behaviour, three studies (Dettbarn-Reggentin 2005, Te Boekhorst 2009 Wolf-Ostermann 2012) examined global behaviour, two studies (Yoon 2015; Te Boekhorst 2009) examined social engagement and two studies (Yoon 2015; Te Boekhorst 2009) examined depression.

For global behaviour, Te Boekhorst 2009 used the Neuropsychiatric Inventory (NPI), Wolf-Ostermann 2012 used the NPI-Nursing Home version (NPI-NH) and Dettbarn-Reggentin 2005 examined global behaviour using the Nurses Observation Scale for Geriatric Patients (NOSGER). For depression, Te Boekhorst 2009 used the Revised Memory and Behaviour Problems Checklist (RMBPC) and Yoon 2015 used the Mood Scale Score (MSS). For subdomains of behaviour, Annerstedt 1993 used the Organic Brain Syndromes (OBS) scale to report outcomes for dyspraxia, hallucinations, lack of vitality, dysphasia, paranoia, aggressiveness, depression, clinical variations, restlessness, and Wolf-Ostermann 2012 used the Cohen-Mansfield Agitation Inventory (CMAI) to report changes in verbal agitation, physical non-aggressive and physical aggressive behaviour. For all of these measures, lower scores indicate fewer behavioural symptoms. For social engagement, Yoon 2015 used the Index of Social Engagement (ISE) and Te Boekhorst 2009 used Revised Index of Social Engagement (RISE), and higher scores indicate better social engagement.

Behaviour, mood and/or depression outcomes were examined at baseline (Annerstedt 1993; Dettbarn-Reggentin 2005; Te Boekhorst 2009; Wolf-Ostermann 2012; Yoon 2015), three months (Yoon 2015), six months (Annerstedt 1993, Dettbarn-Reggentin 2005,Te Boekhorst 2009, Wolf-Ostermann 2012, Yoon 2015), nine months (Yoon 2015), 12 months (Annerstedt 1993, Dettbarn-Reggentin 2005, Wolf-Ostermann 2012, Yoon 2015), 15 months (Yoon 2015), and 18 months (Yoon 2015).

Dettbarn-Reggentin 2005 did not adjust results for baseline differences between the groups, but the authors stated there was a "significant influence of the residential group environment on the social behaviour and state of mind of the residents". The results from Wolf-Ostermann 2012 stated for global behaviour: "interactions between settings and development over time could not be proved". No effect estimate for Wolf-Ostermann 2012 could be derived because of the reporting of the data. Results from Te Boekhorst 2009 suggested little or no difference in global behaviour (mean difference (MD): -0.04, 95% Confidence Interval (CI) -0.13 to 0.04; Analysis 1.2.1; 1 study).

Results on depression outcomes could not be combined in a meta-analysis because Yoon 2015 examined the change of depression and probability of having zero depressive symptoms whereas Te Boekhorst 2009 reported the endpoint depression results. Yoon 2015 indicated an increase in depressive symptoms over 18 months with a home-like model of care (rate ratio 1.15, 95% CI 1.02 to 1.29; Analysis 1.2.2; 1 study with 242 participants), but the effect on the probability of zero depressive symptoms was uncertain (odds ratio (OR) 0.36, 95% CI 0.12 to 1.07; Analysis 1.2.2; 1 study). Te Boekhorst 2009 found little or no difference in depressive symptoms at six months (MD 0.01, 95% CI -0.12 to 0.14; Analysis 1.2.2; 1 study). It is uncertain whether home-like models of care improve depressive symptoms because the certainty of this evidence is very low.

Annerstedt 1993 reported that "a difference in clinical changes was significant" between the intervention and control groups after six months in dyspraxia (spatial disorientation) and depression, but aggressiveness increased among the intervention group (Analysis 1.2.3). Wolf-Ostermann 2012 found little or no effect on verbal agitation, physical non-aggressive or physical aggressive behaviour with the home-like model.

Results for social engagement could not be combined in a meta-analysis because Yoon 2015 examined the change of social engagement and probability of not being socially engaged over 18 months, whereas Te Boekhorst 2009 reported social engagement over six months. Yoon 2015 had contradictory findings with little or no difference in change in the level of social engagement over 18 months (rate ratio 0.99, 95% CI 0.82 to 1.19; Analysis 1.2.4; 1 study with 242 participants), but an increase in probability of social engagement (a decrease in the probability of not being socially engaged) for those in a home-like model of care (OR 0.76, 95% CI 0.62 to 0.94; Analysis 1.2.4; 1 study). Te Boekhorst 2009 found an increase in social engagement at six months (MD 0.79, 95% CI 0.11 to 1.50; Analysis 1.2.4; 1 study with 164 participants). It is uncertain whether home-like models of care improve social engagement because the certainty of this evidence is very low.

Function

It is uncertain whether home-like models improved function because the certainty of the evidence is very low (4 studies; 499 participants; very low-certainty evidence). The certainty of evidence was downgraded from low-certainty to very low-certainty because of very serious concerns due to risk of bias and serious concerns due to imprecision (499 participants in total across outcomes but reported across different measures and at different time points). Meta-analyses could not be completed because of differences in follow-up times and availability of data.

Four controlled before-after studies (499 participants) assessed function (Dettbarn-Reggentin 2005; Te Boekhorst 2009; Wolf-Ostermann 2012; Yoon 2015). To measure function, Yoon 2015 used the Activities of Daily Living (ADL)-long form scale, Te Boekhorst 2009 used the Interview for the Deterioration of Daily Living activities in Dementia (IDDD) and both Wolf-Ostermann 2012 and Dettbarn-Reggentin 2005 used the Barthel Index. Lower scores indicate better function for the ADL-long-form scale and IDDD, whereas higher scores indicate better function for the Barthel Index.

Function was measured at three months (Yoon 2015), six months (Te Boekhorst 2009, Yoon 2015, Wolf-Ostermann 2012), nine months (Yoon 2015), 12 months (Yoon 2015 , Wolf-Ostermann 2012, Dettbarn-Reggentin 2005) and 18 months (Yoon 2015).

Wolf-Ostermann 2012 stated for functional status: "interactions between settings and development over time could not be proved". Dettbarn-Reggentin 2005 stated that function declined in both the intervention and control groups, but function declined "more sharply" in the control group (Analysis 1.3).

Yoon 2015 reported little or no difference in change in function over 18 months after admission (MD -0.09, 95% CI -0.46 to 0.28; Analysis 1.3; 1 study). Te Boekhorst 2009 reported an increase in function (decreased IDDD score) for those in a home-like model of care six months after admission (MD -4.37, 95%CI -7.06 to -1.69; Analysis 1.3; 1 study).

Global cognitive function

It is uncertain whether home-like models improved global cognitive function because the certainty of the evidence is very low (4 studies; 569 participants; very low-certainty evidence). The certainty of evidence was downgraded from low-certainty to very low-certainty because of very serious concerns due to risk of bias and imprecision (569 participants in total across outcomes but reported across different measures and at different time points). Meta-analyses could not be completed because of differences in follow-up times and availability of data.

Four controlled before-after studies (569 participants) reported global cognitive function as an outcome (Dettbarn-Reggentin 2005; Te Boekhorst 2009; Wolf-Ostermann 2012; Yoon 2015). Two studies used the Mini-Mental State Examination (MMSE) (Dettbarn-Reggentin 2005; Wolf-Ostermann 2012), one study used the standardised MMSE (Te Boekhorst 2009) and one study used the Cognitive Performance Scale (CPS) (Yoon 2015). Higher scores indicate better global cognitive function, except for the CPS where lower scores indicate better global cognitive function.

Global cognitive function was measured at three months (Yoon 2015), six months (Te Boekhorst 2009, Yoon 2015, Wolf-Ostermann 2012), nine months (Yoon 2015), 12 months (Yoon 2015 , Wolf-Ostermann 2012, Dettbarn-Reggentin 2005) and 18 months (Yoon 2015).

Yoon 2015 did not conduct any analysis to examine the evidence of an effect, and the means reported were unadjusted for potential confounding factors. Dettbarn-Reggentin 2005 suggested a sharper decline in MMSE scores over time for the control group compared to the intervention group, but the results were not adjusted for potential confounding factors. Wolf-Ostermann 2012 suggested better MMSE scores for those in a home-like model of care at

baseline to six months and little or no difference at 12 months, but the results were also not adjusted for potential confounding factors (Analysis 1.4). The results from the study by Te Boekhorst 2009 showed that home-like models of care made no difference to global cognitive function (MD 0.54, 95% CI -1.43 to 2.50; Analysis 1.4; 1 study).

Quality of care

It is uncertain whether home-like models of care improved quality of care because the certainty of the evidence is very low (1 study; weighted estimate 74,449 participants; very low-certainty evidence). The certainty of evidence was downgraded from low-certainty to very low-certainty because of very serious concerns due to risk of bias.

One controlled before-after study (weighted estimate 74,449 participants at enrolment) examined quality of care by reporting the number of bedfast residents, catheter use, high-risk pressure ulcers, low-risk pressure ulcers, hospital readmissions and avoidable hospital readmissions as proxy measures for quality of care (Afendulis 2016). Afendulis 2016 comprised the majority of the participants in this review, but did not examine any of the primary outcomes. Quality of care outcomes were assessed between January 1, 2005 and September 30, 2010 to determine the frequency of occurrence. The study estimated difference-in-difference regression coefficients for the pre-post difference in the home-like model homes minus the pre-post difference in traditional homes. The coefficients suggested the difference in percentage points (e.g. percentage of hospital readmissions) between the home-like model of care and traditional model, with lower scores indicating better quality of care according to the proxy measures. The follow-up time in this study was unclear.

For those in a home-like model of care, Afendulis 2016 reported a reduction in the number of bedfast residents (MD -0.3%, 95% CI -0.4% to -0.2%; Analysis 1.5; 1 study), catheter use (MD -4.1%, 95% CI -6.1% to -2.1%; Analysis 1.5; 1 study), low-risk pressure ulcers (MD -1.9%, 95%CI -2.5% to -1.3%; Analysis 1.5; 1 study), hospital readmissions (MD -5.5%, 95% CI -10.2% to -0.8%; Analysis 1.5; 1 study) and avoidable hospital readmissions (MD -3.9%, 95% CI -7.6% to -0.2%; Analysis 1.5; 1 study). After accounting for multiple comparisons, the authors indicated that these differences were statistically significant. Whilst these differences may be small in percentage terms (representing a range of 0.3% for bedfast residents, to 5.5% for hospital readmissions), given the large numbers of residents living in aged care homes, these values could translate to large numbers of individuals at a regional or national level. Any improvement in such critical outcomes that are likely to impact on quality life may be considered clinically meaningful. Afendulis 2016 reported that a home-like model of care may have little to no effect on high-risk pressure ulcers (MD -1.2%, -3.8% to 1.4%; Analysis 1.5; 1 study), but the evidence is very uncertain.

Serious adverse effects

It is uncertain whether home-like models of care reduce physical restraint use as the certainty of the evidence is very low (one study; weighted estimate 74,449 participants). The certainty of evidence was downgraded from low to very low due to very serious concerns about the risk of bias.

One controlled before-after study (Afendulis 2016) examined serious adverse effects. This study reported a slight reduction in the use of physical restraints for those in a home-like model of care (MD -0.3%, 95%CI -0.5% to -0.1%; Analysis 1.5; 1 study) between January 1, 2005 and September 30, 2010 (Afendulis 2016). The authors conducted analyses accounting for multiple comparisons and reported that this finding was not statistically significant. As discussed above, although the difference observed represented 0.3% of residents, any improvement observed in such a critical outcome is potentially clinically meaningful. No other serious adverse effects were examined or reported in any of the included studies. However, as the certainty of the evidence is considered very low, there is uncertainty in this finding.

Outcomes for carers

No included studies reported on outcomes for carers.

Outcomes for staff

No included studies reported on outcomes for staff.

Refurbishment versus traditional environment

Five studies examined refurbishment of care homes in conjunction with measures to develop person-centred care compared to a traditional environment (1357 participants). Three studies were controlled before-after studies (Burack 2012; Diaz-Veiga 2014; Wylie 2001) and two studies were cluster-randomised trials (Chenoweth 2014; Galik 2021). Burack 2012 examined refurbishment in conjunction with person-centred care referred to as 'culture change' compared to a traditional environment and traditional care. Diaz-Veiga 2014 examined refurbishment using the Etxean Ondo model which aims to develop a domestic setting in conjunction with person-centred care. Wylie 2001 examined refurbishment using the Eden Alternative which introduces pets, plants and children in addition to person-centred care. One cluster-randomised trial (Chenoweth 2014) studied the effect of a person-centred environment (with or without person-centred care) compared to a traditional environment and traditional care, and the development of the person-centred environment and person-centred care involved the use of the Person-Centred Environment and Care Assessment Tool (PCECAT). A different cluster-randomised trial (Galik 2021) examined an intervention called Function and Behavior Focused Care for the Cognitively Impaired (FBFC) compared to an education-only control group. Within the FBFC intervention, FBFC research nurses examined the environment to identify opportunities for physical activity and engaging in functional tasks as well as barriers to these activities and based on these assessments, modifications in policy and the environment were made.

Health-related quality of life

It is uncertain whether refurbishment comprising of a person-centred environment improved health-related quality of life because the certainty of the evidence is very low (MD 3.00, 95% CI -1.91 to 7.91; 1 study; 143 participants; very low-certainty evidence; Analysis 2.1). The certainty of evidence was downgraded from high-certainty to very low-certainty due to very serious concerns because of risk of bias and serious concerns due to imprecision. A further two studies examined the impact of refurbishment on quality of life, but these were not randomised trials and due to heterogeneity in the interventions, a meta-analysis was not performed.

Three studies (820 participants) examined quality of life (Chenoweth 2014; Diaz-Veiga 2014; Wylie 2001) comparing refurbishment with the traditional environment. One study was a randomised trial (Chenoweth 2014) and two were controlled before-after studies (Diaz-Veiga 2014; Wylie 2001).

Quality of life was measured using DEMQOL Proxy (Chenoweth 2014), FUMAT scale (Diaz-Veiga 2014), QUALID scale (Diaz-Veiga 2014) or Life Satisfaction Index (LSI) (Wylie 2001). For all of these measures, higher scores indicate better quality of life, except the Qualid where lower scores indicate better quality of life. Quality of life was measured at baseline (Chenoweth 2014; Diaz-Veiga 2014; Wylie 2001), six months (Diaz-Veiga 2014; Wylie 2001), four months (Chenoweth 2014), eight months (Chenoweth 2014), 12 months (Wylie 2001), and 18 months (Wylie 2001).

A mean difference in quality of life with refurbishment, with and without person-centred care (PCC), compared with a traditional environment was estimated post-intervention (with PCC: MD 3.00, 95% CI -1.20 to 7.20; without PCC: MD 2.00, 95% CI -2.19 to 6.19) and at eight months (with PCC: MD 2.00, 95% CI -2.91 to 6.91; without PCC: MD 3.00, 95% CI -1.91 to 7.91) (Chenoweth 2014). It is uncertain whether a person-centred environment, with or without person-centred care improves quality of life because the certainty of this evidence is very low.

Findings from the two controlled before-after studies were uncertain (Analysis 2.1). Diaz-Veiga 2014 reported that "in the post-study phase, the experimental group showed much better levels in quality of life (QUALID) in comparison to the control group", but the authors did not adjust the results for the baseline differences between the groups.

For individuals with mild levels of cognitive impairment, the authors stated no "significant differences" between the groups were recorded at the post-evaluation stage. Wylie 2001 also did not adjust for baseline differences between the groups.

Behaviour, mood and depression

It is uncertain whether refurbishment comprising of a person-centred environment improved agitation because the certainty of the evidence is very low (1 study; 143 participants; MD 4.00, 95% CI -9.21 to 17.21; very low-certainty evidence). The certainty of evidence was downgraded from high-certainty to very low-certainty due to very serious concerns because of risk of bias and serious concerns due to imprecision. Refurbishment comprising the FBFC intervention may make little or no difference to agitation or depression (agitation: MD -0.72, 95% CI -2.63 to 1.20, 1 study, low-certainty evidence; depression: MD -0.73, 95% CI -1.93 to 0.47,1 study ; low-certainty evidence). The certainty of evidence was downgraded from high-certainty to low-certainty because of serious concerns due to risk of bias and serious concerns due to imprecision. One further non-randomised study examined the impact of refurbishment on behaviour, mood and depression, but due to heterogeneity in the interventions and follow-up times, a meta-analysis was not performed.

Three studies (1138 participants) examined behaviour (Burack 2012 ; Chenoweth 2014; Galik 2021). Chenoweth 2014 and Galik 2021 are randomised trials while Burack 2012 is a controlled before-after study. All three studies used the Cohen-Mansfield Agitation Inventory (CMAI) for outcome measurement, where lower scores indicate fewer behavioural symptoms. Behaviour was measured at baseline (Burack 2012; Chenoweth 2014; Galik 2021), four months (Chenoweth 2014; Galik 2021), eight months (Chenoweth 2014), 12 months (Galik 2021) and 24 months (Burack 2012). One study (Galik 2021) also examined resistiveness to care using the Resistiveness to Care Scale where lower scores indicate lower resistive behaviours, and depression using the Cornell Scale for Depression in Dementia (CSDD) where lower scores indicate fewer depressive symptoms.

The FBFC intervention may make little or no difference to depression compared to an education control (low-certainty evidence) after four months (MD -0.73, 95% CI -1.93 to 0.47; Analysis 2.2.1; 1 study) or 12 months follow-up (MD -0.04, 95% CI -1.35 to 1.26; Analysis 4.1; 1 study). This intervention may also make little or no difference to agitation (low-certainty evidence) at four months (MD -0.72, 95% CI -2.63 to 1.20; Analysis 2.2.2; 1 study) or 12 months follow-up (MD -0.36, 95% CI -2.41 to 1.69; Analysis 2.2.2; 1 study). The FBFC intervention may make little or no difference to resistiveness to care (4 months, MD -1.56, 95% CI -2.71 to -0.40; Analysis 2.2.2; 1 study; 12 months, MD 0.32, 95% CI -0.29 to 0.94; Analysis 2.2.2; 1 study).

Burack 2012 examined refurbishment in combination with 'culture change' and reported a slight reduction in forceful behaviours (MD -0.06, 95% CI -0.10, -0.02; Analysis 2.2.2; 1 study with 101 participants) and physical agitation (MD -0.070, 95% CI -0.136 to -0.004; Analysis 2.2.2; 1 study), but little or no difference in verbal agitation (MD 0.110, 95% CI -0.004 to 0.224; Analysis 2.2.2; 1 study). However, the impact of the intervention on behaviour is uncertain because the certainty of this evidence is considered very low.

The effect of a person-centred environment on agitation, with or without PCC, was uncertain (without PCC: MD 2.00, 95% CI -11.29 to 15.29; Analysis 2.2.2; 1 study; with PCC: MD 7.00, 95% CI -5.66 to 19.66; Analysis 2.2.2; 1 study post-intervention; 8 months follow-up without PCC: MD 4.00, 95% CI -9.21 to 17.21; Analysis 2.2.2; 1 study; with PCC: MD 13.00, 95% CI -0.22 to 26.22; Analysis 2.2.2; 1 study; very low-certainty evidence).

Function

Refurbishment may make little or no difference to function (low-certainty evidence). The certainty of evidence was downgraded from high to low due to serious concerns about risk of bias and imprecision. One randomised controlled trial examined the FBFC intervention with the Barthel index, where higher scores indicate better function (Analysis 2.3; 4 months: MD 1.24, 95% CI -3.34 to 5.81; 12 months: MD 1.49, 95% CI -3.53 to 6.50; 1 study, 336 participants).

Global cognitive function

No included studies reported on outcomes for global cognitive function.

Quality of care

It is uncertain whether refurbishment comprising of a person-centred environment improves quality of care because the certainty of this evidence is very low (1 study; 143 participants; MD 0.00, 95% CI -8.34 to 8.34; very low-certainty evidence). The certainty of evidence was downgraded from high-certainty to very low-certainty because of very serious concerns due to risk of bias and serious concerns due to imprecision.

One randomised controlled trial examined quality of care (601 participants) from refurbishment compared to the traditional environment (Chenoweth 2014) using the Quality of Interactions Schedule (QUIS), where higher scores indicate better quality of care. The outcome was measured at baseline, four months (post-intervention) and eight months. The findings suggested an increase in quality of care at post-intervention for the intervention group both with or without PCC (without PCC: MD 8.00, 95% CI 1.03 to 14.97; Analysis 2.4; 1 study; with PCC: MD 13.00, 95% CI 6.02 to 19.98; Analysis 2.4; 1 study; post-intervention). At eight months (four months after the intervention), the effect on quality of care was uncertain (without PCC: MD 0.00, 95% CI -8.34 to 8.34; Analysis 2.4; 1 study; with PCC: MD -2.00, 95% CI -9.67 to 5.67; Analysis 2.4; 1 study).

Serious adverse effects

No included studies reported on outcomes for serious adverse effects.

Outcomes for carers

No included studies reported on outcomes for carers.

Outcomes for staff

No included studies reported on outcomes for staff.

Special care units versus traditional environment

One controlled before-after study (66 participants) examined a special care unit for people with dementia compared with a traditional environment (Frisoni 1998). The results were not considered suitable to contribute to the quantitative analysis as they were unadjusted for differences in baseline characteristics of the participants.

Health-related quality of life

No included studies reported quality of life.

Behaviour, mood and depression

It is uncertain whether special care units for people with dementia improved behaviour because the certainty of the evidence is very low. Frisoni 1998 examined global behaviour and subdomains including delusions, hallucinations, agitation, anxiety, euphoria/elation, disinhibition, irritability/lability, abnormal motor behaviour and sleep using the Neuropsychiatric Inventory (NPI), agitation using the CMAI and depression using the Cornell Depression Scale. For all measures, lower scores indicate fewer behavioural symptoms and these were measured at baseline and three months.

In this study, the unadjusted results suggested special care units were associated with a reduction in global behaviour (Analysis 3.1.1), depressive symptoms (Analysis 3.1.2) and in delusions, hallucinations, agitation and sleep (Analysis 3.1.3). The traditional environment was also associated with a reduction in global behaviour (Analysis 3.1.1), reduction in anxiety and euphoria/elation (Analysis 3.1.3), but conversely was associated with an increase in depressive symptoms (Analysis 3.1.2); however, the certainty of evidence is very low. The effect of special care units on agitation measured by CMAI demonstrated at three months was uncertain (Analysis 3.1.3).

Function

It is uncertain whether special care units for people with dementia improved function because the certainty of the evidence is very low. Frisoni 1998 examined function using two measures: the Bedford Alzheimer's nursing severity scale and the Barthel Index; for both measures, higher scores indicate better function. Function was measured at baseline and three months. The effect of special care units on function using either of the measures was uncertain (Analysis 3.2).

Global cognitive function

Cognitive function was assessed in Frisoni 1998 using the MMSE (higher scores indicate better cognitive function) and Extended Clinical Dementia Rating (higher scores indicate more severe cognitive impairment). Global cognitive function was measured at baseline and three months. The effect of special care units on cognitive function was uncertain using either of the measures investigated (Analysis 3.3).

Quality of care

No included studies reported on outcomes for quality of care.

Serious adverse effects

Frisoni 1998 investigated serious adverse effects by the frequency of falls and use of physical restraints at baseline and three months, but it was unclear if the numbers were referring to the overall number of falls and use of physical restraints or the number of people who fell or were exposed to physical restraints; therefore, these data were not included in this review. It was uncertain if there was a difference in falls at three months between the intervention and control groups, but for physical restraints the authors reported that "while their use in cases did not increase after 3 months, a significant increase was apparent in controls".

Outcomes for carers

No included studies reported on outcomes for carers.

Outcomes for staff

No included studies reported on outcomes for staff.

Corridor versus non-corridor design

One controlled before-after study (105 participants) examined a corridor design compared with a non-corridor design in group living units (Elmstahl 1997).

Health-related quality of life

No included studies reported on outcomes for quality of life.

Behaviour, mood and depression

It is uncertain whether a corridor design or non-corridor design improves behaviour, mood and depression because the certainty of evidence was very low (OR 8.82, 95% CI 1.14 to 68.22 for depression, 1 study; 105 participants; very low-certainty evidence). The certainty of evidence was downgraded from low-certainty to very low-certainty because of very serious concerns due to risk of bias and serious concerns due to imprecision.

Elmstahl 1997 examined 11 sub-domains of behaviour using the Organic Brain Syndrome (OBS) scale including aggressiveness, depression, dyspraxia, hallucinations, lack of vitality, dysphasia,

paranoia, restlessness, disorientation (recent memory, time and identity), and lower scores indicate better behaviour. Behaviour was measured at baseline and 12 months. Results were analysed as the proportion of participants who experienced the behaviours and odds ratios < 1 favoured the corridor design.

Elmstahl 1997 reported a decrease in depression for those in the non-corridor design compared to the corridor design (OR 8.82, 95% CI 1.14 to 68.22; Analysis 4.1.1; 1 study). The effect of a non-corridor design compared to a corridor design on other behavioural measures was uncertain (aggressiveness: OR 2.02, 95% CI 0.56 to 7.27; dyspraxia: OR 4.57, 95% CI 0.76 to 27.35; hallucinations: OR 1.06, 95% CI 0.05 to 22.09; lack of vitality: OR 0.23, 95% CI 0.04 to 1.47; dysphasia: OR 0.87, 95% CI 0.08 to 9.73; paranoia: OR 0.12, 95% CI 0.01 to 1.24; restlessness: OR 0.21, 95% CI 0.04 to 1.00; recent memory: OR 0.87, 95% CI 0.31 to 2.42; time: OR 0.66, 95% CI 0.22 to 2.01; identity: OR 1.23, 95% CI 0.56 to 2.68 (Analysis 4.1.2, 1 study).

No included studies reported on outcomes for global behaviour.

Function

No included studies reported on outcomes for function.

Global cognitive function

No included studies reported on outcomes for global cognitive function.

Quality of care

No included studies reported on outcomes for quality of care.

Serious adverse effects

No included studies reported on outcomes for serious adverse effects.

Outcomes for carers

No included studies reported on outcomes for carers.

Outcomes for staff

No included studies reported on outcomes for staff.

Alternative physical environmental design without whole-facility changes

Lighting intervention versus control lighting

Three cluster-randomised trials (291 participants) studied the effect of lighting interventions on long-term residential care compared to control lighting (Figueiro 2019; Hopkins 2017; Riemersma-vanDerLek 2008). The studies did not take clustering in to account in their estimates and provided insufficient data to correct analyses for cluster-randomised trials as described in the *Cochrane Handbook* (Higgins 2011).

Health-related quality of life

No studies examined quality of life.

Behaviour, mood and depression

It is uncertain whether bright lighting improves global behaviour because the certainty of this evidence is low (MD 0.50, 95% CI -1.80 to 2.80; 1 study, 74 participants; low-certainty evidence). The certainty of evidence was downgraded from high-certainty to low-certainty because of serious concerns due to risk of bias and serious concerns due to imprecision. It is uncertain whether bright lighting improves depression because the certainty of evidence is very low (SMD -0.22, 95% CI -0.45 to 0.01; 3 studies; very low-certainty evidence; I^2 = 64%). The certainty of evidence was downgraded from high-certainty to very low-certainty because of very serious concerns due to risk of bias and serious concerns due to imprecision.

Riemersma-vanDerLek 2008 examined global behaviour in 94 participants in a randomised trial using the questionnaire format of the NPI (NPI-Q) and withdrawn behaviour using the Multi Observational Scale for Elderly Subjects (MOSES) and mood using the Philadelphia Geriatric Centre Affect Rating Scale (PGCARS). For all measures, lower scores indicate better behaviour except for the PGCARS (for positive mood higher scores indicate better positive mood). Behaviour, mood and depression were measured at baseline, six weeks, six months, one year, 1.5 years and two years.

Riemersma-vanDerLek 2008 reported little to no effect on global behaviour (MD 0.50 (95% CI -1.80 to 2.80) at six months; Analysis 5.1.1; 1 study; low-certainty evidence).

The effect of bright lighting on depression was examined by Riemersma-vanDerLek 2008 and Figueiro 2019 using the Cornell Scale for Depression in Dementia (CSDD) and Hopkins 2017 using the depression subset of the hospital anxiety and depression (HADD) scale. There was little or no difference in depression at four to six weeks (SMD -0.22, 95% CI -0.45 to 0.01; Analysis 5.2; 3 studies, very low-certainty evidence, I^2 = 64%). Depression was further examined at longer time points by Riemersma-vanDerLek 2008, but little to no effect on depression was reported at six months, 12 months, 18 months or 24 months (Analysis 5.1.2).

Hopkins 2017 assessed anxiety as a behaviour outcome using the anxiety subset of the Hospital Anxiety and Depression (HADA) scale and lower scores indicate lower anxiety levels. Anxiety was assessed at four weeks. and Hopkins 2017 reported little or no difference in anxiety at four weeks (MD -0.10, 95% CI -1.67 to 1.47; Analysis 5.1.3; 1 study). Riemersma-vanDerLek 2008 reported little or no effect on distress, withdrawn behaviour, positive mood and negative mood (Analysis 5.1.3). This study did report a reduction for those in the bright lighting intervention group in withdrawn behaviour at 18 months only (MD -4.30, 95% CI -7.45 to -1.15; Analysis 5.1.3; 1 study) and a reduction in negative mood only at 24 months (MD -2.70, 95% CI -4.80 to -0.60; Analysis 5.1.3; 1 study). Two studies (Figueiro 2019; Riemersma-vanDerLek 2008) examined the impact of increased lighting on agitation using the CMAI, and lower scores indicate better behaviour. There was little or no difference in agitation at four to six weeks (SMD -0.16, 95% CI -0.45 to 0.14; Analysis 5.3; 2 studies, low-certainty evidence, I^2 = 17%). It is uncertain whether bright lighting improves agitation because the certainty of this evidence is low.

Function

It is uncertain whether bright lighting improves function because the certainty of this evidence is low (SMD -0.29, 95% CI -0.69 to 0.00; 2 studies, 179 participants; low-certainty evidence). The certainty of evidence was downgraded from high-certainty to low-certainty because of serious concerns due to risk of bias and serious concerns due to imprecision.

Two cluster-randomised trials (94 participants) assessed the effect of bright lighting on function (Figueiro 2019; Riemersma-vanDerLek 2008). Function was assessed by the nurse-informant adaptation (NI-ADL) of the scale by Katz and colleagues (Riemersma-vanDerLek 2008) and the Minimum Data Set Activities of Daily Living Scale (MDS-ADL) (Figueiro 2019), and higher scores indicate more functional limitations. Riemersma-vanDerLek 2008 measured function at baseline, six weeks, six months, one year, 1.5 years and two years and Figueiro 2019 measured function at four weeks. There was little or no difference in function at four to six weeks (SMD -0.29, 95% CI -0.69 to 0.00; Analysis 5.4; 2 studies, low-certainty evidence, I^2 = 0%). Riemersma-vanDerLek 2008 reported an increase in function (decrease in NI-ADL scores) at 18 months and 24 months (Analysis 5.5; 1 study), but there was little to no effect at six months or 12 months.

Global cognitive function

It is uncertain whether bright lighting improves global cognitive function because the certainty of this evidence is low (MD 1.20, 95% CI -1.56, 3.96; 1 study; 74 participants; low-certainty evidence). The certainty of evidence was downgraded from high-certainty to low-certainty because of serious concerns due to risk of bias and serious concerns due to imprecision.

One cluster-randomised trial (87 participants at six weeks) assessed the effect of bright lighting in communal living spaces during the day on global cognitive function (Riemersma-vanDerLek 2008). Cognitive function was assessed using the MMSE and higher scores indicate better global cognitive function. Global cognitive function was measured at baseline, six weeks, six months, one year, 1.5 years and two years. There was little to no effect on global cognitive function at the five follow-up times between six weeks and 24 months (Analysis 5.6).

Quality of care

No included studies reported on outcomes for quality of care.

Serious adverse effects

No included studies reported on outcomes for serious adverse effects.

Outcomes for carers

No included studies reported on outcomes for carers.

Outcomes for staff

No included studies reported on outcomes for staff.

Dining space redesign versus usual environment

Three studies examined the effect of dining interventions (403 participants) in long-term residential care compared to the usual dining environment (Kenkmann 2010, Mathey 2001 and Nijs 2006). Two studies were cluster-randomised trials (Mathey 2001; Nijs 2006) and one study was a controlled before-after study (Kenkmann 2010).

Health-related quality of life

It is uncertain whether dining space redesign improves health-related quality of life because the certainty of this evidence is very low (2 studies; 283 participants; very low-certainty evidence). This certainty of the evidence was downgraded from high to very low because of very serious concerns due to risk of bias and serious concerns due to imprecision. Meta-analysis was not possible because one of the studies reported results as percentage changes over time without adjustment for clustering.

Two studies (283 participants) measured the effect of dining space redesign on quality of life (Mathey 2001; Nijs 2006). Quality of life was measured by the Dutch Quality of Life of Somatic Nursing Home Residents questionnaire (Nijs 2006) or the Sickness Impact Profile (SIP) and the Dutch version of the Philadelphia Geriatric Center Moral Scale (PGCMS) (Mathey 2001). Higher scores in the tools used indicate better quality of life. Quality of life was measured at baseline (Mathey 2001; Nijs 2006), six months (Nijs 2006) and 12 months (Mathey 2001).

Nijs 2006 reported a higher quality of life for those with the family-style dining intervention; there was less decline in quality of life in the intervention group (MD 6.10, 95% CI 2.10 to 10.10; Analysis 6.1; 1 study) and results were adjusted for clustering and baseline characteristics of the residents. Mathey 2001 reported results as percentage changes over time and a summary is provided in Analysis 6.1. Mathey 2001 did not adjust for clustering and did not provide sufficient data to perform correct analyses for cluster-randomised trials as described in the *Cochrane Handbook* (Higgins 2011). The authors reported SIP scores had "significantly declined" in the control group, "stayed stable" in the intervention group, and PGCMS scores remained "relatively stable" in both the intervention and control groups.

Behaviour, mood and depression

One study (120 participants) examined the effect of dining space redesign on anxiety using the HAD scale (Kenkmann 2010). Anxiety was measured at baseline and 12 months. The results were not considered suitable to contribute to the quantitative analysis as they were unadjusted for differences in baseline characteristics of the participants; a summary is presented in Analysis 6.2. The authors did not comment on the statistical significance of the results.

No included studies reported on any further outcomes for behaviour and depression.

Function

It is uncertain whether dining space redesign improves function because the certainty of evidence is very low (MD 3.20, 95% CI 0.90 to 5.50; 1 study; 178 participants; very low-certainty evidence). This certainty of the evidence was downgraded from high to very low due to very serious concerns due to risk of bias and serious concerns due to imprecision.

One study (178 participants) examined change in function using the Nursing Home Physical Performance test and higher scores indicate better function (Nijs 2006). Function was measured at baseline and six months. Nijs 2006 reported better function for those with the family-style dining intervention, as there was less decline over time (MD 3.20, 95% CI 0.90 to 5.50; Analysis 6.3; 1 study).

Global cognitive function

One study examined the effect of dining space redesign on global cognitive function using the MMSE (Kenkmann 2010). Global cognitive function was measured at baseline and 12 months. The results were not considered suitable to contribute to the

quantitative analysis as they were unadjusted and are presented in Analysis 6.4. The authors commented that "there was no evidence that the food and drink intervention had an impact on residents cognitive functioning".

Quality of care

No included studies reported on outcomes for quality of care.

Serious adverse effects

It is uncertain whether dining space redesign impacts the rate or risk of falls because the certainty of this evidence is very low (rate ratio 0.76, 95% CI 0.57 to 1.01; 1 study; 120 participants; very low-certainty evidence). The certainty of evidence was downgraded from low to very low because of very serious concerns due to risk of bias and serious concerns due to imprecision.

One study examined serious adverse effects through an adjusted rate of falls and proportion of people falling at baseline and 12 months (Kenkmann 2010). Kenkmann 2010 reported little to no effect on the rate of falls (rate ratio 0.76, 95% CI 0.57 to 1.01; Analysis 6.5, 1 study). The risk of falling (i.e. the proportion of people falling) in 12 months is also presented in Analysis 6.5 but the results were unadjusted, and the authors commented that differences between the groups "were not statistically significant".

Outcomes for carers

No included studies reported on outcomes for carers.

Outcomes for staff

No included studies reported on outcomes for staff.

Garden vignette versus traditional environment

One repeated measures study (33 participants) examined the effect of a garden vignette in long-term residential care using five phases: two intervention phases and three washout phases (Marcy-Edwards 2011).

Health-related quality of life

No included studies reported on outcomes for quality of life.

Behaviour, mood and depression

It is uncertain whether a garden vignette improves global behaviour because the certainty of this evidence is very low (MD 12.8, 95% CI -10.7 to 36.3; 1 study; 33 participants; very low-certainty evidence). The certainty of evidence was downgraded because of very serious concerns due to risk of bias and very serious concerns due to imprecision.

The authors had not conducted a statistical comparison of time trends before and after the intervention; we re-analysed the results as recommended in EPOC 2017c. Global behaviour was measured with the NPI-NH and lower scores indicate fewer behavioural symptoms. The effect of a garden vignette on global behaviour was uncertain (MD 12.8, 95% CI -10.7 to 36.3; Analysis 7.1; 1 study).

Function

No included studies reported on outcomes for function.

Global cognitive function

No included studies reported on outcomes for global cognitive function.

Quality of care

No included studies reported on outcomes for quality of care.

Serious adverse effects

No included studies reported on outcomes for serious adverse effects.

Outcomes for carers

No included studies reported on outcomes for carers.

Outcomes for staff

No included studies reported on outcomes for staff.

DISCUSSION

Summary of main results

The main objective of this review was to determine the effects of changes to the physical environment of residential aged care or alternative models of residential aged care on the quality of life of older residents. The included studies compared home-like small-scale models of care to more traditional large-scale models of care. We also included studies which examined interventions which were not changes to the whole building, but refurbishment or changes to one or more design components. These changes included changes to lighting, design of the dining room or addition of a garden vignette. There were too few studies included to examine whether dementia alters the effects of changes to the physical environment or alternative models of residential aged care on quality of life.

The literature search identified six studies for the main comparison (Afendulis 2016; Annerstedt 1993; Dettbarn-Reggentin 2005; Te Boekhorst 2009; Wolf-Ostermann 2012; Yoon 2015), but the certainty of evidence was very low with all the studies being non-randomised and usually of small sample size. A large study by Afendulis 2016 included the majority of the participants in the review. Afendulis 2016 examined a home-like model of care (the Green House model) compared to traditional care, but the study was non-randomised and rated at high risk of bias. The study also only reported on quality of care measures rather than any of the prespecified primary outcomes of interest in this review.

Clinical heterogeneity involving differences in interventions, comparisons and outcome measures precluded pooling of study results on most occasions. In addition, there was variation in the methods of statistical analyses including whether the study reported results unadjusted or adjusted for differences in baseline characteristics of the participants. For the main comparison, we were not able to pool any studies. There were also insufficient data to explore whether changes to the physical environment have a different impact depending on whether the population is living with dementia.

For the primary outcomes, one study examined the effect of home-like models on quality of life and stated "no statistically significant differences were observed between the intervention and control groups" (Wolf-Ostermann 2012). Three studies examined global behaviour for a home-like compared to traditional model of care

(Dettbarn-Reggentin 2005; Te Boekhorst 2009; Wolf-Ostermann 2012). One study found little or no difference in global behaviour change at six months and two additional studies examined global behaviour, but these were unsuitable for determining a summary effect estimate. Two studies examined depression for the main comparison (Te Boekhorst 2009; Yoon 2015). After 18 months, one study reported an increase in the rate of depressive symptoms, but the effect of home-like models of care on the probability of no depressive symptoms was uncertain (Yoon 2015). One study reported little or no difference in depressive symptoms at six months (Te Boekhorst 2009). Four studies examined function as an outcome for the main comparison (Dettbarn-Reggentin 2005; Te Boekhorst 2009; Wolf-Ostermann 2012; Yoon 2015). Differences in the study design and reporting made interpretation difficult. One study reported evidence of a positive effect of a home-like model compared to a more traditional model on function and one study reported little or no difference in function. Two additional studies measured function but could not be included in the quantitative analysis. One study examined quality of care and reported a reduction in the number of bedfast residents, catheter use, low-risk pressure ulcers and avoidable hospital readmission, but reported little or no difference in high-risk pressure ulcers (Afendulis 2016). One study reported a slight reduction in the use of physical restraints, but no other serious adverse effects were examined (Afendulis 2016). The certainty of evidence was rated as very low on GRADE for all outcomes for the main comparison; therefore, it is uncertain whether a home-like model of care affects outcomes including quality of life, behaviour, mood and depression, function or serious adverse effects.

In addition to the main comparison, included studies also compared interventions which focused on one or more design components within residential aged care. Five studies examined the effect of refurbishment of residential aged care facilities in conjunction with measures to improve person-centred care (Burack 2012; Chenoweth 2014; Diaz-Veiga 2014; Galik 2021; Wylie 2001). Three studies (one randomised trial) assessed quality of life but it is uncertain whether refurbishment compared to traditional environments improved quality of life because the certainty of evidence was very low.

Three studies examined the impact of refurbishment on behaviour (Burack 2012; Chenoweth 2014; Galik 2021). Two randomised trials examined the impact of refurbishment on behaviour; one found little or no difference in behaviour with the intervention (Galik 2021), and the effects in the other trial were uncertain (Chenoweth 2014). One further non-randomised study examined the effect of refurbishment in combination with 'culture change' (Burack 2012). Three sub-domains of behaviour were examined in relation to this intervention and a reduction in forceful behaviours and physical agitation was found, but there was little or no difference in verbal agitation. However, it is uncertain if refurbishment with culture change improves behaviour as the certainty of evidence was very low.

One randomised trial examined the impact of refurbishment on function. Refurbishment comprising the FBFC intervention may make little or no difference to function (low-certainty evidence). No studies examined the effect of refurbishment on serious adverse effects.

One non-randomised study examined the effect of a special care unit for people with dementia (Frisoni 1998). This study did not adjust results for potential baseline differences between the groups; therefore, the results should be interpreted with caution and the effects on behaviour, function, physical restraints and falls are considered uncertain. No studies examined the effect of special care units on quality of life or quality of care.

One non-randomised study (Elmstahl 1997) examined the effect of a corridor vs non-corridor design and reported a decrease in depression associated with the non-corridor design, but the certainty of evidence was very low. The effect of a corridor design on 10 other measures of behaviour was uncertain. Therefore, whether a corridor vs non-corridor design within group living units is preferable for behaviour is uncertain. No studies examined the effect of a corridor versus non-corridor design on quality of life, quality of care, function or serious adverse effects.

Three cluster-randomised trials examined the effect of lighting interventions (Figueiro 2019; Hopkins 2017; Riemersma-vanDerLek 2008). All of the studies reported results at short-term follow-up (four to six weeks) and one study also reported results at longer follow-up (Riemersma-vanDerLek 2008, up to 24 months). However, there was large loss to follow-up in the study by Riemersma-vanDerLek 2008 and little or no effect was reported for global behaviour. Pooled data from the three studies showed little or no difference in depression at short-term follow-up. Two cluster-randomised trials assessed the effect of bright lighting on function (Figueiro 2019; Riemersma-vanDerLek 2008). There was little or no difference in function at four to six weeks. The certainty of evidence was low, therefore, the effects of lighting for behaviour or function are uncertain. No studies examined the effect of lighting interventions on quality of life, quality of care or serious adverse effects.

Two cluster-randomised trials and one non-randomised trial examined the effect of dining space redesign (Kenkmann 2010; Mathey 2001; Nijs 2006). One randomised trial (Nijs 2006) found better quality of life and function for participants receiving a family-style dining intervention over six months. The other two studies did not conduct appropriate adjustments for potential confounding or clustering. One study reported better function with a family-style dining intervention, as there was less decline over time (Nijs 2006). Another reported little to no effect on the rate of falls (Kenkmann 2010). However, it is uncertain whether dining space design effects quality of life, function or rate of falls because the certainty of evidence was very low. One study examined the effect of dining space redesign on anxiety, but the results were not suitable to contribute to the quantitative analysis as they were unadjusted for differences in baseline characteristics of the participants (Kenkmann 2010). No studies examined the effect of dining space redesign on quality of care.

One repeated measures study examined the effect of a garden vignette intervention using 14-day phases incorporating intervention and washout phases (Marcy-Edwards 2011). The effect of a garden vignette on global behaviour was uncertain, and the effects of a garden vignette on other outcomes were not examined.

Overall completeness and applicability of evidence

We used a comprehensive search strategy, and therefore we are likely to have identified all studies that meet the inclusion criteria for this review, but we cannot be certain. Whilst a number of grey literature sites were searched, it is possible that some studies that

have not been published in mainstream literature databases were not identified. The studies included were from many countries including the USA, the Netherlands, the UK, Sweden, Germany, Spain, Italy, Canada and Australia and some included studies were published in non-English languages (one German and one Spanish). Included studies were published over a prolonged period (24 years) and, over this time, residential aged care policies and practices have changed. Therefore, the applicability of some older studies to current practice, in particular, where there is a comparison to 'standard care' may be reduced; the earliest included study was published in 1993 (Annerstedt 1993).

We could not make robust conclusions from the evidence due to the limited number of eligible studies identified and variability in design, interventions, outcomes, instruments used to assess outcomes, and statistical analysis approaches. The wide variability in outcomes assessed and measures used generally prevented pooling of the data. The majority of the evidence for large-scale design interventions was from non-randomised studies. For the lighting and dining interventions, four of five studies were randomised, most likely due to the increased feasibility of conducting this type of study. Studies also varied by which type of statistical analyses were performed, whether endpoint data or change over time data were analysed, whether the studies adjusted for potential confounding factors and which potential confounding factors were adjusted for in analyses. Five cluster-randomised studies were included in the review. Two of these studies took the effect of clustering in to account in their analyses (Chenoweth 2014; Nijs 2006). The other studies did not adjust for clustering and did not provide sufficient data to perform adjusted analyses for clustering as described in the *Cochrane Handbook* (Higgins 2011).

In accordance with Cochrane EPOC review guidance, only controlled before-after and cluster-randomised studies which had more than one control and intervention site were included. Therefore, many studies which only reported results for one intervention and/or one control site were excluded from the review (including Kane 2007; Reimer 2004).

In addition, observational study designs were required to include pre- and post-intervention measures (i.e. controlled before-after studies or repeated measures). This excluded a number of studies which did not include pre-intervention baseline measures (i.e. a measure of participant outcomes on admission to care), including De Boer 2017; De Rooij 2012; Verbeek 2014. For example, Verbeek 2014 investigated small-scale home-like environments in comparison to traditional environments for 259 residents with dementia. The study suggested positive effects on outcomes including fewer physical restraints and psychotropic medicines, but little or no difference in behaviour and quality of life. However, by not including pre-intervention measures, determining the effect of the intervention is limited. Similarly, De Boer 2017 has reported increased social interaction in residents of green care farms in comparison to traditional facilities, but no pre-intervention measures were reported.

A total of 77,265 participants were included in 20 studies, but most (n = 74,449) of these participants were from a single study. Therefore, most of the studies included small numbers of participants (range 34 to 601). Most of the included studies for large-scale design interventions were non-randomised which means that even well-designed studies are only likely to provide low level evidence. However, for whole models of care, conducting randomised trials is rarely feasible. While a clustered design of refurbishment is possible, this is unlikely to be able to capture large-scale changes to the physical size and design of the buildings. In contrast, randomised trials for smaller scale interventions such as lighting or dining changes are more feasible, and several randomised trials were identified.

Identified evidence was only sufficient to allow for the pooling of data from two randomised studies for one outcome for one comparison (depression with lighting interventions) and heterogeneity for this outcome was substantial. Most of the evidence was from individual studies which were usually modest in size and likely to be underpowered. For all outcomes and comparisons, the certainty of evidence was very low.

Studies generally did not report fidelity assessments. One randomised study examined the effects of an intervention which involved assessing the environment with the Environmental Audit Tool and identifying areas for improvement. This study reported difficulties in implementing the proposed design changes (Chenoweth 2014). Similarly, Wylie 2001 reported that one of the facilities which received the Eden Alternative intervention discontinued its implementation, but did not state the reasons for this.

Some included studies did not measure quality of life as an outcome which is a limitation of the review. We included studies which examined other primary outcomes and secondary outcomes, because these included outcomes are likely to impact quality of life for residents. Care home residents are often unable to complete health-related quality of life questionnaires for themselves and the validity of quality of life measures for care home residents has been questioned (Usman 2019). Therefore, we think it is important to consider multiple outcomes which impact quality of life for residents, not only self- and proxy-reported quality of life measures.

The searches for this review were completed during the coronavirus 2019 (COVID-19) pandemic, but all the included studies were conducted prior to the start of the COVID-19 pandemic. This review focuses on quality of life, thus infection-related outcomes were not included in the protocol. Since this time, questions have arisen regarding the role of the design of residential aged care facilities in infection control (Werner 2020). Older people living in residential aged care have been disproportionately impacted by the COVID-19 pandemic in many countries including the UK and the US. Based on data from 22 countries to January 2021, 41% of all COVID-19-related deaths were of people living in aged care (Comas-Herrera 2021). It has been suggested that alternative architectural designs of aged care facilities may benefit both resident quality of life and infection control (Anderson 2020). However, others have questioned whether home-like designs contain the necessary infrastructure for tight infection control (Ibrahim 2020). Other characteristics which may have impacted rates of COVID-19 infections in residential aged care settings include ownership, staffing, provider size and resident characteristics (Bach-Mortensen 2021). Further research on the impact of design of residential aged care and the impact on infection rates and outbreak control is needed. This should be in conjunction with addressing issues regarding funding, staffing and support for residential aged care facilities which will impact quality of life for residents (Oliver 2020).

Quality of the evidence

For the main comparison of home-like models compared to traditional models of care, attrition was often high. Often studies did not adequately report the numbers lost to follow-up, the reasons for loss to follow-up or differences between those lost to follow-up and those not lost to follow-up. If reasons for loss to follow-up are imbalanced across the groups, this is likely to impact on the estimate of effect and introduce bias to the study findings.

For all controlled before-after studies, random sequence generation and allocation concealment is rated at high risk of bias as these criteria cannot be met for this study design. There was also a lack of adjustment for differences in baseline characteristics of participants in many studies. By not adequately adjusting for differences in baseline characteristics, the potential for confounding factors influencing the results is high. In addition, it is possible that not all likely confounding factors (e.g. public versus private ownership, resident access to healthcare) were taken into account in the included studies, and the design of many of the included studies means that they are particularly prone to bias from lack of adjustment for confounding factors. Four studies were rated at high risk of bias and four studies were rated at unclear risk of bias for selective outcome reporting as they listed outcomes in their methods and did not report results. However, 56% of studies reported results as indicated in the methods or protocol and were rated at low risk of bias for selective reporting. Only two studies were considered to be at risk of contamination of the intervention in the control group, as for most studies the participants of the intervention and control groups were living in different facilities or living units. However, one study reported one of the control sites had previously implemented and discontinued the intervention, and one study randomised wards within one home; therefore, contamination was likely. Of the included studies, 67% were rated at high risk of bias for other bias, mainly due to the potential for residual confounding associated with the use of non-randomised study designs.

Few studies examined serious adverse effects as an outcome. Falls risk is an important factor to include in the consideration of any environmental design changes, however, falls outcomes were frequently not reported.

There are feasibility and ethical considerations when considering the design of a study to assess whole-facility changes to the model of care and design of the built environment. For instance, offering improved environments to only some residents on a site may be perceived as inappropriate to both residents and family members. Furthermore, when examining the impact of changes to the whole facility it is difficult to effectively isolate the impact of the built environment from the impact of other changes to the model of care such as care practice changes or staffing changes. It is also difficult to adequately account for changes to the health of residents with progressive diseases over time. This review highlights the complexities of care and quality of life in residential aged care settings. Design elements may be important factors in decision-making for families, but other elements including model of care should also be considered.

Potential biases in the review process

As the list of included interventions was broad, identifying relevant studies was challenging. We minimised publication bias by using a comprehensive search strategy of multiple databases, including trial registers and grey literature. Authors of completed studies identified in trials registers for which study publications were not been identified were contacted, as were authors of studies identified only as conference abstracts. We did not restrict the search strategy by language and non-English language studies were included in the review (Dettbarn-Reggentin 2005; Diaz-Veiga 2014). Correspondence with authors provided additional information on study methods and results. However, we cannot be certain that there was no publication bias in the included studies.
Each study was assessed by two reviewers working independently at all stages of the study selection process, and we were careful not to exclude relevant studies. Yet, it is still possible that there are additional relevant studies which were not identified that would have met the inclusion criteria. The data extraction, risk of bias assessment and GRADE assessment for each study was also conducted in duplicate by two reviewers working independently.

Agreements and disagreements with other studies or reviews

Marquardt 2014 conducted a review with a systematic search of the design of the physical environment for people with dementia living in residential aged care. The review included 169 studies with a broad range of study designs and the review also included temporary therapies; six of the studies were eligible for inclusion in the current review. The review included 30 studies of small-scale home-like environments and the review suggested that there was a potential improvement in function and social abilities, no evidence for a beneficial effect on cognition and conflicting results for behaviour. The review assessed the quality of the studies by focusing on the study design and did not assess other methodological issues or risk of bias. In a scoping review, Ausserhofer 2016 examined the effect of home-like models of care in comparison to usual care in residential aged care for older people. The review completed a broad but comprehensive literature search and included 14 studies, three of which met the inclusion criteria for the current review. The review authors did not critically appraise the risk of bias of included studies. The review authors concluded that there was evidence of "benefit related to physical functioning of residents living in dementia-specific small houses and satisfaction with care of residents living in non-dementia-specific small houses compared with those living in traditional nursing homes". However, no benefit was found for other outcomes for residents, family or staff. Overall, the authors stated there was limited evidence on home-like models of residential aged care and a stronger evidence base was needed, which accorded with the conclusions of this review. Ausserhofer 2016 did not rate the certainty of the evidence.

A 2009 Cochrane review of special care units for people with dementia experiencing behavioural problems included eight studies, of which four provided data suitable for analysis (Lai 2009). The review included studies reporting on the outcomes of behaviour and physical restraint use. One of these studies (Frisoni 1998) was also included in the current review. Outcome data came from single studies and no eligible RCTs were identified. The authors commented that almost all the positive outcomes of special care units in the review came from a single study (Nobili 2006). The authors concluded that there was no strong evidence for benefit of special care units, however the design features of

special care units are often focused on increased safety rather than improving resident quality of life.

Joseph 2015 included 66 studies in a systematic review of the physical environment of residential health, care and support facilities. The review had much broader inclusion criteria than the current review in terms of setting (e.g. including assisted living and rehabilitation facilities), study design (e.g. including cross-sectional studies) and outcomes (e.g. including physical activity engagement and medication errors). The authors stated that the quality of the studies varied, with some studies with stronger designs having data from very few participants and that additional research was needed. Nevertheless, the authors stated that the review indicated that "the built environment is an important component of the care provided in residential care settings".

A systematic review of use of the physical environment to support people with dementia included 72 studies conducted in any setting including the home (Woodbridge 2018), although most were from residential settings. The review focused on the outcome of function, i.e. everyday tasks. No specific inclusion/exclusion criteria by study design were applied, nor were any quality appraisal tools applied to the included studies. The authors concluded that "more work is needed to extend theoretical understandings of how people with dementia interact with their environments so that these spaces can be designed to further support activities of daily living performance".

A healthy technology assessment by the Canadian Agency for Drugs and Technologies in Health (CADTH) included a "limited literature search" in 2010 of the effects of the Eden Alternative and Green House designs (CADTH 2010). Three non-randomised studies were included in this assessment which we identified in our search, but the studies did not meet the inclusion criteria. The authors also concluded that evidence was limited and noted issues in attrition bias and adoption of design principles by residential aged care facilities. Brownie 2013 reviewed person-centred care interventions which included eight studies which examined the Eden Alternative, Green House model or facility-specific person-centred care; one of the included studies was included in the current review. The review concluded that the Eden Alternative was associated with significant improvements in boredom and helplessness, but also noted limitations in study designs and potential for confounding bias. Our review only identified one study which examined the Eden Alternative that met the inclusion criteria; in that study, the authors found little or no difference in quality of life.

There have been many studies conducted examining non-environmental design interventions to improve quality of life for older adults living in residential aged care. A systematic review of organisational level person-centred care for people with dementia found a significant effect for quality of life post-intervention, but this review included hospital care and extra-care community housing in addition to residential aged care (Chenoweth 2019). Non-pharmacological interventions such as music therapy and function-analysis based interventions can be effective in improving behavioural symptoms for people with dementia without associated serious adverse effects (Dyer 2017). A Cochrane review of music therapy for people with dementia found that at least five sessions of a music-based therapeutic intervention probably reduced depressive symptoms, improves behavioural problems and may also improve quality of life and emotional well-being (Van der Steen 2018). Another systematic review has concluded that receptive music therapy could reduce agitation, behavioural symptoms, and anxiety in older people with dementia, and appears to be more effective than interactive music therapy (Tsoi 2018). A Cochrane review of functional-analysis-(FA)-based interventions for people with dementia included 18 RCTs and found positive effects for certain outcomes at post-intervention, but not follow-up, including the frequency of reported challenging behaviour and for caregiver reaction (Moniz Cook 2012). In people with dementia, animal-assisted therapy may have a slight reduction in depressive symptoms (Lai 2019). While several of these reviews did not focus specifically on residential aged care settings, there is a high prevalence of cognitive impairment and dementia in people living in these settings (Lang 2017), so interventions with demonstrated benefit may be of value.

A 2016 Cochrane review of interventions to optimise prescribing for older people in residential aged care included 12 studies. Many of the included interventions had multiple components and often involved a review of medicines with a pharmacist and doctor (Alldred 2016). The authors found no evidence of benefit of the interventions with respect to reducing adverse drug events or death, but one of two included studies which investigated quality of life reported a slower decline in health-related quality of life with low-certainty evidence. Selected studies also indicated that multicomponent interventions may provide benefits. A randomised controlled trial of a multicomponent intervention combining communication, systematic pain management, medication review, and activities in 33 nursing homes found, although quality of life worsened significantly during the intervention, quality of life was improved at 4 to 9-month follow-up (Husebø 2019). Another randomised trial examined a multicomponent intervention combining person-centred training for staff and a system for triggering appropriate review of antipsychotic medicines in 69 residential aged care facilities. The study reported improvements in agitation and quality of life for the residents and deemed the intervention to be cost-effective when compared with usual care (Romeo 2018).

Overall, previous reviews have indicated that the physical environment is an important consideration when determining interventions to improve quality of life for residents in aged care facilities, but the quality of evidence is mixed and there is a lack of definitive high-quality evidence. There is also some evidence to suggest non-pharmacological interventions or approaches which do not alter the physical environment may positively impact quality of life.

AUTHORS' CONCLUSIONS

Implications for practice

While 20 studies were included in this review, there was variation in the interventions and outcomes assessed and the certainty of evidence was low or very low for all outcomes investigated. Thus, there is currently insufficient evidence on which to draw conclusions about the impact of physical environment design changes for older people living in residential aged care. Additional studies that examine the effects of physical environmental designs of residential aged care facilities are required to improve the quality of evidence available.

Implications for research

Individually randomised trials for larger-scale interventions of the physical environment for older people living in residential aged care such as changing the scale of the building and whole model of care are unlikely to be feasible. A planned randomised trial of people living with dementia on admission to special care facilities or traditional care had to modify the design due to too few people being wait-listed for admission during the time period of the study (Reimer 2004). Nevertheless, to improve the quality of the evidence available, careful consideration of alternative methods for design should be made by study authors such as cluster-randomised, stepped-wedge randomised trials and interrupted time series with three data points before and after changes. Although non-randomised studies will have potential for risk of bias which cannot be altered due to the lack of randomisation, non-randomised studies can be optimised to reduce the risk of bias and improve the certainty of evidence from these studies. For example, many non-randomised studies were excluded from this review for having only one intervention and/or control site which cannot be considered for inclusion in Cochrane EPOC reviews because "the intervention is completely confounded by study site making it difficult to attribute any observed differences to the intervention rather than to other site-specific variables". Many studies were also excluded because they did not include a control group, or they did not include measurements before the intervention (e.g. on admission to residential aged care) which also limits the usability of the results from such studies and the evidence cannot be included in Cochrane EPOC reviews to inform current evidence. The certainty of evidence was often downgraded due to the imprecision of results and, therefore, studies with larger sample sizes of participants across multiple sites are warranted. Other items of risk of bias that were often deemed high risk were due to inadequate reporting of and adjustment for baseline characteristics and baseline outcome measures of the population being studied, or inadequate reporting of outcomes to be assessed in the methods or study protocol (or not stating reason for choice of outcomes assessed if using a data source with many potential fields). Whilst some prospective cohort studies address these criteria, the lack of reporting participant measures before the intervention (e.g. on admission for whole models of residential aged care) meant that they did not meet the inclusion criteria for this review.

When conducting studies on older people living in residential aged care, attrition due to mortality or ill-health will be an issue in most populations. Adequately reporting loss to follow-up and reasons for differences between those lost to follow-up by group allocation is critical to the interpretation of results. When planning the study, the expected attrition should be considered when determining an appropriate sample size.

Studies should investigate outcomes which are important to both residents and carers including, but not limited to, quality of life, behaviour, function, cognitive function, quality of care, serious adverse effects, outcomes for carers (including quality of life, mood and carer burden) and outcomes for staff (including staff knowledge, attitude, self-efficacy, quality of life and burnout). Outcomes should be measured using instruments which have been validated in older people living in residential aged care. Although residual confounding factors will always be a risk of bias in non-randomised studies, statistical analyses in non-randomised studies should plan analyses during the study design stage, including adequate data collection to allow for adjustment for many potential confounding factors. Cluster-randomised trials should statistically adjust for the effect of clustering as those which do not take clustering into account create a unit of analysis error and produce over-precise results (Higgins 2011). Guidelines and a checklist for reporting interventions are available such as the template for intervention description and replication (TIDieR) checklist and guide (Hoffmann 2014) and study authors should follow these guidelines to ensure they clearly describe the intervention and control arms of studies. Any difficulties in implementing the intervention should also be fully reported, either in the main paper or as supplementary material. As shown in this review, isolating effects of the built environment in a controlled setting whilst minimising bias can be difficult to achieve in a residential aged care setting due to other changes which may occur, such as changes in care practices and changes to the health of the residents. Future studies should be aware of any changes which are likely to occur to the staffing structure or health of the residents during the study period and plan for appropriate statistical analyses to account for these changes.

Cluster-randomised trials are feasible for studies of refurbishment of residential aged care or interventions focusing on a specific design component within a care home (e.g. dining room redesign or lighting). When considering refurbishment in long-term residential aged care, issues in implementing design changes for a specific budget and time frame, as described in the study by Chenoweth 2014, should be considered during the development of the study protocol. Blinding should be carried out on all personnel, where feasible, including those conducting all analyses and those assessing the outcomes, where possible (e.g. patient-reported outcomes, such as quality of life, would be collected in the knowledge of the intervention received whereas others, such as functional ability measures, can be collected by an independent clinician who is blinded) (EPOC 2016a).

ACKNOWLEDGEMENTS

We acknowledge the help and support of Cochrane Effective Practice and Organisation of Care (EPOC). The authors would also like to thank the following editors and peer referees who provided comments to improve the protocol: Signe Flottorp (EPOC Editor), Paul Miller (EPOC Information Specialist), Julie Udell (external Peer Referee), and Jemma Hudson (EPOC Statistician); also Elizabeth Royle and Copy Edit Support for copy editing the protocol. We would also like to thank the following editors and peer referees who provided comments to improve the full review: Phillippa Carnemolla (Content expert, external), Nick Seemann (Content expert, external), Brian Duncan (Consumer, external), Harrison Davies (Consumer, external), JC Han (Assistant Managing Editor, EPOC), Denise O'Connor (Contact Editor, EPOC), Cristián Mansilla (Associate Editor, EPOC), Noah Ivers (Associate Editor, EPOC), Paul Miller (Information Specialist, EPOC) and Jennifer Hilgart (Statistical Editor, Public Health and Health Systems' Network Editorial & Methods Department). We would also like to thank Anne Lethaby for copy-editing the review.

National Institute for Health Research (NIHR), via Cochrane Infrastructure, gave funding to the Effective Practice and Organisation of Care (EPOC) Group. We also acknowledge Ms Natalie May, Ms Megan Winsall, Dr Wendy Shulver, Dr Justine Irving

and Dr Helena Kopunic for assistance in initial abstract and title screening of some citations for full-text review (in duplicate with study authors) and assistance with grey literature searching. We thank Jenni Suen for research assistance. The views and opinions expressed herein are those of the authors and do not necessarily reflect those of the Systematic Reviews Programme, NIHR, National Health Service (NHS), or the Department of Health.

The Australasian Satellite of the Cochrane EPOC Group is funded by Cochrane.

The contents of the published materials are solely the responsibility of the administering institution — Flinders University and The University of Woollongong — and the individual authors identified, and do not reflect the views of the NHMRC or any other funding bodies or the funding partners.

REFERENCES

References to studies included in this review

Afendulis 2016 *{published data only}*

Afendulis CC, Caudry DJ, O'Malley AJ, Kemper P, Grabowski DC, Thrive Research Collaborative.Green house adoption and nursing home quality. *Health Services Research* 2016;**51 Suppl 1**:454-74.

Annerstedt 1993 *{published data only}*

* Annerstedt L, Gustafson L, Nilsson K.Medical outcome of psychosocial intervention in demented patients: one-year clinical follow-up after relocation into group living units. *International Journal of Geriatric Psychiatry* 1993;**8**(10):833-41.

Annerstedt L.An attempt to determine the impact of group living care in comparison to traditional long-term care on demented elderly patients. *Aging Clinical and Experimental Research* 1994;**6**(5):372-80.

Annerstedt L.Group-living care: an alternative for the demented elderly. *Dementia & Geriatric Cognitive Disorders* 1997;**8**(2):136-42.

Annerstedt L.On group-living care for the demented elderly: experiences from the Malmo model. Ann Arbor Lunds Universitet 1995;**C405957**:69.

Burack 2012 *{published data only}*

Burack OR, Reinhardt JP, Weiner AS.Person-centered care and elder choice: a look at implementation and sustainability. *Clinical Gerontologist* 2012;**35**(5):390-403.

* Burack OR, Weiner AS, Reinhardt JP.The impact of culture change on elders' behavioral symptoms: a longitudinal study. *Journal of the American Medical Directors Association* 2012;**13**(6):522-8.

Chenoweth 2014 *{published data only}*

Chenoweth L, Jeon YH, Stein-Parbury J, Forbes I, Fleming R, Cook J, et al.PerCEN trial participant perspectives on the implementation and outcomes of person-centered dementia care and environments. *International Psychogeriatrics* 2015;**27**(12):2045-57.

* Chenoweth L, Forbes I, Fleming R, King MT, Stein-Parbury J, Luscombe G, et al.PerCEN: a cluster randomized controlled trial of person-centered residential care and environment for people with dementia. *International Psychogeriatrics* 2014;**26**(7):1147-60.

Chenoweth L, King M, Luscombe G, Forbes I, Jeon YH, Parbury JS, et al.Study protocol of a randomised controlled group trial of client and care outcomes in the residential dementia care setting. *Worldviews on Evidence-Based Nursing* 2011;**8**(3):153-65.

Chenoweth L.The Percen study: supporting client and care outcomes in the residential dementia care setting. *Alzheimer's and Dementia* 2011;**7**(4 Suppl 1):S292.

Dettbarn-Reggentin 2005 *{published data only}*

Dettbarn-Reggentin J.Study on the influence of environmental residential groups on demented old people in nursing home residents [Studie zum einfluss von wohngruppenmilieus auf demenziell erkrankte in stationären einrichtungen]. *Zeitschrift Fur Gerontologie Und Geriatrie* 2005;**38**(2):95-100.

Diaz-Veiga 2014 *{published data only}*

Diaz-Veiga P, Sancho M, Garcia A, Rivas E, Abad E, Suarez N, et al.Effects from the Person Centered-Care model on quality of life of cognitive impaired persons from gerontological centers [Efectos del Modelo de Atención Centrado en la Persona en la calidadde vida de personas con deterioro cognitivo de centros gerontológicos]. *Revista Espanola de Geriatria y Gerontologia* 2014;**49**(6):266-71.

Elmstahl 1997 *{published data only}*

Elmstahl S, Annerstedt L, Ahlund O.How should a group living unit for demented elderly be designed to decrease psychiatric symptoms? *Alzheimer Disease and Associated Disorders* 1997;**11**(1):47-52.

Figueiro 2019 *{published data only}*

Figueiro M, Rea M.Tailored lighting intervention to improve sleep in patients with dementia. *Sleep Medicine* 2019;**64**:S115.

Figueiro MG, Kalsher M, Plitnick B, Rohan C, Rea MS.Tailored lighting intervention for Alzheimer's patients and its effects on sleep, mood and agitation. *Sleep* 2018;**41**:A113-A114.

* Figueiro MG, Plitnick B, Roohan C, Sahin L, Kalsher M, Rea MS.Effects of a tailored lighting intervention on sleep quality, rest-activity, mood, and behavior in older adults with Alzheimer disease and related dementias: a randomized clinical trial. *Journal of Clinical Sleep Medicine* 2019;**15**(12):1757-67.

Frisoni 1998 *{published data only}*

Bellelli G, Giovanni GB, Bianchetti A, Boffelli S, Guerrini GB, Scotuzzi A, et al.Special care units for demented patients: a multicenter study. *Gerontologist* 1998;**38**(4):456-62.

Bianchetti A, Benvenuti P, Ghisla KM, Frisoni GB, Trabucchi M.An Italian model of dementia special care unit: results of a pilot study. *Alzheimer Disease and Associated Disorders* 1997;**11**(1):53-6.

* Frisoni GB, Gozzetti A, Bignamini V, Vellas BJ, Berger AK, Bianchetti A, et al.Special care units for dementia in nursing homes: a controlled study of effectiveness. *Archives of Gerontology and Geriatrics* 1998;**26**:215-24.

Galik 2021 *{published data only}*

Galik EM, Resnick B, Holmes SD, Vigne E, Lynch K, Ellis J, et al.A cluster randomized controlled trial testing the impact of function and behavior focused care for nursing home residents with dementia. *Journal of the American Medical Directors Association* 2021;**22**(7):1421-8.

Hopkins 2017 *{published data only}*

* Hopkins S, Morgan PL, Schlangen LJM, Williams P, Skene DJ, Middleton B.Blue-enriched lighting for older people living in care homes: effect on activity, actigraphic sleep, mood and alertness. *Current Alzheimer Research* 2017;**14**:1053-62.

Middleton B, Hopkins S, Morgan PL, Barrett D, Schlangen LJ, Skene DJ.Effects of blue-enriched and control white light on activity levels and timing in older people living in care homes. *Journal of Sleep Research* 2010;**19**:188.

Kenkmann 2010 *{published data only}*

Kenkmann A, Hooper L.The restaurant within the home: experiences of a restaurant-style dining provision in residential homes for older people. *Quality in Ageing & Older Adults* 2012;**13**(2):98-110.

* Kenkmann A, Price GM, Bolton J, Hooper L.Health, wellbeing and nutritional status of older people living in UK care homes: an exploratory evaluation of changes in food and drink provision. *BMC Geriatrics* 2010;**10**:28.

Marcy-Edwards 2011 *{published data only}*

* Marcy-Edwards D, Wardell R, Simon J, Hansen J, Baden L, Grant N.The effect of vignette activity on the neuropsychiatric behaviours expressed by individuals with dementia, living in long-term care. *Alzheimer's and Dementia* 2011;**7**(4 Suppl 1):S644-S645.

Marcy-Edwards D.Engaging at a Garden Vignette: the Effect on Neuropsychiatric Behaviour in Moderate to Severe Dementia (thesis). Calgary, Canada: University of Calgary, 2014.

Mathey 2001 *{published data only}*

Mathey MF, Vanneste VG, De Graaf C, De Groot LC, Van Staveren WA.Health effect of improved meal ambience in a Dutch nursing home: a 1-year intervention study. *Preventive Medicine* 2001;**32**(5):416-23.

Nijs 2006 *{published data only}*

Nijs KA, De Graaf C, Kok FJ, Van Staveren WA.Effect of family style mealtimes on quality of life, physical performance, and body weight of nursing home residents: cluster randomised controlled trial. *BMJ* 2006;**332**(7551):1180-4.

Riemersma-vanDerLek 2008 *{published data only}*

Riemersma-van Der Lek RF, Swaab DF, Twisk J, Hol EM, Hoogendijk WJG, Van Someren EJW.Effect of bright light and melatonin on cognitive and noncognitive function in elderly residents of group care facilities - a randomized controlled trial. *JAMA* 2008;**299**:2642-55.

Te Boekhorst 2009 *{published data only}*

Te Boekhorst S, Depla MF, De Lange J, Pot AM, Eefsting JA.The effects of group living homes on older people with dementia: a comparison with traditional nursing home care. *International Journal of Geriatric Psychiatry* 2009;**24**(9):970-8.

Wolf-Ostermann 2012 *{published data only}*

Fischer T, Wolf-Ostermann K.The Berlin study on structures and outcomes of <<Wohngemeinschaften>> for people with dementia (DeWeGE), a small-scale living arrangement [Die Berliner studie zu versorgungsstrukturen and versorgunsergebnissen von Wohngemeinschafrern fur menschen mit demenz (DeWeGe)]. *Zeitschrift fur Gerontopsychologie & Psychiatrie* 2008;**21**(3):179-83.

* Wolf-Ostermann K, Worch A, Fischer T, Wulff I, Graske J.Health outcomes and quality of life of residents of shared-housing arrangements compared to residents of special care units - results of the Berlin DeWeGE-study. *Journal of Clinical Nursing* 2012;**21**(21-22):3047-60.

Wylie 2001 *{published data only}*

Wylie R.Impact of the Eden Alternative™ on Texas Nursing Homes Residents' Quality of Life: a Psychosocial Perspective (thesis). Texas, United States: Texas State University, 2001.

Yoon 2015 *{published data only}*

* Yoon JY, Brown RL, Bowers BJ, Sharkey SS, Horn SD.Longitudinal psychological outcomes of the small-scale nursing home model: a latent growth curve zero-inflated Poisson model. *International Psychogeriatrics* 2015;**27**(6):1009-16.

Yoon JY, Brown RL, Bowers BJ, Sharkey SS, Horn SD.The effects of the Green House nursing home model on ADL function trajectory: a retrospective longitudinal study. *International Journal of Nursing Studies* 2016;**53**:238-47.

Yoon JY.The effect of Green House nursing home model on the health outcome trajectories. University of Wisconsin Madison 2013.

References to studies excluded from this review

Auer 2017 *{published data only}*

Auer S, Kienberger U, Pascher P, Geck M, Hofmann B, Viereckl C.Small-scale group living versus traditional nursing home for persons with dementia [Wohngemeinschaft versus traditionelles pflegeheim für personen mit demenz. Eine vergleichende beobachtungsstudie.]. *Pflegewissenschaft* 2017;**3/4**:156–65.

Barrick 2010 *{published data only}*

Barrick AL, Sloane PD, Williams CS, Mitchell CM, Connell BR, Wood W, et al.Impact of ambient bright light on agitation in dementia. *International Journal of Geriatric Psychiatry* 2010;**25**(10):1013-21.

Bergman-Evans 2004 *{published data only}*

Bergman-Evans B.Beyond the basics. Effects of the Eden Alternative model on quality of life issues. *Journal of Gerontological Nursing* 2004;**30**(6):27-34.

Bonardi 1989 *{published data only}*

Bonardi E, Pencer I, Tourigny-Rivard MF.Observed changes in the functioning of nursing home residents after relocation. *International Journal of Ageing and Human Development* 1989;**28**(4):295-304.

Bond 1999 *{published data only}*

Bond GE, Fiedler FE.A comparison of leadership vs. renovation in changing staff values. *Nursing Economics* 1999;**17**(1):37-43.

Chafetz 1991 *{published data only}*

Chafetz PK.Behavioral and cognitive outcomes of SCU care. *Clinical Gerontologist: Journal of Aging and Mental Health* 1991;**11**(1):19-38.

Chang 2013 *{published data only}*

Chang YP, Li J, Porock D.The effect on nursing home resident outcomes of creating a household within a traditional structure. *Journal of the American Medical Directors Association* 2013;**14**(4):293-9.

Cohen-Mansfield 1998 *{published data only}*

Cohen-Mansfield J, Werner P.The effects of an enhanced environment on nursing home residents who pace. *Gerontologist* 1998;**38**(2):199-208.

Coleman 2002 *{published data only}*

Coleman MT, Looney S, O'Brien J, Ziegler C, Pastorino CA, Turner C.The Eden Alternative: findings after 1 year of implementation. *Journals of Gerontology. Series A, Biological Sciences and Medical Sciences* 2002;**57**(7):422-7.

De Boer 2017 *{published data only}*

De Boer B, Bozdemir B, Jansen J, Hermans M, Hamers JPH, Verbeek H.The Homestead: developing a conceptual framework through co-creation for innovating long-term dementia care environments. *International Journal of Environmental Research and Public Health* 2021;**18**(1):57.

De Boer B, Hamers JP, Beerens HC, Zwakhalen SM, Tan FE, Verbeek H.Living at the farm, innovative nursing home care for people with dementia - study protocol of an observational longitudinal study. *BMC Geriatrics* 2015;**15**:144.

De Boer B, Hamers JP, Zwakhalen SM, Tan FE, Beerens HC, Verbeek H.Green Care Farms as innovative nursing homes, promoting activities and social interaction for people With dementia. *Journal of the American Directors Association* 2017;**18**(1):40-6.

De Rooij 2012 *{published data only}*

De Rooij AH, Luijkx KG, Declercq AG, Emmerink PM, Schols JM.Professional caregivers' mental health problems and burnout in small-scale and traditional long term care settings for elderly people with dementia in the Netherlands and Belgium. *Journal of the American Medical Directors Association* 2012;**13**(5):486.e7-11.

De Rooij AH, Luijkx KG, Schaafsma J, Declercq AG, Emmerink PM, Schols JM.Quality of life of residents with dementia in traditional versus small-scale long-term care settings: a quasi-experimental study. *International Journal of Nursing Studies* 2012;**49**(8):931-40.

De Rooij I, Luijkx K, Declercq A, Schols J.Small-scale living facilities in the Netherlands and Belgium: a longitudinal study on patient outcome; Fourth European Nursing Congress. *Journal of Clinical Nursing* 2010;**19**:139.

Falk 2009 *{published data only}*

Falk H, Wijk H, Persson LO.The effects of refurbishment on residents' quality of life and wellbeing in two Swedish residential care facilities. *Health and Place* 2009;**15**(3):687-94.

Giggins *{published data only}*

Giggins OM, Doyle J, Hogan K, George M.The impact of a cycled lighting intervention on nursing home residents: a pilot study. *Gerontology & Geriatric Medicine* 2019;**5**:2333721419897453.

Hermer 2017 *{published data only}*

Hermer L, Bryant NS, Pucciarello M, Mlynarczyk C, Zhong B.Does comprehensive culture change adoption via the Household model enhance nursing home residents' psychosocial well-being? *Innovation in Aging* 2017;**1**(2):igx033.

Holmes 1990 *{published data only}*

Holmes D, Teresi J, Weiner A, Monaco C, Ronch J, Vickers R.Impacts associated with special care units in long-term care facilities. *Gerontologist* 1990;**30**(2):178-83.

Inventor 2018 *{published data only}*

Inventor 2018.Longitudinal effects of activities, social environment, and psychotropic medication use on behavioral symptoms of individuals with Alzheimer's disease in nursing homes. *Journal of Psychosocial Nursing & Mental Health Services* 2018;**56**(11):18-26.

Kane 2007 *{published data only}*

Kane RA, Lum TY, Cutler LJ, Degenholtz HB, Yu TC.Resident outcomes in small-house nursing homes: a longitudinal evaluation of the initial green house program. *Journal of the American Geriatrics Society* 2007;**55**(6):832-9.

Klosinska *{published data only}*

Kłosińska U, Derejczyk J, Benek I, Szczepanek A, Derejczyk G.Look around-architectural interventions in LTC home and professional stress of formal caregivers. *European Geriatric Medicine* 2019;**10**:S179.

Kok 2017 *{published data only}*

* Kok JS, Berg IJ, Blankevoort GCG, Scherder EJA.Rest-activity rhythms in small scale homelike care and traditional care for residents with dementia. *BMC Geriatrics* 2017;**17**(1):137.

Kok JS, Van Heuvelen MJ, Berg IJ, Scherder EJ.Small scale homelike special care units and traditional special care units: effects on cognition in dementia; a longitudinal controlled intervention study. *BMC Geriatrics* 2016;**16**:47.

Kok 2018 *{published data only}*

Kok JS, Nielen MMA, Scherder EJA.Quality of life in small-scaled homelike nursing homes: an 8-month controlled trial. *Health & Quality of Life Outcomes* 2018;**16**(1):38.

Kubsch 2018 *{published data only}*

Kubsch SM, Tyczkowski BL, Passel C.The impact of the Eden Alternative on hope. *Nursing & Residential Care* 2018;**20**(2):91-4.

Lee 2016 *{published data only}*

Lee SY, Chaudhury H, Hung L.Effects of physical environment on health and behaviors of residents with dementia in long-term care facilities: a longitudinal study. *Research in Gerontological Nursing* 2016;**9**(2):81-91.

Lum 2008 *{published data only}*

Lum TY, Kane RA, Cutler LJ, Yu TC.Effects of Green House nursing homes on residents' families. *Health Care Financing Review* 2008;**30**(2):35-51.

Molony 2011 *{published data only}*

Molony SL, Evans LK, Jeon S, Rabig J, Straka LA.Trajectories of at-homeness and health in usual care and small house nursing homes. *Gerontologist* 2011;**51**(4):504-15.

O'Connor 1991 *{published data only}*

O'Connor BP, Davidson H, Gifford R.Window view, social exposure and nursing home adaptation. *Canadian Journal on Aging* 1991;**10**(3):216-23.

Palm 2019 *{published data only}*

Palm R, Trutschel D, Sorg CG, Dichter MN, Haastert B, Holle B.Quality of life in people with severe dementia and its association with the environment in nursing homes: an observational study. *Gerontologist* 2019;**59**(4):665-74.

Pomeroy 2011 *{published data only}*

Pomeroy SH, Scherer Y, Runkawatt V, Iamsumang W, Lindemann J, Resnick B.Person-environment fit and functioning among older adults in a long-term care setting. *Geriatric Nursing* 2011;**32**:368-78.

Potter 2018 *{published data only}*

Potter R, Sheehan B, Cain R, Griffin J, Jennings PA.The impact of the physical environment on depressive symptoms of older residents living in care homes: a mixed methods study. *Gerontologist* 2018;**58**(3):438-47.

Reimer 2004 *{published data only}*

Reimer MA, Slaughter S, Donaldson C, Currie G, Eliasziw M.Special care facility compared with traditional environments for dementia care: a longitudinal study of quality of life. *Journal of the American Geriatrics Society* 2004;**52**(7):1085-92.

Scott 2014 *{published data only}*

Scott TL, Masser BM, Pachana NA.Multisensory installations in residential aged-care facilities: increasing novelty and encouraging social engagement through modest environmental changes. *Journal of Gerontological Nursing* 2014;**40**(9):20-31.

Steiner 2020 *{published data only}*

Steiner B.Assisted living facilities in inpatient and outpatient settings [Wohn- und hausgemeinschaften in stationären und ambulanten settings]. *Zeitschrift Fur Gerontologie Und Geriatrie* 2020;**53**(6):505-12.

Varshawsky *{published data only}*

Varshawsky A, Traynor V.Live behind the orange door - the effects of changing suite doors for individuals living with dementia. *Australian Nursing & Midwifery Journal* 2018;**25**(7):38-9.

* Varshawsky AL, Traynor V.Graphic designed bedroom doors to support dementia wandering in residential care homes: innovative practice. *Dementia - International Journal of Social Research and Practice* 2021;**20**(1):348–54.

Verbeek 2014 *{published data only}*

Verbeek H, Van Rossum E, Zwakhalen SM, Kempen GI, Hamers JP.Small, homelike care environments for older people with dementia: a literature review. *International Psychogeriatrics* 2009;**21**(2):252-64.

Verbeek H, Zwakhalen SM, Van Rossum E, Ambergen T, Kempen GI, Hamers JP.Dementia care redesigned: effects of small-scale living facilities on residents, their family caregivers, and staff. *Journal of the American Medical Directors Association* 2010;**11**(9):662-70.

* Verbeek H, Zwakhalen SM, Van Rossum E, Ambergen T, Kempen GI, Hamers JP.Effects of small-scale, home-like facilities in dementia care on residents' behavior, and use of physical restraints and psychotropic drugs: a quasi-experimental study. *International Psychogeriatrics* 2014;**26**(4):657-68.

Verbeek H, Zwakhalen SM, Van Rossum E, Kempen GI, Hamers JP.Small-scale, homelike facilities in dementia care: a process evaluation into the experiences of family caregivers and nursing staff. *International Journal of Nursing Studies* 2012;**49**(1):21-9.

Zwakhalen SM, Hamers JP, Van Rossum E, Ambergen T, Kempen GI, Verbeek H.Working in small-scale, homelike dementia care: effects on staff burnout symptoms and job characteristics. A quasi-experimental, longitudinal study. *Journal of Research in Nursing* 2018;**23**(2-3):109-22.

References to studies awaiting assessment

Kolberg 2020 *{published and unpublished data}*

Johnsen Hjetland G.The Effect of Bright Light on Sleep in Nursing Home Patients with Dementia (PhD thesis). Norway: University of Bergen, 2021.

* Kolberg E, Pallesen S, Johnsen Hjetland G, Nordhus IH, Thun E, Flo-Groeneboom E.The potential of bright light treatment in the management of depression and anxiety in dementia during winter. *Journal of Sleep Research* 2020;**29**(Suppl 1):P309.

References to ongoing studies

Willemse 2011 *{published data only}*

Prins M, Willemse BM, Heijkants CH, Pot AM.Nursing home care for people with dementia: update of the design of the Living Arrangements for people with Dementia (LAD) study. *Journal of Advanced Nursing* 2019;**75**(12):3792-804.

Smit D, De Lange J, Willemse B, Pot AM.Predictors of activity involvement in dementia care homes: a cross-sectional study. *BMC Geriatrics* 2017;**17**:175.

Smit D, Willemse B, De Lange J, Pot AM.Wellbeing-enhancing occupation and organizational and environmental contributors in long-term dementia care facilities: an explorative study. *International Psychogeriatrics* 2014;**26**(1):69-80.

* Willemse BM, Smit D, De Lange J, Pot A.Nursing home care for people with dementia and residents' quality of life, quality of care and staff well-being: design of the Living Arrangements for people with Dementia (LAD) study. *BMC Geriatrics* 2011;**11**:11.

Willemse BM.Working conditions and person-centredness of the dementia care workforce: impact on quality of care, staff and resident well-being. Vrije Universiteit Amsterdam: Amsterdam, the Netherlands (accessed prior to 12 Feb 2022).

Additional references

ADI 2015

Alzheimer's Disease International.World Alzheimer Report 2015: the global impact of dementia. www.alz.co.uk/research/world-report-2015 (accessed 10 March 2017).

Alldred 2016

Alldred DP, Kennedy M, Hughes C, Chen TF, Miller P.Interventions to optimise prescribing for older people in care homes. *Cochrane Database of Systematic Reviews* 2016, Issue 2. Art. No: CD009095. [DOI: 10.1002/14651858.CD009095.pub3]

Anderson 2020

Anderson RM, Grey T, Kennelly S, O'Neill D.Nursing home design and COVID-19: balancing infection control, quality of life, and resilience. *Journal of the American Medical Director's Association* 2020;**21**(11):1519–24.

Ausserhofer 2016

Ausserhofer D, Deschodt M, De Geest S, Van Achterberg, Meyer G, Verbeek H, et al."There's No Place Like Home": a scoping review on the impact of homelike residential care models on resident, family, and staff-related outcomes. *Journal of the American Medical Directors Association* 2016;**17**(8):685-93.

Bach-Mortensen 2021

Bach-Mortensen AM, Verboom B, Movsisyan A, Esposti MD.A systematic review of the associations between care home ownership and COVID-19 outbreaks, infections and mortality. *Nature Aging* 2021;**1**:948-61.

Bradshaw 2012

Bradshaw SA, Playford ED, Riazi A.Living well in care homes: a systematic review of qualitative studies. *Age and Ageing* 2012;**41**(4):429-40.

Brownie 2011

Brownie S, Neeleman P, Noakes-Meyer C.Establishing the Eden Alternative™ in Australia and New Zealand. *Contemporary Nurse* 2011;**37**(2):222-4.

Brownie 2013

Brownie S, Nancarrow S.Effects of person-centered care on residents and staff in aged-care facilities: a systematic review. *Clinical Interventions in Aging* 2013;**8**:1-10.

CADTH 2010

Canadian Agency for Drugs and Technologies in Health.Eden Alternative and Green House concept of care: review of clinical effectiveness, cost-effectiveness, and guidelines. cadth.ca/media/pdf/L0166_Eden_Alternative_Concept_final.pdf (accessed prior to 4 March 2022).

Cameron 2018

Cameron ID, Dyer SM, Panagoda CE, Murray GR, Hill KD, Cumming RG, et al.Interventions for preventing falls in older people in care facilities and hospitals. *Cochrane Database of Systematic Reviews* 2018, Issue 9. Art. No: CD005465. [DOI: 10.1002/14651858.CD005465]

Chenoweth 2019

Chenoweth L, Stein-Parbury J, Lapkin S, Wang A, Liu Z, Williams A.Effects of person-centered care at the organisational-level for people with dementia. A systematic review. *PLOS One* 2019;**14**(2):e0212686.

Comas-Herrera 2021

Comas-Herrera A, Zalakaín J, Lemmon E, Henderson D, Litwin C, Hsu AT, et al.Mortality associated with COVID-19 in care homes: international evidence. ltccovid.org/wp-content/uploads/2021/02/LTC_COVID_19_international_report_January-1-February-1-2.pdf (accessed prior to 12 Feb 2022).

Covidence [Computer program]

Covidence Systematic Review software.Veritas Health Innovation. Melbourne, Australia: Cochrane, 2019.

DEEP 2015

Dementia Enabling Environment Project (DEEP).Dementia enabling environments. www.enablingenvironments.com.au (accessed 20 March 2017).

Deshmukh 2018

Deshmukh SR, Holmes J, Cardno A.Art therapy for people with dementia. *Cochrane Database of Systematic Reviews* 2018, Issue 9. Art. No: CD011073. [DOI: 10.1002/14651858.CD011073.pub2]

Doty 2007

Doty MM, Koren M, Sturla EL.Culture change in nursing homes: how far have we come? Findings from the Commonwealth Fund 2007 National Survey of Nursing Homes. www.commonwealthfund.org/Publications/Fund-Reports/2008/May/Culture-Change-in-Nursing-Homes--How-Far-Have-We-Come--Findings-From-The-Commonwealth-Fund-2007-Nati.aspx (accessed 1 April 2017).

Dyer 2017

Dyer SM, Harrison SL, Laver K, Whitehead C, Crotty M.An overview of systematic reviews of pharmacological and non-pharmacological interventions for the treatment of behavioral

and psychological symptoms of dementia. *International Psychogeriatrics* 2020;**30**(3):295-309.

Dyer 2018

Dyer SM, Liu E, Gnanamanickam E, Milte R, Easton T, Harrison SL, et al.Clustered domestic residential aged care in Australia: fewer hospitalisations and better quality of life. *Medical Journal of Australia* 2018;**208**(10):433-8.

Ellis 2010

Ellis JM.Psychological transition into a residential care facility: older people's experiences. *Journal of Advanced Nursing* 2010;**66**(5):1159-68.

Endnote [Computer program]

Endnote X9.Philadelphia: Clarivate, 2013.

EPOC 2016a

Cochrane Effective Practice and Organisation of Care (EPOC).The EPOC taxonomy of health systems interventions. EPOC Resources for review authors, 2016. epoc.cochrane.org/epoc-specific-resources-review-authors (accessed prior to 12 Feb 2022).

EPOC 2016b

Effective Practice and Organisation of Care.What study designs should be included in an EPOC review? EPOC Resources for review authors. epoc.cochrane.org/epoc-specific-resources-review-authors (accessed prior to 12 Feb 2022).

EPOC 2017a

Cochrane Effective Practice and Organisation of Care (EPOC).Suggested risk of bias criteria for EPOC reviews. EPOC resources for review authors, 2017. epoc.cochrane.org/epoc-specific-resources-review-authors (accessed prior to 12 Feb 2022).

EPOC 2017b

Cochrane Effective Practice and Organisation of Care (EPOC).EPOC worksheets for preparing a 'Summary of findings' table using GRADE. EPOC resources for review authors, 2017. epoc.cochrane.org/epoc-specific-resources-review-authors.

EPOC 2017c

Cochrane Effective Practice and Organisation of Care (EPOC).Interrupted time series (ITS) analyses. EPOC Resources for review authors. epoc.cochrane.org/epoc-specific-resources-review-authors.

Figueiro 2014

Figueiro MG, Plitnick BA, Lok A, Jones GE, Higgins P, Hornick TR, et al.Tailored lighting intervention improves measures of sleep, depression, and agitation in persons with Alzheimer's disease and related dementia living in long-term care facilities. *Clinical Interventions in Aging* 2014;**9**:1527-37.

Fleming 2010

Fleming R, Purandare N.Long-term care for people with dementia: environmental design guidelines. *International Psychogeriatrics* 2010;**22**(7):1084-96.

Fleming 2011

Fleming R.An environmental audit tool suitable for use in homelike facilities for people with dementia. *Australasian Journal on Ageing* 2011;**30**(3):108-12.

Funaki 2005

Funaki Y, Kaneko F, Okamura H.Study on factors associated with changes in quality of life of demented elderly persons in group homes. *Scandinavian Journal of Occupational Therapy* 2005;**12**(1):4-9.

GRADEpro GDT 2015 [Computer program]

McMaster University (developed by Evidence Prime) GRADEpro GDT.Hamilton (ON): McMaster University (developed by Evidence Prime), 2015. Available at gradepro.org.

Guyatt 2008

Guyatt GH, Oxman AD, Vist G, Kunz R, Falck-Ytter Y, Alonso-Coello P, et al, GRADE Working Group.GRADE: an emerging consensus on rating quality of evidence and strength of recommendations. *BMJ* 2008;**336**(7650):924-6.

Higgins 2011

Higgins JP, Green S, editor(s).Cochrane Handbook for Systematic Reviews of Interventions Version 5.1.0 (updated March 2011). The Cochrane Collaboration, 2011. Available from training.cochrane.org/handbook/archive/v5.1.

Hoffmann 2014

Hoffmann TC, Glasziou PP, Bourton I, Milne R, Perera R, Moher D, et al.Better reporting of interventions: template for intervention description and replication (TIDieR) checklist and guide. *BMJ* 2014;**348**:g1687.

Husebø 2019

Husebø BS, Ballard C, Aarsland D, Selbaek G, Slettebo DD, Gulla C, Aasmul A, Habiger T, Elvegaard T, Testad I, Flo E.The effect of a multicomponent intervention on quality of life in residents of nursing homes: a randomized controlled trial (COSMOS). *Journal of the American Medical Director's Association* 2019;**2**(3):330-9.

Ibrahim 2020

Ibrahim JE.COVID-19 and residential aged care in Australia. *Australian Journal of Advanced Nursing* 2020;**37**:3. [DOI: https://doi.org/10.37464/2020.373.226]

Joseph 2015

Joseph A, Young-Seon C, Quan X.Impact of the physical environment of Residential Health, Care, and Support Facilities (RHCSF) on staff and residents. *Environment and Behavior* 2016;**48**(10):1203-41.

Kane 2003

Kane RA, Kling KC, Bershadsky B, Kane RL, Giles K, Degenholtz HB, et al.Quality of life measures for nursing home residents. *Journals of Gerontology. Series A, Biological Sciences and Medical Sciences* 2003;**58**(3):240-8.

Lai 2009

Lai CKY, Yeung JHM, Mok V, Chi I.Special care units for dementia individuals with behavioural problems. *Cochrane Database of Systematic Reviews* 2009, Issue 4. Art. No: CD006470. [DOI: 10.1002/14651858.CD006470.pub2]

Lai 2019

Lai N, Chang S, Ng S, Tan S, Chaiyakunapruk N, Stanaway F .Animal-assisted therapy for dementia. *Cochrane Database of Systematic Reviews* 2019, Issue 1. Art. No: CD013243. [DOI: 10.1002/14651858.CD013243]

Lang 2017

Lang L, Clifford A, Wei L, Zhang D, Leung D, Augustine G, et al.Prevalence and determinants of undetected dementia in the community: a systematic literature review and a meta-analysis. *BMJ Open* 2017;**7**(2):e011146.

Liberati 2009

Liberati A, Altman DG, Tetzlaff J, Mulrow C, Gotzsche PC, Loannidis JP, et al.The PRISMA statement for reporting systematic reviews and meta-analyses of studies that evaluate health care interventions: explanation and elaboration. *PLOS Medicine* 2009;**6**(7):e1000100.

Livingston 2014

Livingston G, Kelly L, Lewis-Holmes E, Baio G, Morris S, Patel N, et al.A systematic review of the clinical effectiveness and cost-effectiveness of sensory, psychological and behavioural interventions for managing agitation in older adults with dementia. *Health Technology Assessment* 2014;**18**(39):1-226.

Lyketsos 2000

Lyketsos CG, Steinberg M, Tschanz JT, Norton MC, Steffens DC, Breitner JC.Mental and behavioral disturbances in dementia: findings from the Cache County Study on Memory in Aging. *American Journal of Psychiatry* 2000;**157**(5):708-14.

Marquardt 2014

Marquardt G, Bueter K, Motzek T.Impact of the design of the built environment on people with dementia: an evidence-based review. *Health Environments Research and Design Journal* 2014;**8**(1):127-57.

Moniz Cook 2012

Moniz Cook ED, Swift K, James I, Malouf R, De Vugt M, Verhey F.Functional analysis-based interventions for challenging behaviour in dementia. *Cochrane Database of Systematic Reviews* 2012, Issue 2. Art. No: CD006929. [DOI: 10.1002/14651858.CD006929.pub2]

Nobili 2006

Nobili A, Piana I, Balossi L, Tettamanti M, Trevisan S, Lucca U, et al.Patients with dementia. Comparative study of patients with dementia admitted to Alzheimer Special Care Units and other nursing home wards in the Lombardy Region: differences in characteristics and clinical outcomes. *Ricerca e Pratica* 2006;**22**(5):196-215.

Oliver 2020

Oliver D.Let's not forget care homes when Covid-19 is over. *British Medical Journal* 2020;**369**:m1629.

Olsen 2016

Olsen C, Pedersen I, Bergland A, Enders-Slegers MJ, Jøranson N, Calogiuri G, et al.Differences in quality of life in home-dwelling persons and nursing home residents with dementia – a cross-sectional study. *BMC Geriatrics* 2016;**16**:137.

Post 2014

Post MWM.Definitions of quality of life: what has happened and how to move on. *Topics in Spinal Cord Injury Rehabilitation* 2014;**20**(3):167-80.

Review Manager 2014 [Computer program]

Nordic Cochrane Centre, The Cochrane Collaboration Review Manager 5 (RevMan 5).Version 5.3. Copenhagen: Nordic Cochrane Centre, The Cochrane Collaboration, 2014.

Romeo 2018

Romeo R, Zala D, Knapp M, Orrell M, Fossey J, Ballard C.Improving the quality of life of care home residents with dementia: cost-effectiveness of an optimized intervention for residents with clinically significant agitation in dementia. *Alzheimer's & Dementia* 2018;**15**(2):282-91.

Soril 2014

Soril LJJ, Leggett LE, Lorenzetti DL, Silvius J, Robertson D, Mansell L, et al.Effective use of the built environment to manage behavioural and psychological symptoms of dementia: a systematic review. *PLOS One* 2014;**9**(12):e115425.

Sterne 2011

Sterne JA, Sutton AJ, Loannidis JP, Terrin N, Jones DR, Lau J, et al.Recommendations for examining and interpreting funnel plot asymmetry in meta-analyses of randomised controlled trials. *BMJ* 2011;**343**:d4002.

Tesh 2002

Tesh AS, McNutt K, Courts NF, Barba BE.Characteristics of nursing homes adopting environmental transformations. *Journal of Gerontological Nursing* 2002;**28**(3):28-34.

Tolson 2011

Tolson D, Rolland Y, Andrieu S, Aquino JP, Beard J, Benetos A, et al.International Association of Gerontology and Geriatrics: a global agenda for clinical research and quality of care in nursing homes. *Journal of the American Medical Directors Association* 2011;**12**(3):184-9.

Tsoi 2018

Tsoi KKF, Chan JYC, Ng YM, Lee MMY, Kwok TCY, Wong SYS.Receptive music therapy is more effective than interactive music therapy to relieve behavioral and psychological symptoms of dementia: a systematic review and meta-analysis. *Journal of the American Medical Director's Association* 2018;**19**(7):568-76.

UN 2015

United Nations.World Population Ageing. www.un.org/en/development/desa/population/publications/pdf/ageing/WPA2015_Report.pdf (accessed prior to 11 April 2017).

Usman 2019

Usman A, Lewis S, Hinsliff-Smith K, Long A, Housley G, Jordan J, et al.Measuring health-related quality of life of care home residents: comparison of self-report with staff proxy responses. *Age and Ageing* 2019;**48**(3):407–13.

Van der Steen 2018

Van der Steen JT, Smaling HJA, Van der Wouden JC, Bruinsma MS, Scholten RJPM, Vink AC.Music-based therapeutic interventions for people with dementia. *Cochrane Database of Systematic Reviews* 2018, Issue 7. Art. No: CD003477. [DOI: 10.1002/14651858.CD003477.pub4]

Werner 2020

Werner RM, Hoffman AK, Coe NB.Long-Term Care Policy after Covid-19 — Solving the Nursing Home Crisis. *New England Journal of Medicine* 2020;**383**(10):903-5. [DOI: 10.1056/NEJMp2014811]

Whear 2014

Whear R, Coon JT, Bethel A, Abbott R, Stein K, Garside R.What is the impact of using outdoor spaces such as gardens on the physical and mental well-being of those with dementia? A systematic review of quantitative and qualitative evidence. *Journal of the American Medical Directors Association* 2014;**15**(10):697-705.

WHO 2015

World Health Organization.World report on ageing and health. www.who.int/ageing/events/world-report-2015-launch/en/ (accessed 20 March 2017).

Willemse 2014

Willemse BM, Depla MFIA, Smit D, Pot AM.The relationship between small-scale nursing home care for people with dementia and staff's perceived job characteristics. *International Psychogeriatrics* 2014;**26**(5):805-16.

Willemse 2015

Willemse BM, De Jonge J, Smit D, Visser Q, Depla MFIA, Pot AM.Staff's person-centredness in dementia care in relation to job characteristics and job-related well-being: a cross-sectional survey in nursing homes. *Journal of Advanced Nursing* 2015;**71**(2):404-16.

Willemse 2016

Willemse BM.Working Conditions and Person-Centredness of the Dementia Care Workforce: Impact on Quality of Care, Staff and Resident Well-Being (thesis). Amsterdam, The Netherlands: Vrije Universiteit Amsterdam, 2016.

Woodbridge 2018

Woodbridge R, Sullivan MP, Harding E, Crutch S, Gilhooly KJ, Gilhooly MLM, et al.Use of the physical environment to support everyday activities for people with dementia: a systematic review. *Dementia (London, England)* 2018;**17**(5):533-72.

Zimmerman 2016

Zimmerman S, Bowers BJ, Cohen L, Grabowski DC, Horn SD, Kemper P, THRIVE Research Collaborative.New evidence on the Green House model of nursing home care: synthesis of findings and implications for policy, practice, and research. *Health Services Research* 2016;**51**(S1):475-96.

References to other published versions of this review

Harrison 2017

Harrison SL, Dyer SM, Laver KE, Milte RK, Fleming R, Crotty M.Physical environmental designs in residential care to improve quality of life of older people. *Cochrane Database of Systematic Reviews* 2017, Issue 12. Art. No: CD012892. [DOI: 10.1002/14651858.CD012892]

* Indicates the major publication for the study

CHARACTERISTICS OF STUDIES

Characteristics of included studies *[ordered by study ID]*

Afendulis 2016

Study characteristics	
Methods	Study design: Controlled before-after study Number of facilities: unclear (total of GreenHouse, control and excluded GreenHouse owned "legacy" homes: 190; 12 intervention and 178 control)
Participants	N = 74,449 (weighted sample) Mean age: not reported. % Female: not reported. % Dementia: 33.9

Afendulis 2016 *(Continued)*

	Mean number of comorbidities: not reported Country: USA Inclusion criteria: Nursing homes: • that adopted the GreenHouse (GH) model over the period 2005 to 2010 (from list provided by The Green House Project) • were in operation in the period prior to adoption - non-GH nursing home organisations matched at facility-level by OSCAR (Online Survey, Certification, and Reporting) • nursing home level data for each GH nursing home plus matched on state and year of adoption, using nearest neighbour matching • matched on these covariates: nonprofit ownership, for-profit ownership, government ownership, chain status, small size (75 beds or fewer), medium size (76–125 beds), large size (126 or more beds), rural location, above median Medicaid share, above median Medicare share, above median private-pay share, and a nursing home-level aggregate activities of daily living (ADL) score (0 if less than 4 on a scale of 0–5, 1 otherwise), with propensity score weighting Exclusion criteria: • Residents who were not entitled to Medicare Part A in the month of admission • Residents who died during the month of admission • Residents who were enrolled in the Medicare Advantage program during the month of admission
Interventions	Type of intervention: Home-like model Name of intervention: Green House model. Design features: Small buildings (maximum 12 residents) and fit the style of surrounding neighbourhood Other features that differed: Residents have more control over daily activities. Control: Matched by multiple facility characteristics, state and year that did not adopt the Green House model, not a "small house" model
Outcomes	The following outcomes were reported: Rehospitalisations, avoidable rehospitalisations, bedfast residents, catheter use, pressure ulcers (low risk and high risk) and use of physical restraints Follow-up: Up to five years
Notes	Study supported by the Robert Wood Johnson Foundation. Conflicts of interest: None. Ethical approval: not stated. Data reported on "Legacy" units within the GreenHouse organisation (that were not GreenHouse model of care homes) were excluded.

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	High risk	Controlled before-after study
Allocation concealment (selection bias)	High risk	Controlled before-after study

Afendulis 2016 *(Continued)*

Blinding of participants and personnel (performance bias) All outcomes	High risk	Blinding not feasible
Blinding of outcome assessment (detection bias) All outcomes	High risk	Blinding not feasible
Incomplete outcome data (attrition bias) All outcomes	Unclear risk	Loss to follow-up not stated
Selective reporting (reporting bias)	Unclear risk	No protocol; likely to be many fields in MDS not reported
Other bias	High risk	Method of selection of facilities unclear and potential residual confounding. Significant differences in baseline characteristics. Significant differences for many baseline outcome measures

Annerstedt 1993

Study characteristics	
Methods	Study design: Controlled before-after study Number of facilities: 6 (3 intervention and 3 control)
Participants	N = 56 (intervention: N = 28; control: N = 28) Mean age (SD): Intervention: 82.8 (5.0), control: 81.6 (5.0) % Female: Intervention: 89.3, control: 82.1 % Dementia: not reported Mean number of comorbidities: not reported Country: Sweden Inclusion criteria: • Intervention residents: Alzheimer's, vascular dementia or mixed according to DSM-III criteria (severity of dementia II to IV on Berger's scale) • Control residents: matched by age, gender, diagnosis and level of dementia to the intervention residents Exclusion criteria: • Patients suffering from physical illness, clinically estimated to become terminal within 1 year
Interventions	Type of intervention: Home-like model Design features: 8-10 residents, situated in ordinary blocks of flats in suburbs, specially adapted for people living with dementia. Flats had private areas with 1 or 2 rooms with toilet and shower, kitchen, living room, dining room and laundry room available to staff and residents. Staff/patient ratios were similar in the two types of care (0.69 in group living; 0.71 in traditional). However, the intervention staff were responsible not only for patient care but also for cooking, cleaning, washing, transportation and activating therapies.

Annerstedt 1993 *(Continued)*

	Other features that differed: Staff familiar with resident biographies. A group living project was connected to a clinic, responsible for the geriatric care in a certain area corresponding to 20% of the persons 65 years old or older of the population in the community. Control: Offered in three big long-term care hospitals, mostly with wards of 50 patients and originally designed for acute medical care or rehabilitation. The care was usually organised in four separate groups in order to break the large-scale design of the physical environment. Each of these groups included both somatic long-term care patients with and without dementia. Staff training was seldom regularly scheduled and surveyed most aspects of geriatric care, favouring physical items.
Outcomes	The following outcomes (measurement scale) were reported: Dyspraxia, hallucinations, lack of vitality, dysphasia, paranoia, aggressiveness, depression, clinical variations, restlessness, recent memory and identity (Organic Brain Syndrome Scale: OBS Scale) Follow-up: 6 months and 12 months
Notes	Sponsorship source: Swedish Medical Research Council, the Swedish Council for Social Research, Alzheimer Foundation and Medical Foundation at Lund University. Conflicts of interest: Not stated. Ethical approval: Not stated

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	High risk	Controlled before-after study
Allocation concealment (selection bias)	High risk	Controlled before-after study
Blinding of participants and personnel (performance bias) All outcomes	High risk	Blinding not feasible
Blinding of outcome assessment (detection bias) All outcomes	High risk	Blinding not feasible
Incomplete outcome data (attrition bias) All outcomes	High risk	21% loss to follow-up
Selective reporting (reporting bias)	Low risk	All outcomes discussed were reported.
Other bias	High risk	Possible confounding, unadjusted results. Significant baseline differences in the time the participants had been institutionalised prior to relocation; participants in traditional facilities received more neuroleptic treatment. Differences in baseline outcomes e.g. dyspraxia and identity not controlled for.

Burack 2012

Study characteristics

Methods	Study design: Controlled before-after study

Burack 2012 *(Continued)*

	Number of facilities: 13 (7 intervention and 6 control)
Participants	N = 201 enrolled, 101 analysed (intervention: N = 50; control: N = 51) Mean age (SD): Intervention: 83.8 (8.8), control: 83.5 (9.8) % Female: Intervention: 62, control: 67 % Dementia: 59 (not reported by intervention and control groups) Mean (SD) number of comorbidities: 4.3 (1.9) (intervention: 4.2 (1.9) and control: 4.4 (2.0)) Country: USA Inclusion criteria: Facilities • Intervention: 2 to 3 pilot communities at each of 3 nursing home campuses for a total of 7 communities operated by one provider. Nursing and administrative staff chose communities with well-functioning teams (2 communities each at 2 of the campuses, and 3 communities at the third campus) to pilot the culture change intervention to optimise the potential for a successful culture change transformation. • Comparison: 2 communities at each campus were identified to serve as a comparison group (for a total of 6 comparison communities), selected by administrative and nursing leaderships' clinical expertise to best match the culture change group by the level of care needed by elders, staff team functioning, number of elders in the community, and the environmental community structure. Residents • Living in community for at least 3 months, 60 years or older Exclusion criteria: • Not reported
Interventions	Name of intervention: Culture change model Design features: Environmental changes were implemented in elder rooms and common areas, with a focus on person-centred care. Elders and their family members were encouraged to individualise elder rooms with personal items, decoration, and pictures. Within the common areas, attention was given to creating a calm, peaceful environment. In the dining areas, new table cloths were purchased, centre-pieces were placed on tables, art work decorated the walls, and water and juice were easily accessible to elders at all times. Hallways were decorated with painted murals and new wallpaper. The outsides of the elders' rooms were individualised to facilitate easy room recognition for the elders. Additionally, homey nooks were created at the end of hallways with comfortable seating. Noise level was addressed by discontinuing the overhead paging system and turning off TVs and radios when they were not being actively used. Other features that differed: Community co-ordinators, education, organisational and community structure changes, meaningful activities and resident choice, family involvement, reduced floating and consistent staffing Control: Continued to function along the nursing home's pre-culture change model, following the typical nursing home organisational structure and standard administrative and departmental hierarchy of care
Outcomes	The following outcomes (measurement scale) were reported: Behaviour: forceful behaviours, physical agitation and verbal agitation (Cohen-Mansfield Agitation Inventory: CMAI) Follow-up: 2 years

Burack 2012 *(Continued)*

Notes	Sponsorship source not reported. Conflicts of interest: None. Ethical approval: Not stated

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	High risk	Controlled before-after study
Allocation concealment (selection bias)	High risk	Controlled before-after study
Blinding of participants and personnel (performance bias) All outcomes	High risk	Blinding not feasible
Blinding of outcome assessment (detection bias) All outcomes	High risk	Blinding not feasible
Incomplete outcome data (attrition bias) All outcomes	Unclear risk	Large loss to follow-up; no differences between those lost and those with follow-up, but this not reported by group allocation
Selective reporting (reporting bias)	High risk	Only reported behavioural outcomes, not changes in ADLs or cognition. CMAI overall score not reported and reported according to specific groupings
Other bias	High risk	Culture change communities selected based on "well-functioning teams" to optimise potential for successful transformation. Significant baseline differences in ADLs and race reported. Significant differences in baseline outcome measurements

Chenoweth 2014

Study characteristics

Methods	Study design: Cluster-randomised controlled trial. Number of facilities: 38 (8 control, 10 PCE, 10 PCC, 10 PCE + PCC)
Participants	N = 601 (person-centred environment (PCE): 154, person-centred care (PCC): 155, PCE + PCC: 150, usual environment (UE, control): 142) Mean age (SD): PCE: 84 (8), PCC: 84 (8), PCE + PCC: 84 (7), control: 86 (7) % Female: PCE: 66, PCC: 67, PCE + PCC: 70, control: 77 % Dementia: 100 Mean (SD) number of comorbidities: not reported. % > 3 comorbidities: PCE: 35, PCC: 51, PCE + PCC: 55, control: 68 Country: Australia Inclusion criteria: Residential aged care home

Chenoweth 2014 *(Continued)*

- Government accreditation and building certification; high-level care homes; accessible by sealed road, located within a 500 km radius of Sydney, Australia; with room for improvement in both PCE and PCC according to the Person-Centred Environment and Care Assessment Tool (PCECAT), a validated 44-item rating instrument with three domains designed for evaluation of residential aged care. The PCECAT 4-point scale was rescored 0 (the best possible rating) and 1, 2, 3 (the worst possible ratings, ranked).
- A total "room for improvement score" (RFI) was calculated by summing across items (20 items in domain 2 (care services), and 19 in domain 3 (environment)). Homes that scored 1–3 for both care services and environment RFI were considered eligible.

Participants

- Self-consent, proxy consent or Guardianship Tribunal consent
- Recorded dementia diagnosis
- Permanent stay
- Admission at least 3 months prior to baseline
- Assessed high care needs and presence of agitation
- Ability to participate over the life of the study (e.g. no florid mental illness or end-stage dementia)

Exclusion criteria:

- Did not meet inclusion criteria

Interventions	Type of intervention: PCE or PCE + PCC PCE: Two chief investigators with expertise in Person-Centre Environment design and a Master of Design research student took responsibility for implementing the PCE interventions at each of the 10 PCE and 10 PCE + PCC sites. The Environment Audit Tool (EAT) was employed to evaluate the relationships between operations and space in terms of effectiveness and ideal resident care, and determining required environmental changes to meet PCE principles at the sites. Discussions of EAT findings were held with the home's executive staff and managers to initially determine their understanding of the dysfunction generated for residents through the poor physical environment features identified. Planning then occurred with these senior staff to determine the best ways to undertake the most essential and inexpensive environmental changes required. Planned modifications to the environment were undertaken in some homes where feasible by a contracted building company. The environment interventions, agreed to by the managers and priced by the contractor, were as follows: (1) two facilities needed extensions of activity space made by covering balconies or areas that were previously open; (2) two facilities had changes made to internal walls that would allow better visual access to activity and bedroom spaces; (3) one facility was to be altered to provide access to a courtyard from a dining area needed for activity and group activities; (4) two facilities needed internal divisions with added partitions to reduce the overstimulation in larger group spaces; (5) two facilities had walls removed to make sitting areas visible to residents passing in the corridor; (6) one facility had fire doors relocated to improve access to the garden and (7) the remaining facilities all had some variation of external paving, new sitting areas in gardens or covered spaces in a landscaped exterior. All these changes were considered to provide maximum benefit in achieving improved support or staff undertaking PCC-focused activities while engaging with residents. PCC: Kitwood's (1997) PCC principles, using experiential and adult learning approaches, were facilitated by two chief investigators with expertise in PCC approaches and one expert PCC trainer from Alzheimer's Australia, employing train-the-trainer processes. Five staff (one Care Manager, one Registered Nurse, two Enrolled Nurses or Assistants in Nursing, one Diversion/Recreation Therapist) from each of the 10 PCC and 10 PCC + PCE homes were involved in the PCC training. The 32-hour off-site training occurred over 1 week, complemented by a further 32 hours of on-site education and support to implement PCC in daily care practices and recreation activities. Prior experiences, case studies, role plays and simulations were utilised to develop awareness and insight of the relationship between care and the resident's quality of life. The PCC trainer guided and supported PCC-trained staff to employ PCC learning resources, mentoring and role modelling in educating all care and therapy staff in PCC. With the support of their managers and the PCC trainer, direct-care staff members were assisted to develop person-centred resident care and recreation activity plans, and to implement changes in care routines and procedures, with the focus on improving residents' quality of life and reducing changed

Chenoweth 2014 *(Continued)*

	behaviours. Ongoing telephone support continued for PCC-trained staff by the PCC trainer until post-test. Control: Regular monitoring of any unplanned changes to the environment
Outcomes	The following outcomes (measurement scale) were reported: Quality of life (Dementia Quality of Life: DEMQOL), agitation (Cohen-Mansfield Agitation Inventory: CMAI), quality of care (Quality of Interactions Schedule: QUIS) Follow-up: 8 months
Notes	Sponsorship source: National Health and Medical Research Council, Australia (funding source category 1), University of Technology Sydney, Australia (primary sponsor) and Australian Health Ministers-States & Territories, Australia (secondary sponsor). Conflicts of interest: None. Ethical approval: Research ethics approval was granted by the University of Technology Sydney Human Research Ethics committee approval number: UTS-HREC 2006-269A in November 2007, and also by the participating residential care homes. Proxy consent was obtained for all participating residents and both written and verbal consent were obtained from a small number of residents who were able to understand and remember the study's purpose and procedures prior to administering the measures that required their direct involvement.

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Low risk	Generated using a SAS program
Allocation concealment (selection bias)	Unclear risk	Unclear where the randomisation sequence was stored
Blinding of participants and personnel (performance bias) All outcomes	High risk	Blinding not feasible
Blinding of outcome assessment (detection bias) All outcomes	High risk	Blinding not possible on outcomes collected involving residents, family or staff
Incomplete outcome data (attrition bias) All outcomes	Unclear risk	31% loss to follow-up and reasons not described. Analysis compared completers and non-completers.
Selective reporting (reporting bias)	Low risk	Published protocol and outcomes reported in protocol were the same as in the main paper.
Other bias	Low risk	No other instances for bias obvious from the study

Dettbarn-Reggentin 2005

Study characteristics

Methods	Study design: Controlled before-after study

Dettbarn-Reggentin 2005 *(Continued)*

	Number of facilities: 6 (3 intervention and number of control facilities unclear, but stated there was a control group "for each of the three residential groups")
Participants	N = 60 (Intervention: N = 27; control N = 33) Mean age: Intervention: 82.9, control: 83.1 % Female: Intervention: 81.5, control: 78.5 % Dementia: 100 Mean (SD) number of comorbidities: not reported Country: Germany Inclusion criteria: Intervention participants • Residents from 3 dementia-specific facilities • Moderate or severe dementia (MMSE < 18) • Barthel 25-50 • Not excluded based on behaviour Control participants • Residents from home operated by same provider • Matched by age • Progression of dementia and mobility (Barthel) Cognition: MMSE; function: Barthel; length of stay in months Exclusion criteria: • Not reported
Interventions	Name of intervention: Residential group environment Design features: This was the focus of residential groups for people with dementia. A residential living environment was created in small residential units that followed family structures. The size was between 6 and 12 and, exceptionally, up to 15 residents. A home-like living environment, adapted to the residents, was created for all three segregated residential groups (13, 15, 15 residents). All three residential groups operated under the live-in kitchen model, aimed at addressing the residents' multiple facets (activation, communication, emotion, chronological structuring). Other features that differed: Nursing home typical organisational structures were replaced by small-scale design, familiarity, communication, needs-based activity and close human interaction (staff consistency and staff on duty). The daily routine was not dominated by the care activity, but relied on familiar day-to-day household tasks. Staff members interacted with the residents in a trusting respectful manner. The events of the day were aligned to the residents' mobility, cognitive abilities as well as their habits. The staff assigned to the participating residential groups and the control groups had comparable qualifications and rosters. Control: Nursing home typical organisational structures.
Outcomes	The following outcomes (measurement scale) were reported: Social behaviour (Nurses Observations Scale for Geriatric Patients: NOSGER), function (Barthel Index) and cognitive function (Mini Mental State Examination: MMSE) Follow-up: 12 months
Notes	Sponsorship source not reported. Conflicts of interest: Not stated

Dettbarn-Reggentin 2005 *(Continued)*

Ethical approval: Not stated

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	High risk	No randomisation
Allocation concealment (selection bias)	High risk	Controlled before-after study
Blinding of participants and personnel (performance bias) All outcomes	High risk	Blinding not feasible
Blinding of outcome assessment (detection bias) All outcomes	High risk	Blinding not feasible
Incomplete outcome data (attrition bias) All outcomes	High risk	Stated 158 residents participated and 111 available for all three surveys but results for 60 presented
Selective reporting (reporting bias)	High risk	Stated Cohen-Mansfield Agitation Inventory measured but results not shown
Other bias	High risk	No adjustments made so potential for confounding. For baseline characteristics: no statistical tests completed, appeared to be some differences but unclear if statistically or clinically significant. Baseline differences in social behaviour

Diaz-Veiga 2014

Study characteristics

Methods	Study design: Controlled before-after study Number of facilities: 8 (3 intervention and 5 control)
Participants	N = 119 enrolled (Intervention: N = 60, control: N = 59) Mean age (SD): Intervention: 82.3 (5.7, mild cognitive impairment) 81.5 (7.4, severe cognitive impairment), control: 82.7 (8.0, mild cognitive impairment) 82.2 (8.0, severe cognitive impairment) % Female: Intervention: 79.8 (mild cognitive impairment) 82.1 (severe cognitive impairment), control: 78.1 (mild cognitive impairment) 82.1 (severe cognitive impairment) % Dementia: not reported Mean (SD) number of comorbidities: not reported Country: Spain Inclusion criteria: • Cognitive impairment

Diaz-Veiga 2014 *(Continued)*

- Experimental group: resided in one of the 8 day or permanent cohabitation units, where the interventions relating to "Etxean Ondo" were incorporated
- Control group: The members of the control group were identified from five distinct centres, three of which coincided with the location of the cohabitation units.

Exclusion criteria:

- Absence of cognitive impairment, measured by Lobo's Cognitive Mini Examination (MEC > 29)

Interventions	Name of intervention: Etxean Ondo Design features: Creation of domestic environments. "Comfortable, safe and accessible homelike environments, which expedite the daily life of the residents by integrating their important preferences, customs and activities" and "physical spaces were selected that were susceptible to be adapted to the features of domestic environments, favouring the incorporation of their own furniture and other decorative and important items both in public and private spaces". Other features that differed: The development of important activities and organisational processes based on the daily life and the resources of residents, families and professionals. Support staff who volunteered to work in the units. Increased staff ratio "support staff ratio was increased, reducing the staff rotation between the different areas in the centres, and providing them with continuous professional development" and "periodical meetings of the technical staff (doctor, nurse, psychologist, etc.) with the support teams were set up, changing the decision-making in relation to the care, with adaptations based on the information provided by the support staff, who act as "reference professionals" for the residents." Control: Provision of public health services in accordance with the health needs of the residents, the formal registration of care tasks and activities, and the prioritisation of safety both in the design of the spaces and the organisation.
Outcomes	The following outcomes (measurement scale) were reported: Quality of life (Quality of Life in Late-Stage Dementia: QUALID for severe cognitive impairment or Fumat for mild cognitive impairment) Follow-up: 6 months
Notes	Sponsorship source not reported. Conflicts of interest: None Ethical approval: Not stated

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	High risk	No randomisation
Allocation concealment (selection bias)	High risk	Controlled before-after study
Blinding of participants and personnel (performance bias) All outcomes	High risk	Blinding not feasible
Blinding of outcome assessment (detection bias) All outcomes	High risk	Blinding not feasible
Incomplete outcome data (attrition bias)	Unclear risk	Did not report loss to follow-up

Diaz-Veiga 2014 *(Continued)*

All outcomes

Selective reporting (reporting bias)	Low risk	Outcomes reported as per methods
Other bias	High risk	No adjustments made so potential confounding. Stated statistically different quality of life measurements between groups at baseline. Possible contamination through professional staff "reduced staff rotation" mentioned which indicates there may have still been some rotation, plus technical staff meetings

Elmstahl 1997

Study characteristics	
Methods	Study design: Controlled before-after study Number of facilities: 18 (14 corridor design and 4 non-corridor design)
Participants	N = 105 (Corridor design: N = 66; non-corridor design: N = 39) Mean age (SD): Corridor design: 82.9 (5.3), non-corridor design: not reported % Female: Corridor design: 89, non-corridor design: 87 % Dementia: 100 Mean (SD) number of comorbidities: not reported Country: Sweden Inclusion criteria: • Living with dementia and admitted to group living units in Malmo, Sweden during study period • Group living eligibility: dementia of Alzheimer's type or vascular dementia, care planning team judged home care situation as insufficient Exclusion criteria: • Not reported
Interventions	Type of intervention: building layout (comparison of group living units with a corridor design versus non-corridor design (L-shaped, square or H-shaped)) Design features: Built for 6-8 residents, with specially designed community area comprising living room, laundry, kitchen and dining room shared by the residents and staff. Each resident has a private area of approximately 25 m^2, furnished by the resident and included a toilet and shower. Located in ordinary blocks of flats outside institutions. Physical environment assessed by architect in standardised manner using Therapeutic Environment Screening Scale (TESS-2)
Outcomes	The following outcomes (measurement scale) were reported: Dyspraxia, hallucinations, lack of vitality, dysphasia, paranoia, aggressiveness, depression, clinical variations, restlessness, recent memory and identity (Organic Brain Syndrome Scale: OBS Scale) Follow-up: 12 months
Notes	Supported by the Swedish Council for Social Research. Conflicts of interest: Not stated. Ethical approval: Not stated

Elmstahl 1997 *(Continued)*

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	High risk	Controlled before-after study
Allocation concealment (selection bias)	High risk	Controlled before-after study
Blinding of participants and personnel (performance bias) All outcomes	High risk	Blinding not feasible
Blinding of outcome assessment (detection bias) All outcomes	High risk	No blinding
Incomplete outcome data (attrition bias) All outcomes	Low risk	> 90% follow-up; unlikely to bias results
Selective reporting (reporting bias)	High risk	In the methods, there was mention of measuring ADLs and MMSE but results for these have not been reported. Also 6-month data were not reported.
Other bias	Unclear risk	Potential residual confounding and baseline characteristics not shown by group. Significant differences in lack of vitality and restlessness at baseline. Adjusted analysis accounted for other symptoms.

Figueiro 2019

Study characteristics	
Methods	Study design: cluster-randomised trial (participants served as own controls) Number of facilities: 8
Participants	N = 52 Mean age (SD): 85.1 (7.1) % Female: 65.2% % Dementia: 100 Number of comorbidities: not reported Country: USA Inclusion criteria: diagnosis of dementia according to Diagnostic and Statistical Manual of Mental Disorders, Fourth Edition; a Mini Mental State Examination (MMSE) score between 4 and 24 points (indicating severe [≤ 10] to mild [< 25] dementia) or a Brief Interview for Mental Status (BIMS) score between 3 and 12 points (indicating severe [≤ 7] to moderate [8–12] cognitive impairment), depending on the particular facility's evaluation procedures; and a score > 5 (indicating sleep disturbance) on the Pittsburgh Sleep Quality Index (PSQI) questionnaire

Figueiro 2019 *(Continued)*

	Exclusion criteria: Major organ failure, a major illness, a history of head injury, uncontrolled generalised disorders (e.g. diabetes), obstructing cataracts, macular degeneration, blindness, or used psychotropic medicine. Those with severe sleep apnoea or restless legs syndrome were also excluded
Interventions	Lighting designed to provide high circadian stimulus. Custom-built floor luminaires, light boxes and light tables were used. Timers activated lights according to wake times and lights were placed in the person's bedroom or in the common area until 6 pm.
Outcomes	The following outcomes (measurement scale) were reported: Quality of life (Minimum Data Set Activities of Daily Living Scale (MDS-ADL)), behaviour (Cohen-Mansfield Agitation Inventory (CMAI)) and depression (Cornell Scale for Depression in Dementia (CSDD))
Notes	Sponsorship source: This research was funded by the National Institute on Aging (grant #R01AG034157); the following manufacturers are acknowledged for their provision of in-kind lighting products: GE Current, a Daintree company; OSRAM Sylvania; Ketra; and Sharp Corporation. Conflicts of interest: Neither the funding agency nor the in-kind contributors had any role in the design, methods, data analysis, or preparation of the manuscript. Figueiro, Plitnick, Roohan, Sahin, and Rea received research grant support from the National Institutes of Health, Office of Naval Research, The United States General Services Administration, and industry (Acuity Brands; Axis Lighting; GE Current, a Daintree company; OSRAM Sylvania; Ketra; USAI Lighting; Armstrong Ceilings and Walls; Philips Lighting; Cree; View Glass; Marriott International). Kalsher received research grant support from the National Institutes of Health. Ethical approval: Approved by the Rensselaer Polytechnic Institute Institutional Review Board

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Unclear risk	Unclear as to method of sequence generation
Allocation concealment (selection bias)	Unclear risk	Did not specify details
Blinding of participants and personnel (performance bias) All outcomes	Unclear risk	Details of blinding not reported
Blinding of outcome assessment (detection bias) All outcomes	Unclear risk	Details of blinding not reported
Incomplete outcome data (attrition bias) All outcomes	Unclear risk	No flow of participants reported. Reported data not available for 4 participants due to nonadherence and some data were not usable
Selective reporting (reporting bias)	Low risk	Trial registered
Other bias	Low risk	Participants served as own controls.

Frisoni 1998

Study characteristics

Frisoni 1998 *(Continued)*

Methods	Study design: Controlled before-after study Number of facilities: 43 (25 SCU and 18 control)
Participants	N = 66 (Special care unit (SCU): N = 31; control: N = 35) Mean age (SD): SCU: 81 (8), control: 81 (6) % Female: SCU: 71, control: 80 % Dementia: 100 Mean (SD) number of comorbidities: SCU: 18 (4), control: 19 (3) Country: Italy Inclusion criteria: Facilities • NHs of East Lombardia region and Milano area that admitted residents with dementia with some degree of behavioural disturbance expected to stay at least 3 months Patients • Newly admitted • Diagnosis of degenerative or vascular dementia according to accepted criteria, MMSE 21 or lower plus CDR 4 or lower plus at least one behavioural disturbance of mild to moderate severity • MMSW 16 or lower, CDR score 2-4, NPI total 24 or higher or score of 12 or more in at least one subscale Exclusion criteria: • MMSE 22 or higher, extended CDR scale 5 or higher (bed-bound) • 15 days or more between admission and communication • Incomplete data provided by NH physician in first screening form • History of mental insufficiency, psychosis or major depression
Interventions	Type of intervention: 10 two-bed rooms, a large wandering area, a dining room, and a separate area for structured activity (physical and occupational therapy). Exit doors were secured by magnetic locks opening with a digital code. Noxious stimuli were minimised, and wall colours were made neutral. Way-finding cues were used to help residents identify different areas.
Outcomes	The following outcomes (measurement scale) were reported: Delusions, hallucinations, agitation, anxiety, euphoria/elation, disinhibition, irritability/lability, abnormal motor behaviour, sleep and global behaviour (NPI), agitation (CMAI), depression, cognitive function (MMSE and Clinical Dementia Rating), function (Bedford Alzheimer's Nursing Severity Scale), function (Barthel Index), falls in 3 months, physical restraints Follow-up: 3 months
Notes	Supported by European Commission (DGV). Conflicts of interest: Not stated. Ethical approval: Not stated

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	High risk	Controlled before-after study

Frisoni 1998 *(Continued)*

Allocation concealment (selection bias)	High risk	Allocation not concealed
Blinding of participants and personnel (performance bias) All outcomes	High risk	Blinding not feasible
Blinding of outcome assessment (detection bias) All outcomes	High risk	Not blinded. Follow-up assessment carried out by same interviewer who carried out baseline assessment whenever possible.
Incomplete outcome data (attrition bias) All outcomes	Low risk	Appeared to be no loss to follow-up over 3 months
Selective reporting (reporting bias)	Low risk	All relevant outcomes in the methods section were reported in the results section.
Other bias	High risk	Possibility of residual confounding. High risk of falls outcome only; low risk for other outcomes. Higher risk of falls (Tinetti balance and gait scale) in traditional arm. Differences in behavioural disturbances at baseline (although not statistically significant) and no adjustments made

Galik 2021

Study characteristics	
Methods	Study design: cluster-randomised controlled trial Number of facilities: 12 (6 intervention and 6 control)
Participants	N = 336 (173 intervention, 163 control) Mean age (SD): 82.6 (10.1). Intervention: 82.7 (9.8), control: 82.5 (10.4) % Female: 72.0%. Intervention: 72.3%, control: 71.8% % Dementia: not reported Mean comorbidities (SD): 2.9 (1.6). Intervention: 2.8 (1.5), control: 3.1 (1.7) Country: USA Inclusion criteria: 55 years of age or older, able to speak English, currently living in the nursing home, and scored ≤ 15 on the Mini-Mental State Examination (MMSE) Exclusion criteria: receiving hospice or sub-acute rehabilitation
Interventions	Function and Behavior Focused Care for the Cognitively Impaired (FBFC). The FBFC Research Nurse worked with the facility Champion to assess the facility's policies and the environment to identify opportunities for physical activity and engaging in functional tasks as well as barriers to these activities. For example, corridors were evaluated for wide, clear areas for walking and outdoor access was assessed. In addition, the FBFC Nurse and Champion collaborated with the activities director and rehabilitation staff (as available) to determine opportunities for exercise classes within the facility. Barriers to physical activity, such as policies that unnecessarily restrict movement for fear of falls, and environments that lack rest areas and age-appropriate exercise materials also were assessed. Based on these

Galik 2021 *(Continued)*

	assessments, modifications in policy and the environment were made, such as increasing availability of recreational activities that included physical activity (i.e. horseshoes, resistance bands, physical activity, BINGO), having adequate supply of chairs in dining rooms to allow for transfer out of wheelchairs for meals, having safe access to the outdoors, placing a bench in a hallway to have a resting place when walking, providing long-handle sponges, no spill cups, adaptive utensils as appropriate, and changing the height of a toilet or bed to facilitate function.
Outcomes	The following outcomes (measurement scale) were reported: Depression (Cornell Scale for Depression in Dementia (CSDD)), behaviour (Cohen-Mansfield Agitation Inventory (CMAI)), resistiveness to care (Resistiveness to Care Scale) and function (Barthel Index)
Notes	Sponsorship source: National Institute on Aging grant R01 AG046217. Conflicts of interest: None. Ethical approval: Approved by a university-based institutional review board

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Low risk	Coin toss within matched pairs
Allocation concealment (selection bias)	Unclear risk	Not specified
Blinding of participants and personnel (performance bias) All outcomes	High risk	Blinding not feasible
Blinding of outcome assessment (detection bias) All outcomes	High risk	High for staff reported, functional ability, behaviour and mood
Incomplete outcome data (attrition bias) All outcomes	Unclear risk	Large loss to follow-up, 146 (30%) after randomisation due to MMSE but unclear which randomised group they belonged to. Other reasons: very roughly balanced follow-up 61% intervention group, 73% control group (119/163)
Selective reporting (reporting bias)	Low risk	All reported as per methods
Other bias	Unclear risk	Differences in baseline outcome measures but no statistical significance reported

Hopkins 2017

Study characteristics

Methods	Study design: Randomised trial (cross-over) Number of facilities: 8 (cross-over trial)
Participants	N = 80 enrolled; N = 69 post-intervention Mean age (SD): 85.8 (7.5) % Female: 86.3

Hopkins 2017 *(Continued)*

	% Dementia: not reported Mean (SD) number of comorbidities: not reported Country: England Inclusion criteria: • Resident of one of seven included care homes over 60 years of age • Willing and able to give written informed consent or their family spend time each day in communal rooms where lights were installed Exclusion criteria: • Did not meet inclusion criteria
Interventions	Type of intervention: lighting (blue-enriched lighting) Design features: High colour temperature (17000 K) blue-enriched white light in communal areas Control: Low colour temperature (4000 K) white light
Outcomes	The following outcomes (measurement scale) were reported: Behaviour and depression (Hospital Anxiety and Depression: HAD scale and Geriatric Depression Scale: GDS) Follow-up: 4 weeks
Notes	Sponsorship source: Cross-Council New Dynamics of Ageing (NDA) Initiative Conflicts of interest: There were no financial, personal, potential conflicts of interest in the conduct of the study or in the manuscript development. Although Philips Lighting supplied the light fitments, they had no part in the design of the protocol nor in the analysis of the data. Prof. Skene and Dr Middleton are co-directors of Stockgrand Ltd and Prof. Skene has in the past received research grant support from Philips. Dr. Luc Schlangen is an employee of Philips Research. Ethical approval: A favourable ethical opinion was obtained from the University of Surrey Ethics Committee and the care homes, whilst all research was carried out according to the Declaration of Helsinki 2008. Informed written consent was obtained from participants or their families where participants were unable to give consent themselves.

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Unclear risk	Described as randomised but did not specify randomisation
Allocation concealment (selection bias)	Unclear risk	Did not specify details
Blinding of participants and personnel (performance bias) All outcomes	High risk	No blinding reported
Blinding of outcome assessment (detection bias) All outcomes	High risk	No blinding reported
Incomplete outcome data (attrition bias)	High risk	69 completed study but 56 at most were analysed for included outcomes.

Hopkins 2017 *(Continued)*
All outcomes

Selective reporting (reporting bias)	Unclear risk	Paper did not report details of published study protocol or trial registration.
Other bias	Unclear risk	Age and sex reported for each care home at baseline appeared to be different, but no statistical tests performed and no other characteristics reported. Baseline outcomes measures reported in little detail

Kenkmann 2010

Study characteristics	
Methods	Study design: Controlled before-after study Number of facilities: 6 (3 intervention and 3 control)
Participants	N = 120 (Intervention: N = 57; control: N = 48) Mean age (SD): Intervention: 86.1 (6.7), control: 87.7 (6.8) % Female: Intervention: 67, control: 75 % Dementia: not reported Mean (SD) number of comorbidities: not reported Country: UK Inclusion criteria: • If informed assent provided (where the resident could not self-consent), the interview only went ahead if the resident appeared happy and relaxed during the process. Exclusion criteria: • Living in the care home less than two months
Interventions	Type of intervention: dining Design features: Food displayed for residents to see, fewer tables in dining room, tablecloths, flowers on table, white crockery with side plates for vegetables, drinks machine available at all times, biscuits, fruit, sandwiches and yoghurts on display available any time Other features that differed: Increased choice at meals, increased number of hot meal options at breakfast and evening meal, choice of meal at mealtime with change of mind accommodated, use of buffet and Bain-Marie to display options to residents, dining open for 90 minutes with several sittings of residents, visitors welcome, large variety of self-service snacks available Control: Limited choice at meals, only cold meal options available at breakfast and evening meal, residents make their meal selection in advance, meals at set times with single sitting, visitors rarely eat with residents, limited drinks and snacks available only on drinks trolley
Outcomes	The following outcomes (measurement scale) were reported: Cognitive function (Mini Mental State Examination: MMSE), behaviour and depression (Hospital Anxiety and Depression: HAD scale) and adverse events (number of falls) Follow-up: 12 months

Kenkmann 2010 *(Continued)*

Notes	Funded by Norfolk City Council Conflicts of interest: The research was funded by Norfolk County Council, and JB works for Norfolk County Council. These links did not affect the way that the data are presented. Ethical approval: Ethical approval for the study was obtained from the University of East Anglia, Faculty of Health, Ethics Committee. The trial was registered as ISRCTN86057119 (see http://www.controlled-tri- al-s.com/ISRCTN86057119).

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	High risk	Non-randomised trial
Allocation concealment (selection bias)	High risk	Non-randomised trial
Blinding of participants and personnel (performance bias) All outcomes	High risk	Blinding not feasible
Blinding of outcome assessment (detection bias) All outcomes	High risk	Primary outcome (falls) measured from the notes as reported by staff (who knew the allocation)
Incomplete outcome data (attrition bias) All outcomes	High risk	Significant incomplete outcome data (which authors themselves noted)
Selective reporting (reporting bias)	Low risk	No evidence of selective reporting as all outcomes described in methods were in results
Other bias	High risk	Potential residual confounding. Significant differences in baseline characteristics between groups at baseline

Marcy-Edwards 2011

Study characteristics

Methods	Study design: Repeated measures study with no control group Number of facilities: 2 (repeated measures study)
Participants	N = 34 Mean age: 77.8 % Female: 33 % Dementia: 100 Mean (SD) number of comorbidities: not reported Country: Canada Inclusion criteria:

Marcy-Edwards 2011 *(Continued)*

- A diagnosis of dementia
- Presence of one or more difficult to manage behaviours
- Living in a long-term care setting
- Consent from their legal guardian to participate
- Moderate to severe dementia as indicated by Global Deterioration Scale/Functional Assessment Staging (GDS/FAST) (138, 139) scores of 5 to 7 and Mini Mental State Exam (MMSE) (139, 140) score of less than 20
- Residence on the unit for a minimum of four weeks
- A minimum of one difficult-to-manage behaviour such as delusions, hallucinations, agitation/aggression, depression/dysphoria, anxiety, elation/euphoria, apathy/indifference, disinhibition, irritability/lability, aberrant motor behaviour, sleep and night-time behaviour disorders, and appetite and eating disorders

Exclusion criteria:

- Presence of intractable pain

Interventions	Type of intervention: Garden vignette Design features: Designated area that contained clusters of gardening and nature-related objects designed to both attract attention and encourage self-determined interaction and exploration. Identical vignettes were established on each unit directly opposite each other but separated by a five-foot high wall. Positioned in a highly visible, high traffic space. The vignette included all objects required to accomplish the activity of gardening: a sturdy garden centre table; soil, plastic pots, garden seeds, light plastic garden tools, and a plastic watering can; scented, colourful, edible plants; glossy gardening magazines with engaging pictures; and large artificial flowers to attract attention. When the garden vignette was in place, all residents had unobstructed exposure and access, 24 hours per day.
Outcomes	The following outcomes (measurement scale) were reported: Behaviour (Neuropsychiatric Inventory for Nursing Homes: NPI-NH and NPI-NH-Occupational Distress: NPI-NH-OD) Follow-up: Placed for 14 days then removed for 14 days and process repeated once
Notes	Sponsorship source: Canadian Nurses Foundation, Dr. Ann Beckingham Scholarship and the Alberta Registered Nurses Educational Trust Scholarship. Conflicts of interest: Not stated. Ethical approval: The Institutional Ethics Review Board of the University of Calgary granted ethics approval

Risk of bias

Bias	Authors' judgement	Support for judgement
Allocation concealment (selection bias)	High risk	Repeated measures study, no control group
Incomplete outcome data (attrition bias) All outcomes	Low risk	Lowest follow-up for one outcome was 29/34 = 85%.
Selective reporting (reporting bias)	Low risk	All outcomes reported as stated in methods
Other bias	Low risk	Same study participants used as repeated measures study. Intervention removed during washout phases

Marcy-Edwards 2011 *(Continued)*

Intervention independent of other changes (ITS)	Unclear risk	No reported compelling evidence that intervention was independent, nor that that intervention was not independent of other changes in time
Shape of the intervention effect pre-specified (ITS)	High risk	Baseline measurement spread over 4 weeks, performed at time of admission, then intervention effect in second week of vignette rather than at the time of intervention
Intervention unlikely to affect data collection (ITS)	Low risk	Sources and methods of data collection were the same before and after the intervention.

Mathey 2001

Study characteristics	
Methods	Study design: Cluster-randomised controlled trial Number of facilities: 4 wards in one nursing home randomised (2 Intervention wards and 2 control wards)
Participants	N enrolled: Intervention: 21, control: 17. N analysed: Intervention: 20, control: 14 Mean age (SD): Intervention: 82.6 (7.5), control: 78.2 (7) % Female: Intervention: 66.6, control: 70 % Dementia: Not reported Mean (SD) number of comorbidities: Intervention: 3 (1.2), control: 2.3 (1.3) Country: The Netherlands. Inclusion criteria: • Resident in a nursing home from one of the four wards invited to join the study • Older than 65 years • Resident for more than 3 months at the start of the study Exclusion criteria: • Parenteral nutrition • Terminal phase of a disease • A specific exclusion criterion for the analyses of biochemical indicators of health was applied for the patients with severe anaemia.
Interventions	Type of intervention: Dining Design features: Plant or flowers placed on every table and sufficient lighting. Background music chosen by the patients. Just before meals, tables were dressed up in the dining room with appropriate tablecloths and dinner plates, trays and covers removed from the table, carers out of patients' sight. Other features that differed: Dishes served on dinner plate per course and per table, simultaneous start of the meal per table, and possibility of receiving help when necessary. Breakfast and supper served per table and at patients' discretion: no ready-to-eat sandwiches. Continuous availability of coffee, tea, and soft drinks such as fruit juices outside meal periods. Rescheduling nursing staff timetable to have enough nurses at mealtime (one nurse for two patients). No walking around of the nursing staff in the dining room during meals. Medications handed out before the start of the meal to distinguish medical care and meals. No interference with patients' meal: no questions or wishes for the next meal. Programme monitoring every trimester by both nursing staff and researchers. No cleaning activities in the

Mathey 2001 *(Continued)*

	dining room during meal consumption. Immediately after meals, tidying up the dining-room for the social activities
Outcomes	The following outcomes (measurement scale) were reported: Quality of life (Sickness Impact Profile: SIP and Dutch version of the Philadelphia Geriatric Center Moral Scale: PGCMS) Follow-up: 4 months, 8 months and 12 months
Notes	Sponsorship source: Not reported. Conflicts of interest: Not stated. Ethical approval: The study protocol was approved by the ethical committee of the nursing home.

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Unclear risk	Randomisation method not stated
Allocation concealment (selection bias)	Unclear risk	No details reported
Blinding of participants and personnel (performance bias) All outcomes	High risk	Blinding not feasible
Blinding of outcome assessment (detection bias) All outcomes	Unclear risk	Not reported
Incomplete outcome data (attrition bias) All outcomes	High risk	58% loss to follow-up for quality of life outcomes
Selective reporting (reporting bias)	Unclear risk	Protocol or trial registration not mentioned
Other bias	High risk	Some clinical differences between groups in baseline characteristics. Statistical significance of differences not reported. Likely some contamination as wards randomised but within one nursing home

Nijs 2006

Study characteristics

Methods	Study design: Cluster-randomised controlled trial Number of facilities: 6 (3 intervention and 3 control)
Participants	N enrolled: Intervention: 133, control: 112. N analysed: Intervention: 95, control: 83 Mean age (SD): Intervention: 78 (11.1), control: 75 (9.9) % Female: Intervention: 70, control: 55

Nijs 2006 *(Continued)*

	% Dementia: 0 Mean (SD) number of comorbidities: Intervention: 3 (1.4), control: 3 (1.6) Country: The Netherlands Inclusion criteria: • Residing in an eligible nursing home ward (medium-sized, general population, two wards for chronic somatic disease, long-term care, cover different parts of country, similar in organisational characteristics) Exclusion criteria: • Terminal phase of disease • Needing total parenteral feeding • Unable to give informed consent owing to a physical or mental condition
Interventions	Type of intervention: Dining Design features: Tablecloths, normal plates and glasses, full cutlery, and flower arrangements Other features that differed: Cooked meals served on table, greater choice at meals, residents decide when meal begins, staff sit down with residents Control: No tablecloth, plastic cups, pre-designed plate, divided into 3 sections, residents wear bibs. Cooked meals served individually on pre-plated tray, residents choose meals two weeks before, staff do not sit down, no choice in meal times
Outcomes	The following outcomes (measurement scale) were reported: Quality of life (Dutch Quality of Life of Somatic Nursing Home Residents questionnaire) and function (Nursing Home Physical Performance test) Follow-up: 6 months
Notes	Sponsorship source: Netherlands Organisation for Health Research and Development. Conflicts of interest: None. Ethical approval: This study was approved by the Ethical Committees of the nursing homes and the Medical Ethical Committee of Wageningen University.

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	High risk	Non-random component in the sequence generation (e.g. using first letter of ward name)
Allocation concealment (selection bias)	Low risk	Randomisation at start of study
Blinding of participants and personnel (performance bias) All outcomes	High risk	Blinding not feasible
Blinding of outcome assessment (detection bias) All outcomes	Unclear risk	Allocation was blinded but did not describe details of whether the analyses were blinded

Nijs 2006 *(Continued)*

Incomplete outcome data (attrition bias) All outcomes	High risk	Follow-up < 80%
Selective reporting (reporting bias)	Low risk	All outcomes in methods reported in results
Other bias	High risk	Baseline differences between groups in age, gender and length of stay

Riemersma-vanDerLek 2008

Study characteristics	
Methods	Study design: 2 x 2 factorial randomised trial Number of facilities: 12 (6 intervention and 6 control)
Participants	N enrolled: intervention: 49, control: 45. N analysed: Intervention: 47, control: 40 Mean age (SD): Intervention: 85 (6), control: 85 (5) % Female: Intervention: 91.8, control: 88.9 % Dementia: 100 Mean (SD) number of comorbidities: not reported Country: The Netherlands Inclusion criteria: • Resident at one of 12 facilities who agreed to participate (assisted-care facilities in which residents have their own apartment where they sleep and retreat, but spend most of the daytime in a common living room supervised by caregivers) Exclusion criteria: • Nil other
Interventions	Type of intervention: Lighting (bright light) Design features: Light exposure was manipulated by installing a large number of ceiling-mounted fixtures with Plexiglas diffusers containing an equal amount of Philips TLD 840 and 940 fluorescent tubes in the common living room. Lights were on daily between approximately 9 am and 6 pm. Light intensity was increased to ± 1000 lux between 10 am and 6 pm at the 6 light facilities (active condition) Control: An equal number of fixtures were installed, but these contained only half of the tubes, accommodated concealed band-stop filters, and were installed at a greater distance from the eyes.
Outcomes	The following outcomes (measurement scale) were reported: Behaviour (Neuropsychiatric Inventory: NPI), depression (Cornell Scale for Depression in Dementia: CSDD), withdrawn behaviour (sub-scale of the Multi Observational Scale for Elderly Subjects: MOSES), agitation (Cohen-Mansfield Agitation Inventory: CMAI), positive and negative mood (Philadelphia Geriatric Centre Affect Rating Scale: PGCARS), cognitive function (Mini Mental State Examination: MMSE), and function (Nurse-informant adaptation of the scale by Katz and colleagues)

Riemersma-vanDerLek 2008 *(Continued)*

	Follow-up: 6 weeks, 6 months, 12 months, 18 months and 24 months
Notes	Sponsorship source: Financial and material support were provided by the Netherlands Organisation for Health Research, The Hague, by grants 0028-300-30 and 907-00-012; the Netherlands Organisation for Scientific Research, The Hague, by grants 016.025.041 and 051.04.010; the Stichting De Drie Lichten, Leiden;Stichting RVVZ; Zeist by grant 01-220; Japan Foundation for Aging and Health; Hersenstichting Nederland by grant 11F04-2.47; Internationale Stichting Alzheimer Onderzoek by grant 05511. Philips Lighting BV, Braun, and Cambridge Neurotechnology supplied material for this study at reduced cost. Conflicts of interest: Reported no financial disclosures Ethical approval: The Medical Ethics Committees of Hospital De GelderseVallei, Ede, and the VU University Medical Center, Amsterdam, the Netherlands, approved the study.

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Low risk	Random number generator
Allocation concealment (selection bias)	Low risk	Managed by a research assistant external to the study
Blinding of participants and personnel (performance bias) All outcomes	Low risk	Stated caregivers blinded and no significant difference when they asked caregivers to guess their facilities light status
Blinding of outcome assessment (detection bias) All outcomes	Low risk	Assessors were blinded to allocation.
Incomplete outcome data (attrition bias) All outcomes	High risk	High loss to follow-up
Selective reporting (reporting bias)	Low risk	Registered on clinical trial registry - all outcomes reported
Other bias	Low risk	No significant differences in baseline characteristics between groups. No differences in baseline outcome variables. Light exposure randomised by facility protecting against contamination

Te Boekhorst 2009

Study characteristics

Methods	Study design: Controlled before-after study Number of facilities: 26 (19 intervention and 7 control)
Participants	N enrolled: Intervention: 79, control: 132. N analysed: Intervention: 67, control: 97 Mean age (95% confidence interval): Intervention: 81.2 (79.7, 82.7), control: 83.6 (81.1, 86.1) % Female: Intervention: 91.0, control: 73.2 % Dementia: 100

Te Boekhorst 2009 *(Continued)*

Mean (SD) number of comorbidities: not reported

Country: The Netherlands

Inclusion criteria:

- Psychogeriatric group living homes and psychogeriatric nursing homes or nursing homes with psychogeriatric units were selected.

Group living homes

- Maximum 6 residents
- Maximum 6 units
- Situated more than 200 m from the nursing home to which they belonged
- Prepared their own meals
- Built more than 2 years prior to the start of the study

Traditional nursing homes

- Built according to the Dutch 1997 Building Regulation for Nursing Homes
- 20 residents per unit

Exclusion criteria:

- Residents not surviving to 6 months

Interventions	Type of intervention: home-like model Design features: Psychogeriatric group living homes. Criteria based on Concept Map that defined group living care (a) had a maximum of six residents; (b) had a maximum of six units; (c) were situated more than 200 meters from the nursing home to which they belonged; (d) prepared their own meals and (e) were built more than 2 years prior to the start of the study. Control: Psychogeriatric nursing homes or nursing homes with psychogeriatric units. Built according to the Dutch 1997 Building Regulation for Nursing Homes, as these facilities offer, among other structural improvements, only single bedrooms. Large-scale: more than 20 residents per unit were included in the study.
Outcomes	The following outcomes (measurement scale) were reported: Quality of life (Dementia Quality of Life: DQoL), behaviour (Revised Memory and Behavior Problems Checklist: RMBPC and the Neuropsychiatric Inventory-Questionnaire: NPI-Q), cognitive function (Standardised Mini Mental State Examination: S-MMSE), function (Interview for the Deterioration of Daily Living activities in Dementia: IDDD), social engagement (Revised Index of Social Engagement: RISE from the Resident Assessment Instrument: RAI) and physical restraints (nursing home physician or psychologist asked whether residents were prescribed one or more physical restraints) Follow-up: 6 months
Notes	Sponsorship source: Dutch ministry of Health Welfare and Sport, Foundation Het Zonnehuis, ActiZ organisation of care entrepreneurs The authors had no conflicts of interests during any part of the study. Sponsors had no role in the design, collection, analysis and interpretation of the data, nor in writing the report and the decision to submit it for publication. Ethical approval: The study was approved by the Medical Ethics Committee of the National Institute of Mental Health and Addiction.

Risk of bias

Bias	Authors' judgement	Support for judgement

Te Boekhorst 2009 *(Continued)*

Random sequence generation (selection bias)	High risk	Controlled before-after study
Allocation concealment (selection bias)	High risk	Controlled before-after study
Blinding of participants and personnel (performance bias) All outcomes	High risk	Blinding not feasible
Blinding of outcome assessment (detection bias) All outcomes	High risk	Blinding not feasible
Incomplete outcome data (attrition bias) All outcomes	High risk	< 80% follow-up
Selective reporting (reporting bias)	Low risk	All outcomes reported as stated in methods
Other bias	High risk	Potential residual confounding. Significant differences in cognition (MMSE) and depression scores at baseline

Wolf-Ostermann 2012

Study characteristics	
Methods	Study design: Controlled before-after study Number of facilities: 112 (89 intervention and 23 control)
Participants	N enrolled: Intervention: 34, control: 22. N analysed: Intervention: 20, control: 13 Mean age (SD): Intervention: 83.4 (8.1), control: 81.2 (10.4) % Female: Intervention: 76.9, control: 23.1 % Dementia: 100 Mean (SD) number of comorbidities: not reported Country: Germany Inclusion criteria: • New residents of SHA and SCU with dementia in Berlin 1 July-31 Dec 2008 • Established diagnosis dementia - MMSE 24 or below • Moving into SHA or SCU within 14 days • Control (SCU): Admission criteria were eligibility to benefits under the long-term care insurance scheme, a medical diagnosis of irreversible dementia and a score of less than 18 points according to the MMSE, severe behavioural problems according to the modified Cohen-Mansfield Agitation Inventory and being able to participate in group activities and general group social life. Exclusion criteria: • Not reported

Wolf-Ostermann 2012 *(Continued)*

Interventions	Type of intervention: home-like model Design features: Small-scale living shared housing arrangements were completely disconnected from traditional nursing homes. Often situated in large apartments in mostly urban settings, mostly 6-8 people, which had typical structures of a flat with a kitchen, a living room and private bedrooms Control: Special-care unit for people with dementia. Admission criteria for special-care unit for people with dementia in Berlin were eligibility to benefits under the long-term care insurance scheme, a medical diagnosis of irreversible dementia and a score of less than 18 points according to the MMSE, severe behavioural problems according to the modified Cohen-Mansfield Agitation Inventory and being able to participate in group activities and general group social life.
Outcomes	The following outcomes (measurement scale) were reported: Quality of life (Dementia-specific QUALIDEM), behaviour (Neuropsychiatric Inventory for Nursing Homes: NPI-NH), cognitive function (Mini Mental State Examination: MMSE and Global Deterioration Scale: GDS to assess severity of dementia) and function (Barthel ADL Index) Follow-up: 6 months and 12 months
Notes	Sponsorship source: Grant of the German Federal Ministry of Health 'Leuchtturmprojekt Demenz' Conflicts of interest: Not stated Ethical approval: The study was approved by the Medical Ethics Committee of Charité–Universitätsmedizin Berlin (application number EA1/109/08).

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	High risk	Controlled before-after study
Allocation concealment (selection bias)	High risk	Controlled before-after study
Blinding of participants and personnel (performance bias) All outcomes	High risk	Blinding not feasible
Blinding of outcome assessment (detection bias) All outcomes	High risk	Blinding not feasible
Incomplete outcome data (attrition bias) All outcomes	High risk	Large loss to follow-up; not balanced between groups
Selective reporting (reporting bias)	Low risk	Outcomes reported as per methods
Other bias	High risk	Potential residual confounding. Significant differences in gender at baseline

Wylie 2001

Study characteristics

Wylie 2001 *(Continued)*

Methods	Study design: Controlled before-after study Number of facilities: 5 (3 intervention and 2 control)
Participants	N enrolled: Intervention: 41, control: 59. N analysed: Intervention: 25, control: 45 Mean age: Not reported % Female: Not reported % Dementia: Not reported Mean (SD) number of comorbidities: not reported Country: USA Inclusion criteria: Facilities • Experimental: Texas nursing homes initiating the implementation process of the Eden Alternative™ model in their respective facilities • Control: Texas nursing homes not initiating the Eden Alternative™ model agreed to participate. Residents • Facility social workers' assessment of the residents' cognitive ability to understand and complete questionnaires • Agree to participate
Interventions	Name of intervention: Eden alternative Design features: Human habitat model - pets, plants and children. Imbued daily life with variety and spontaneity by creating an environment in which unexpected and unpredictable interactions and happenings can take place. Other features: Provided daily opportunities to give as well as receive care by promoting resident participation in the daily round of activities that are necessary to maintain the Human Habitat. De-emphasised the role of prescription drugs in the residents' daily lives and committed those resources to the maintenance and growth of the Human Habitat. Leadership that placed the need to improve resident quality of life over and above the inevitable objections to change Control: Traditional nursing home
Outcomes	The following outcomes (measurement scale) were reported: Quality of life (Life Satisfaction Index: LSI) Follow-up: 6 months, 12 months and 18 months
Notes	Sponsorship source: Unclear Conflicts of interest: Not stated Ethical approval: Not stated

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	High risk	Not randomised
Allocation concealment (selection bias)	High risk	Controlled before-after study

Wylie 2001 *(Continued)*

Blinding of participants and personnel (performance bias) All outcomes	High risk	Blinding not feasible
Blinding of outcome assessment (detection bias) All outcomes	High risk	Blinding not feasible
Incomplete outcome data (attrition bias) All outcomes	High risk	Loss to follow-up 30% by second data collection point
Selective reporting (reporting bias)	Low risk	Outcomes reported as in methods
Other bias	High risk	Potential residual confounding. Some resident and staff baseline characteristics reported in Table 1, p. 15, no statistical comparisons performed. Differences in staff turnover between facilities. Difference in payer type and racial mix for Eden model. Significant difference in proportion of payers for Eden vs control (reviewer calc: Eden 301/410 vs 25/313 control; P < 0.0000001 Chi-square Epionline). Some contamination; one control facility commenced implementing the Eden alternative and then abandoned.

Yoon 2015

Study characteristics	
Methods	Study design: Controlled before-after study Number of facilities: 13 (9 intervention and 4 control)
Participants	N = 242 (Intervention: N = 93; control: N = 149) Mean age (SD): Intervention: 87.2 (7.2), control: 85.8 (9.7) % Female: Intervention: 73.1, control: 73.9 % Dementia: Intervention: 55.9, control: 50.0 Mean (SD) number of comorbidities: Intervention: 1.9 (1.2), control: 2.3 (1.4) Country: USA Inclusion criteria: • Residing in included nursing home for at least six months Exclusion criteria: • Admitted for short-term rehab or hospice at the start of their stay
Interventions	Type of intervention: home-like model Name of intervention: Green House model Design features: Home-like environment, Cluster of 2 or 3 homes with 10 residents each, private bedroom and bathroom, large common living and dining room, no nurses stations, medication carts, paging systems

Yoon 2015 *(Continued)*

	Other features that differed: Organisational changes to support resident quality of life, care staff have diverse roles and greater autonomy and responsibility in daily care. Control: Traditional large scale nursing homes, hospital-like features such as nurses stations, medication charts, paging systems. Traditional hierarchical organisational structure and traditional care staff roles
Outcomes	The following outcomes (measurement scale) were reported: Social engagement (Index of Social Engagement: ISE), depressive symptoms (Mood Scale Score: MSS), function (ADL long-form scale) and cognitive function (Cognitive Performance Scale: CPS) Follow-up: Up to 18 months
Notes	Study partially supported by a grant from the Robert Wood Johnson Foundation (Grant 66360; PI: SDH) and the Clinical and Translational Science Award Program, through the NIH National Center for Advancing Translational Sciences (grant UL1TR000427; BJB) Conflicts of interest: None Ethical approval: Not stated

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	High risk	Controlled before-after study
Allocation concealment (selection bias)	High risk	Controlled before-after study
Blinding of participants and personnel (performance bias) All outcomes	High risk	Blinding not feasible
Blinding of outcome assessment (detection bias) All outcomes	High risk	Blinding not feasible
Incomplete outcome data (attrition bias) All outcomes	High risk	High loss to follow-up (62%)
Selective reporting (reporting bias)	Unclear risk	Many outcomes on MDS so unclear how outcomes were decided
Other bias	High risk	Potential residual confounding. Significant difference in comorbidities at baseline

ADLs: Activities of Daily Living
BIMS: Brief Interview for Mental Status
CDR: Clinical Dementia Rating
CMAI: Cohen-Mansfield Agitation Inventory
CPS: Cognitive Performance Scale
CSDD: Cornell Scale for Depression in Dementia
DEMQOL: Dementia Quality of Life questionnaire
DQoL: Dementia Quality of Life

DSM-III: Diagnostic and Statistical Manual of Mental Disorders Third Edition
EAT: Environment Audit Tool
FAST: Fuctional Assessment Staging
FBFC: Function and Behavior Focused Care
GDS: Geriatric Depression Scale
GH: GreenHouse
HAD: Hospital Anxiety and Depression Scale
IDDD: Interview for the Deterioration of Daily Living activities in Dementia
ISE: Index of Social Engagement
MDS: Minimum Data Set
MEC: Mini-Examination Cognitive
MMSE: Mini Mental State Examination
MOSES: Multi Observational Scale for Elderly Subjects
MSS: Mood Scale Score
NDA: New Dynamics of Aging
NH: Nursing Home
NOSGER: Nurses Observation Scale for Geriatric Patients
NPI-(Q): Neuropsychiatric Inventory Questionnaire
OBS: Organic Brain Syndrome
OD: Occupational Distress
OSCAR: Online Survey, Certification, and Reporting
PCC: Person-Centred Care
PCE(CAT): Person-Centred Environment (Care Assessment Tool)
PGCARS: Philadelphia Geriatric Centre Affect Rating Scale
PGCMS: Philadelphia Geriatric Center Moral Scale
PSQI: Pittsburgh Sleep Quality Index
QUALID: Quality of Life in Late-Stage Dementia
QUALIDEM: A Dementia-Specific Quality of Life measure
QUIS: Quality of Interactions Schedule
RAI: Resident Assessment Instrument
RFI: Room for Improvement
RISE: Revised Index of Social Engagement
RMBPC: Revised Memory and Behavior Problems Checklist
SAS: Statistial Analytics System
SCU: Special Care Unit
SD: Standard Deviation
SHA: Shared Housing Arrangement
SIP: Sickness Impact Profile
TESS-2: Therapeutic Environment Screening Scale-2
UE: Usual Environment
vs.: versus

Characteristics of excluded studies *[ordered by study ID]*

Study	Reason for exclusion
Auer 2017	Longitudinal study but not before-after (no measure on admission to facility) and only one intervention site
Barrick 2010	Majority of participants were from a hospital setting and could not separate out those who were from a residential care environment.
Bergman-Evans 2004	One intervention and one control site
Bonardi 1989	One intervention and one control site
Bond 1999	One intervention and one control site
Chafetz 1991	One intervention and one control site

Study	Reason for exclusion
Chang 2013	One intervention and one control site
Cohen-Mansfield 1998	One intervention and one control site
Coleman 2002	One intervention and one control site
De Boer 2017	Longitudinal study but not before-after (no measure on admission to facility)
De Rooij 2012	Longitudinal study but not before-after (no measure on admission to facility)
Falk 2009	Longitudinal study but not before-after (no measure on admission to facility)
Giggins	Before-after study with one nursing home and no comparator group
Hermer 2017	Only one intervention site.
Holmes 1990	Longitudinal study but not before-after (no measure on admission to facility)
Inventor 2018	Only one control and one intervention site
Kane 2007	Only one intervention site
Klosinska	Before-after study with one nursing home and no comparator group
Kok 2017	One intervention and one control site
Kok 2018	Only one intervention and one control site
Kubsch 2018	Only one intervention and one control site
Lee 2016	One intervention and one control site
Lum 2008	Only one intervention site
Molony 2011	One intervention and one control site
O'Connor 1991	One intervention and one control site
Palm 2019	Longitudinal study but not before-after (no measure on admission to facility)
Pomeroy 2011	Repeated measures without measures before the intervention
Potter 2018	Longitudinal study but not before-after (no measure on admission to facility)
Reimer 2004	Only one intervention site
Scott 2014	Only one control site
Steiner 2020	Only one control site
Varshawsky	Before-after study with one nursing home and no comparator group
Verbeek 2014	Longitudinal study but not before-after (no measure on admission to facility)

Characteristics of studies awaiting classification *[ordered by study ID]*

Kolberg 2020

Methods	Cluster-randomised controlled trial
Participants	69 participants Inclusion criteria: • ≥ 60 years and in long-term care (> 4 weeks) • had dementia in accordance with DSM-5 • had either sleep/circadian rhythm disturbances, BPSD as identified by NPI-NH, or severely reduced ADL function • provided written informed consent if the participant had capacity or, if not, a written proxy informed consent from a legally authorised representative Exclusion criteria: • blind or might otherwise not benefit from light • took part in another trial • had a condition contra-indicated to the intervention • had an advanced, severe medical disease/disorder and/or expected survival less of than 6 months or other aspects that could interfere with participation • were psychotic or had a severe mental disorder
Interventions	Light-emitting diode (LED) ceiling-mounted bright light solution that was installed in the common rooms of four intervention units. The light setup was delivered by Glamox, using a number of square LED units (Glamox, 1 x C95 48 CCT 6,500 K MP 47 W/4,702 lm). Glamox engineers calculated the number of LED units needed to provide the target light levels in each common room, accounting for the number and direction of windows. The LED units were programmed to provide 400 lux and 3,000 K (measured vertically) from 07:00-10:00, 1,000 lux and 6,000 K from 10:00 to 15:00, 400 lux and 3,000 K from 15:00-18:00, and 100 lux and 2,500 K from 18:00-21:00. Light values gradually changed across 30 minutes.
Outcomes	Depression: Cornell Scale for Depression in Dementia (CSDD) Global behaviour: Neuropsychiatric Inventory Nursing Home Version (NPI-NH)
Notes	Sponsorship source: The dissertation was part of the public sector Ph.D. scheme by the Research Council of Norway (Sponsor's Protocol Code 259987/H40), where the Department of Health and Care, City of Bergen, has been the candidate's employer. The candidate also received funding from Thordis and Johannes Gahrs Fund for Promoting Gerontopsychiatric Research. The trial received funding for the light fittings used in the trial from the Rebekka Ege Hegermanns Grant and the GC Rieber Foundations. Conflicts of interest: None Ethical approval: The trial was approved by the Regional Committee for Medical and Health Research Ethics, Health Region South East (project no. 2016/2246).

ADL: Activities of Daily Living
BPSD: Behavioural and Psychological Symptoms of Dementia
CSDD: Cornell Scale for Depression in Dementia
DSM-5: Diagnostic and Statistical Manual of Mental Disorders Fifth Edition
LED: Light-emitting Diode
NH: Nursing Home
NPI: Neuropsychiatric Inventory

Characteristics of ongoing studies *[ordered by study ID]*

Willemse 2011

Study name	Nursing home care for people with dementia and residents' quality of life, quality of care and staff well-being: design of the Living Arrangements for people with Dementia (LAD)-study
Methods	Non-randomised study with a control group; follow-up every two years
Participants	12 residents and 15 healthcare staff randomly selected from each of the 150 living arrangements (30 living arrangements from five different living arrangements: traditional large-scale nursing homes, nursing home wards in a home for the aged, large nursing home where group living home care was provided, group living homes nearby the mother facility and stand-alone group living homes in the community). Healthcare staff were excluded if they were not working on a permanent basis (temporary staff and student-nurses). Inclusion criteria: • People with a primary diagnosis of dementia • Healthcare staff were randomly selected from 30 living arrangements for each of five categories of living arrangements as per Interventions. Exclusion criteria: • Not reported
Interventions	Traditional large-scale nursing homes, nursing home wards in a home for the aged, large nursing home where group living home care was provided, group living homes nearby the mother facility and stand-alone group living homes in the community
Outcomes	**Resident outcomes:** Quality of life: Quality of life (QUALIDEM) Pain (subscale from Minimum Data Set of the Resident Assessment Instrument: MDS:RAI) Quality of care: Physical restraints (type and number of times used per resident) Psychotropic drugs (type and number of times used per resident) Client satisfaction (Consumer Quality Index: CQ-Index) Approach to dementia (Approach to Dementia Questionnaire ADQ) Involvement in activities (subscale from MDS:RAI) **Staff outcomes:** Job satisfaction (subscale job satisfaction from The Leiden Quality of Work Questionnaire: LQWQ) Burnout complaints (Utrecht Burnout Scale: UBOS) Workload (subscale from LQWQ) Autonomy (subscale from LQWQ) Social support (subscale from LQWQ)
Starting date	Unclear
Contact information	bwillemse@trimbos.nl

Willemse 2011 *(Continued)*

	Netherlands Institute of Mental Health and Addiction (Trimbos-Institute), Utrecht, The Netherlands
Notes	Sponsorship source: Ministry of Health, Welfare and Sports The study is a national monitoring study in the Netherlands which will collect data every two years. A number of cross-sectional analyses from the study have been published that are not eligible for inclusion in this review (Willemse 2014; Willemse 2015; Willemse 2016) Conflicts of interest: None Ethical approval: data of people with dementia were collected via observation by the healthcare staff. For these reasons, this study did not come within the scope of the Medical Research Involving Human Subjects Act (WMO) and therefore it did not need approval. We came to this decision after consultation of a representative of the Medical Ethics committee METiGG.

ADQ: Approach to Dementia Questionnaire
CQ-Index: Consumer Quality Index
LAD: Living Arrangements for people with Dementia
LQWQ: The Leiden Quality of Work Questionnaire
MDS:RAI: Minimum Data Set of the Resident Assessment Instrument
QUALIDEM: Dementia-specific Quality of Life measure
UBOS: Utrecht Burnout Scale

DATA AND ANALYSES

Comparison 1. Home-like vs. traditional environment

Outcome or subgroup title	No. of studies	No. of participants	Statistical method	Effect size
1.1 Quality of life	1		Other data	No numeric data
1.2 Behaviour, mood and depression	5		Other data	No numeric data
1.2.1 Global behaviour	3		Other data	No numeric data
1.2.2 Depression	2		Other data	No numeric data
1.2.3 Behaviour subdomains	2		Other data	No numeric data
1.2.4 Social engagement	2		Other data	No numeric data
1.3 Function	4		Other data	No numeric data
1.4 Global cognitive function	4		Other data	No numeric data
1.5 Quality of care	1		Other data	No numeric data
1.6 Serious adverse effects	1		Other data	No numeric data

Analysis 1.1. Comparison 1: Home-like vs. traditional environment, Outcome 1: Quality of life

Quality of life

Study	Measure	Home-like	Traditional	Sample size	Reported significance

Wolf-Ostermann 2012	QUALIDEM -Feeling at home (adjusted, mean) (higher scores = better)	Baseline: 55.1 6 months: 65.5 12 months: 77.4	Baseline: 58.7 6 months: 65.5 12 months: 83.2	33	Group differences in trends over time adjusted for gender and stage of dementia: P = 0.674
	QUALIDEM -Care relationship (adjusted, mean) (higher scores = better)	Baseline: 68.2 6 months: 74.2 12 months: 90.5	Baseline: 69.5 6 months: 58.0 12 months: 58.9	33	P = 0.065
	QUALIDEM -Positive affect (unadjusted mean (SD)) (higher scores = better)	Baseline: 64.3 (24.7) 6 months: 75.0 (23.2) 12 months: 79.2 (20.0)	Baseline: 68.8 (21.7) 6 months: 76.5 (23.3) 12 months: 81.2 (23.5)	33	P = 0.683
	QUALIDEM -Negative affect (unadjusted mean (SD)) (higher scores = better)	Baseline: 49.4 (28.7) 6 months: 53.6 (25.7) 12 months: 61.7 (23.0)	Baseline: 57.7 (30.6) 6 months: 59.8 (22.2) 12 months: 58.5 (30.0)	33	P = 0.373
	QUALIDEM -Social isolation (unadjusted, mean (SD)) (higher scores = better)	Baseline: 77.8 (20.7) 6 months: 70.6 (24.3) 12 months: 67.8 (22.2)	Baseline: 61.5 (25.9) 6 months: 63.2 (26.6) 12 months: 59.8 (28.8)	33	P = 0.456
	QUALIDEM -Social relations (unadjusted, mean (SD)) (higher scores = better)	Baseline: 61.1 (22.1) 6 months: 67.5 (22.9) 12 months: 68.1 (18.8)	Baseline: 47.9 (17.5) 6 months: 66.2 (20.7) 12 months: 59.8 (14.9)	33	P = 0.947
	QUALIDEM -Positive self-image (unadjusted, mean (SD)) (higher scores = better)	Baseline: 67.8 (28.9) 6 months: 62.0 (23.5) 12 months: 68.6 (25.5)	Baseline: 69.7 (26.3) 6 months: 65.3 (33.8) 12 months: 68.5 (33.8)	33	P = 0.990
	QUALIDEM -Restless tense behaviour (unadjusted, mean (SD)) (higher scores = better)	Baseline: 46.7 (34.3) 6 months: 53.9 (32.1) 12 months: 53.9 (36.3)	Baseline: 45.3 (32.9) 6 months: 54.7 (35.0) 12 months: 54.7 (32.9)	33	P = 0.226
	QUALIDEM -Having something to do (unadjusted, mean (SD)), (higher scores = better)	Baseline: 52.6 (32.5) 6 months: 51.8 (64.6) 12 months: 53.9 (33.1)	Baseline: 29.2 (28.8) 6 months: 62.5 (24.8) 12 months: 55.6 (33.6)	33	P = 0.878

Analysis 1.2. Comparison 1: Home-like vs. traditional environment, Outcome 2: Behaviour, mood and depression

Behaviour, mood and depression

Study	Measure	Home-like	Traditional	Sample size	Effect estimate or reported significance
Global behaviour					
Dettbarn-Reggentin 2005	Nurses Observation Scale for Geriatric Patients (NOSGER) (unadjusted mean) (lower scores = better)	Baseline 15.9 6 months 16.0 12 months 15.3	Baseline 18.0 6 months 18.8 12 months 19.6	60	P < 0.01 at baseline P < 0.001 at 6 months P < 0.0001 at 12 months
Te Boekhorst 2009	Neuropsychiatric Inventory (NPI) (unadjusted mean (95% confidence interval)) (lower scores = better)	Baseline: 12.1 (10.5 to 13.8) 6 months: 7.5 (6.2 to 6.7)	Baseline: 11.7 (10.9 to 12.8) 6 months 8.8 (7.5 to 10.1)	164	Adjusted MD for global behaviour change over 6 months: -0.04 (95% CI -0.13 to 0.04)

Wolf-Ostermann 2012	Neuropsychiatric Inventory-Nursing Home version (NPI-NH) (adjusted mean) (lower scores = better)	Baseline 47.3 6 months 26.7 12 months 17.4	Baseline 34.1 6 months 36.6 12 months 20.5	Baseline: 56 12 months: 33	P > 0.05
Depression					
Te Boekhorst 2009	Revised Memory and Behaviour Problems Checklist (RMBPC) (unadjusted mean (95% confidence interval)) (lower scores = better)	Baseline 14.9 (12.8 to 17.0) 6 months 8.9 (7.4 to 10.5)	Baseline 13.1 (12.3 to 13.8) 6 months 8.0 (7.4 to 8.6)	164	Adjusted MD (95% confidence interval) for global behaviour change over 6 months: 0.01 (-0.12 to 0.14)
Yoon 2015	Mood Scale Score (MSS) (lower scores = better)	N/R	N/R	242	Adjusted RR (95% confidence interval) for level of social engagement over 18 months: 1.15 (1.02 to 1.29) Adjusted OR (95% confidence interval) for probability of not being socially engaged over 18 months: 0.36 (0.12 to 1.07)
Behaviour subdomains					
Annerstedt 1993	Organic Brain Syndrome (OBS) scale -Dyspraxia (unadjusted mean (SD)) (lower scores = better)	0-6 months: 0.95 (0.49) 0-12 months: 0.57 (0.49)	0-6 months: 0.54 (0.54) 0-12 months: 0.69 (0.69)	0-6 months: 53 0-12 months: 44	0-6 months: P < 0.001 0-12 months: P > 0.05
	OBS scale -Hallucinations (unadjusted mean (SD)) (lower scores = better)	0-6 months: 0.02 (0.29) 0-12 months: 0.14 (0.47)	0-6 months: 0.03 (0.36) 0-12 months: 0.14 (0.41)	0-6 months: 53 0-12 months: 44	0-6 months: P > 0.05 0-12 months: P > 0.05
	OBS scale	0-6 months:	0-6 months:	0-6 months:	0-6 months: P > 0.05

	-Lack of vitality (unadjusted mean (SD)) (lower scores = better)	0.05 (0.49) 0-12 months: 0.63 (0.52)	0.24 (0.47) 0-12 months: 0.31 (0.55)	53 0-12 months: 44	0-12 months: P < 0.05
	OBS scale -Dysphasia (unadjusted mean (SD)) (lower scores = better)	0-6 months: 0.04 (0.56) 0-12 months: 0.63 (0.52)	0-6 months: 0.36 (0.48) 0-12 months: 0.42 (0.70)	0-6 months: 53 0-12 months: 44	0-6 months: P < 0.05 0-12 months: P > 0.05
	OBS scale -Paranoia (unadjusted mean (SD)) (lower scores = better)	0-6 months: -0.05 (0.32) 0-12 months: 0.44 (0.40)	0-6 months: 0.17 (0.37) 0-12 months: 0.28 (0.41)	0-6 months: 53 0-12 months: 44	0-6 months: P < 0.05 0-12 months: P > 0.05
	OBS scale -Aggressiveness (unadjusted mean (SD)) (lower scores = better)	0-6 months: 0.22 (0.51) 0-12 months: 0.45 (0.45)	0-6 months: 0.09 (0.58) 0-12 months: 0.07 (0.41)	0-6 months: 53 0-12 months: 44	0-6 months: P > 0.05 0-12 months: P < 0.01
	OBS scale -Depression, anxiousness (unadjusted mean (SD)) (lower scores = better)	0-6 months: -0.19 (0.23) 0-12 months: 0.32 (0.50)	0-6 months: 0.28 (0.60) 0-12 months: 0.30 (0.49)	0-6 months: 53 0-12 months: 44	0-6 months: P < 0.01 0-12 months: P > 0.05
	OBS scale -Clinical variations (unadjusted mean (SD)) (lower scores = better)	0-6 months: 0.06 (0.54) 0-12 months: 0.65 (0.65)	0-6 months: 0.29 (0.75) 0-12 months: 0.16 (0.68)	0-6 months: 53 0-12 months: 44	0-6 months: P > 0.05 0-12 months: P < 0.05
	OBS scale -Restlessness (unadjusted mean (SD)) (lower scores = better)	0-6 months: -0.11 (0.28) 0-12 months: 0.22 (0.53)	0-6 months: 0.09 (0.38) 0-12 months: 0.26 (0.58)	0-6 months: 53 0-12 months: 44	0-6 months: P < 0.05 0-12 months: P > 0.05
Wolf-Ostermann 2012	Cohen-Mansfield Agitation Inventory (CMAI), proportion with physical non-aggressive behaviour (lower scores = better)	Baseline: 35.0% 6 months: 40.0% 12 months: 30.0%	Baseline: 46.2% 6 months: 46.2% 12 months: 53.8%	33	P > 0.05
	CMAI, proportion with verbal agitation (lower scores = better)	Baseline: 50.0% 6 months: 50.0% 12 months: 40.0%	Baseline: 30.8% 6 months: 53.8% 12 months: 61.5%	33	P > 0.05
	CMAI, proportion with physical aggressive behaviour (lower scores = better)	Baseline: 0% 6 months: 5.0% 12 months: 25.0%	Baseline: 30.8% 6 months: 30.8% 12 months: 30.8%	33	P = 0.066 for baseline to 6 months P > 0.05 for baseline to 12 months
Social engagement					
Te Boekhorst 2009	Revised Index of Social Engagement (RISE) (unadjusted mean (95% confidence interval)) (higher scores = better)	Baseline 3.2 (2.7 to 3.7) 6 months 4.5 (4.0 to 5.0)	Baseline 2.9 (2.5 to 3.2) 6 months 3.2 (2.6 t0 3.7)	164	Adjusted MD (95% confidence interval) for global behaviour change over 6 months: 0.79 (0.11 to 1.50)
Yoon 2015	Index of Social Engagement (ISE) (higher scores = better)	N/R	N/R	242	Adjusted RR (95% confiedence interval) for level of social engagement over 18 months: 0.99 (0.82 to 1.19) Adjusted OR (95% confidence interval) for prob-

					ability of not being socially engaged over 18 months: 0.76 (0.62 to 0.94)

Analysis 1.3. Comparison 1: Home-like vs. traditional environment, Outcome 3: Function

Function

Study	Measure	Home-like	Traditional	Sample size	Effect estimate or reported significance
Dettbarn-Reggentin 2005	Barthel Index (unadjusted mean) (higher scores = better)	Baseline: 40.9 12 months: 35.9	Baseline: 35.9 12 months: 23.9	60	P = 0.039
Te Boekhorst 2009	The Interview for the Deterioration of Daily Living activities in Dementia (IDDD) (unadjusted mean (95% confidence interval)) (lower scores = better)	Baseline 25.9 (22.9 to 28.8) 6 months 28.3 (26.3 to 30.3)	Baseline 33.0 (30.5 to 35.6) 6 months 34.6 (31.9 to 37.2)	164	Adjusted MD (95% confidence interval) over six months: -4.37 (-7.06 to -1.69)
Wolf-Ostermann 2012	Barthel Index (adjusted mean) (higher scores = better)	Baseline: 58.6 6 months: 43.7 12 months: 36.2	Baseline: 64.8 6 months: 46.3 12 months: 49.8	Baseline: 56 Follow-up: 33	Interactions between setting and development over time, P > 0.05
	Bathing-decrease in proportion independent 12 months (%, N)	10.0%	7.7%	33	-
	Toilet use-decrease in proportion independent 12 months (%, N)	30.0%	23.1%	33	-
	Grooming-decrease in proportion independent 12 months (%, N)	15.0%	15.4%	33	-
	Bladder-decrease in proportion independent 12 months (%, N)	15.0%	15.4%	33	-
	Stairs-decrease in proportion independent 12 months(%, N)	20.0%	0%	33	-

	Feeding-decrease in proportion independent 12 months (%, N)	20.0%	15.4%	33	-
	Dressing-decrease in proportion independent 12 months (%, N)	15.0%	7.7%	33	-
	Transferring-decrease in proportion independent 12 months (%, N)	15.0%	7.7%	33	-
Yoon 2015	Activities of daily living (ADL) long-form scale (unadjusted mean (SD)) (lower scores = better)	Baseline: 14.5 (6.7) 6 months: 15.6 (6.9) 18 months: 18.5 (4.4)	Baseline: 14.5 (7.4) 6 months: 15.1 (7.3) 18 months: 16.9 (7.0)	Baseline n = 242 6 months n = 238 18 months n = 92	Adjusted MD (95% confidence interval) over 18 months: -0.09 (-0.46 to 0.28)

Analysis 1.4. Comparison 1: Home-like vs. traditional environment, Outcome 4: Global cognitive function

Global cognitive function

Study	Measure	Home-like	Traditional	Sample size	Effect estimate or reported significance
Dettbarn-Reggentin 2005	Mini-Mental State Examination (MMSE) (unadjusted mean) (higher scores = better)	Baseline: 10.3 12 months: 9.9	Baseline: 9.1 12 months: 7.6	60	P = 0.0082
Te Boekhorst 2009	Standardised Mini-Mental State Examination (MMSE) (unadjusted mean (95% confidence interval)) (higher scores = better)	Baseline 15.4 (13.5 to 17.3) 6 months 13.0 (10.4 to 15.6)	Baseline 10.3 (8.3 to 12.3) 6 months 8.9 (6.2 to 11.6)	164	Adjusted MD (95% confidence interval) over 6 months: 0.54 (-1.43 to 2.50)
Wolf-Ostermann 2012	Mini-Mental State Examination (MMSE) (unadjusted mean (SD)) (higher scores = better)	Baseline: 15.7 (6.9) 6 months: 13.8 (6.8) 12 months: 10.8 (10.0)	Baseline: 12.4 (6.5) 6 months: 8.4 (7.4) 12 months: 8.7 (7.7)	33	P = 0.004 for baseline to 6 months P > 0.05 for baseline to 12 months
Yoon 2015	Cognitive Performance Scale (CPS) (unadjusted mean (SD)) (lower scores = better)	Baseline: 2.5 (1.0) 6 months: 2.6 (1.1) 18 months: 2.9 (1.3)	Baseline: 2.2 (1.2) 6 months: 2.3 (1.3) 18 months: 2.3 (1.5)	Baseline n = 242 6 months n=238 18 months n=92	N/R

Analysis 1.5. Comparison 1: Home-like vs. traditional environment, Outcome 5: Quality of care

Quality of care

Study	Measure	Sample size	Effect estimate (unclear follow-up time, reported as up to 5 years)
Afendulis 2016	Number of bedfast residents	Estimated weighted sample 74,449	Adjusted MD (95% confidence interval) -0.3% (-0.4% to -0.2%)
	Catheter use	Estimated weighted sample 74,449	Adjusted MD (95% confidence interval) -4.1% (-6.1% to -2.1%)
	High-risk pressure ulcers	Estimated weighted sample 74,449	Adjusted MD (95% confidence interval) -1.2% (-3.8% to 1.4%)
	Low-risk pressure ulcers	Estimated weighted sample 74,449	Adjusted MD (95% confidence interval) -1.9% (-2.5% to -1.3%)
	Hospital readmissions	Estimated weighted sample 74,449	MD (95% confidence interval)

		-5.5% (-10.2% to -0.8%)
Avoidable hospital readmissions	Estimated weighted sample 74,449	MD (95% confidence interval) -3.9% (-7.6% to -0.2%)

Analysis 1.6. Comparison 1: Home-like vs. traditional environment, Outcome 6: Serious adverse effects

Serious adverse effects

Study	Measure	Sample size	Effect estimate (unclear follow-up, reported as up to 5 years)
Afendulis 2016	Physical restraints	Estimated weighted sample 74,449	Adjusted MD (95% confidence interval): -0.3% (-0.5% to -0.1%)

Comparison 2. Refurbishment vs. traditional environment

Outcome or subgroup title	No. of studies	No. of participants	Statistical method	Effect size
2.1 Quality of life	3		Other data	No numeric data
2.2 Behaviour, mood and depression	3		Other data	No numeric data
2.2.1 Depression	1		Other data	No numeric data
2.2.2 Behaviour subdomains	3		Other data	No numeric data
2.3 Function	1		Other data	No numeric data
2.4 Quality of care	1		Other data	No numeric data

Analysis 2.1. Comparison 2: Refurbishment vs. traditional environment, Outcome 1: Quality of life

Quality of life

Study	Measure	Refurbishment	Traditional	Sample size	Effect estimate or reported significance
Chenoweth 2014	Dementia quality of life (DEMQOL) Proxy (adjusted mean (95% confidence interval)) (higher scores = better)	**Person-centred environment (PCE)** Baseline: 101 (99 to 104) Post-intervention: 102 (99 to 105) 8 months: 106 (103 to 110) **PCE + person-centred care (PCC)** Baseline: 101 (99 to 104) Post-intervention: 103 (100 to 106) 8 months: 105 (102 to 108)	Baseline: 101 (98 to 104) Post-intervention: 100 (97 to 104) 8 months: 103 (99 to 106)	Baseline: 601 Post-intervention: 416 8 months: 296	Adjusted MD (95% confidence interval) **PCE vs. traditional:** Post-intervention: 2.00 (-2.19 to 6.19) 8 months: 3.00 (-1.91 to 7.91) **PCE + PCC vs traditional:** Post-intervention: 3.00 (-1.20 to 7.20) 8 months: 2.00 (-2.91 to 6.91)
Diaz-Veiga 2014	Fumat for mild cognitive impairment (unadjusted mean (SD)) (higher scores = better)	Baseline: 100.6 (8.0) 6 months: 104.5 (8.0)	Baseline: 107.1 (11.1) 6 months: not reported	Unclear	P = 0.850
	Qualid for severe cognitive impairment (unadjusted mean (SD)) (lower scores = better)	Baseline: 27.4 (12.1) 6 months: 23.8 (12.4)	Baseline: not reported 6 months: 30.8 (11.1)	Unclear	P = 0.33

Wylie 2001	Life Satisfaction Index (unadjusted mean (SD)) (higher scores = better)	Baseline: 12.0 (4.1) 6 months: 11.2 (3.4) 12 months: 12.1 (3.3) 18 months: 12.6 (3.3)	Baseline: 12.0 (3.9) 6 months: 11.1 (3.6) 12 months: 11.3 (3.3) 18 months: 11.1 (3.4)	Baseline: 100 6 months: 70 12 months: 43 18 months: 33	'Not significant'

Analysis 2.2. Comparison 2: Refurbishment vs. traditional environment, Outcome 2: Behaviour, mood and depression

Behaviour, mood and depression

Study	Measure	Refurbishment	Traditional	Sample size	Effect measure or reported significance
Depression					
Galik 2021	Cornell Scale for Depression in Dementia (CSDD) (unadjusted mean (SD)) (lower scores = better)	Baseline: 4.5 (4.2) 4 months: 4.4 (4.6) 12 months: 3.9 (4.5)	Baseline: 3.9 (3.8) 4 months: 4.2 (4.3) 12 months: 3.2 (3.5)	336	Adjusted MD (95% confidence interval) baseline to 4 months: -0.73 (-1.93 to 0.47) Adjusted MD (95% confidence interval) baseline to 12 months: -0.04 (-1.35 to 1.26)
Behaviour subdomains					
Burack 2012	Cohen Mansfield Agitation Inventory (CMAI) (adjusted mean) Physical agitation (lower scores = better)	Baseline: 1.68 Two years: 1.44	Baseline: 1.24 Two years: 1.51	101	Adjusted MD (95% confidence interval): -0.07 (-0.14 to -0.00)
	Cohen Mansfield Agitation Inventory (CMAI) (adjusted mean) Forceful behaviours (lower scores = better)	Baseline: 1.50 Two years: 1.35	Baseline: 1.21 Two years: 1.41	101	Adjusted MD (95% confidence interval): -0.06 (-0.10 to -0.02)
	Cohen Mansfield Agitation Inventory (CMAI) (adjusted mean) Verbal agitation (lower scores = better)	Baseline: 2.13 Two years: 1.95	Baseline: 1.48 Two years: 2.06	101	Adjusted MD (95% confidence interval): 0.11 (-0.00 to 0.22)
Chenoweth 2014	Cohen Mansfield Agitation Inventory (CMAI) (adjusted mean (95% confidence interval)) (lower scores = better)	**Person-centred environment (PCE)** Baseline: 65 (57 to 73) Post-intervention: 55 (46 to 64) 8 months: 55 (46 to 64) **PCE + person-centred care (PCC)** Baseline: 57 (49 to 65) Post-intervention: 60 (52 to 69) 8 months: 64 (55 to 73)	Baseline: 52 (43 to 61) Post-intervention: 53 (43 to 63) 8 months: 51 (41 to 62)	Baseline: 601 Post-intervention: 416 8 months: 296	Adjusted MD (95% confidence interval) **PCE vs. traditional:** Post-intervention: 2.00 (-11.29 to 15.29) 8 months: 4.00 (-9.21 to 17.21) **PCE + PCC vs traditional:** Post-intervention: 7.00 (-5.66 to 19.66) 8 months: 13.00 (-0.22 to 26.22)
Galik 2021	Cohen Mansfield Agitation Inventory (CMAI) (unadjusted mean (SD)) (lower scores = better)	Baseline: 19.8 (6.1) 4 months: 19.2 (5.9) 12 months: 19.2 (7.8)	Baseline: 20.2 (6.6) 4 months: 19.7 (6.8) 12 months: 18.9 (5.6)	336	Adjusted MD (95% confidence interval) baseline to 4 months: -0.72 (-2.63 to 1.20) Adjusted MD (95% confidence interval) baseline to 12 months: -0.36 (-2.41 to 1.69)
	Resistiveness to Care scale (unadjusted mean (SD)) (lower scores = better)	Baseline: 0.83 (2.15) 4 months: 0.10 (0.48) 12 months: 0.81 (2.40)	Baseline: 0.65 (1.62) 4 months: 0.46 (1.34) 12 months: 0.59 (1.85)	336	Adjusted MD (95% confidence interval) baseline to 4 months: -1.56 (-2.71 to -0.40) Adjusted MD (95% confidence interval) baseline to 12 months:

					0.32 (-0.29 to 0.94)

Analysis 2.3. Comparison 2: Refurbishment vs. traditional environment, Outcome 3: Function

Function

Study	Measure	Refurbishment, mean	Traditional, mean	Sample size	Effect size
Galik 2021	Barthel Index (unadjusted mean (SD)) (higher scores = better)	Baseline: 45.2 (27.8) 4 months: 44.0 (28.4) 12 months: 42.2 (25.7)	Baseline: 47.6 (27.0) 4 months: 47.9 (28.1) 12 months: 42.2 (25.4)	336	Adjusted MD (95% confidence interval) baseline to 4 months: 1.24 (-3.34 to 5.81) Adjusted MD (95% confidence interval) baseline to 12 months: 1.49 (-3.53 to 6.50)

Analysis 2.4. Comparison 2: Refurbishment vs. traditional environment, Outcome 4: Quality of care

Quality of care

Study	Measure	Refurbishment	Traditional	Sample size	Effect estimate
Chenoweth 2014	Quality of Interactions Schedule (QUIS) (adjusted mean (95% confidence interval)) (higher scores = better)	**Person-centred environment (PCE)** Baseline: 78 (74 to 83) Post-intervention: 81 (76 to 85) 8 months: 82 (76 to 87) **PCE + person-centred care (PCC)** Baseline: 76 (72 to 81) Post-intervention: 86 (81 to 91) 8 months: 80 (75 to 85)	Baseline: 78 (73 to 83) Post-intervention: 73 (68 to 79) 8 months: 82 (76 to 88)	Baseline: 601 Post-intervention: 416 8 months: 296	Adjusted MD (95% confidence interval) **PCE vs. traditional:** Post-intervention: 8.00 (1.03 to 14.97) 8 months: MD 0.00 (-8.34 to 8.34) **PCE + PCC vs traditional:** Post-intervention: 13.00 (6.02 to 19.98) 8 months: -2.00 (-9.67 to 5.67)

Comparison 3. Special-care units for dementia vs. traditional environment

Outcome or subgroup title	No. of studies	No. of participants	Statistical method	Effect size
3.1 Behaviour, mood and depression	1		Other data	No numeric data
3.1.1 Global behaviour	1		Other data	No numeric data
3.1.2 Depression	1		Other data	No numeric data
3.1.3 Behaviour subdomains	1		Other data	No numeric data
3.2 Function	1		Other data	No numeric data
3.3 Global cognitive function	1		Other data	No numeric data

Analysis 3.1. Comparison 3: Special-care units for dementia vs. traditional environment, Outcome 1: Behaviour, mood and depression

Behaviour, mood and depression

Study	Measure	Special care units	Traditional	Sample size	Reported significance
Global behaviour					
Frisoni 1998	Neuropsychiatric Inventory (NPI) (unadjusted mean (SD)) (lower scores = better)	Baseline: 39.2 (18.1) 3 months: 29.0 (15.0)	Baseline: 29.2 (13.8) 3 months: 20.5 (11.1)	66	P = 0.007 for intervention P = 0.006 for comparator
Depression					
Frisoni 1998	Cornell Depression Scale (unadjusted mean (SD)) (lower scores = better)	Baseline: 10.7 (4.6) 3 months: 8.4 (3.4)	Baseline: 6.5 (3.5) 3 months: 10.5 (5.9)	66	P = 0.03 for intervention P = 0.004 for comparator
Behaviour subdomains					
Frisoni 1998	Neuropsychiatric Inventory (NPI) -delusions (unadjusted mean (SD)) (lower scores = better)	Baseline: 4.4 (4.6) 3 months: 2.8 (3.7)	Baseline: 3.0 (4.1) 3 months: 2.2 (3.4)	66	P = 0.06 for intervention P > 0.05 for comparator
	NPI -hallucinations (unadjusted mean (SD)) (lower scores = better)	Baseline: 2.9 (4.5) 3 months: 1.2 (2.6)	Baseline: 1.3 (2.7) 3 months: 0.8 (1.8)	66	p=0.004 for intervention p>0.05 for comparator
	NPI -agitation (unadjusted mean (SD)) (lower scores = better)	Baseline: 5.4 (4.4) 3 months: 3.8 (3.5)	Baseline: 3.5 (4.0) 3 months: 2.5 (2.9)	66	p=0.02 for intervention p>0.05 for comparator
	NPI -anxiety (unadjusted mean (SD)) (lower scores = better)	Baseline: 4.8 (4.5) 3 months: 4.0 (4.0)	Baseline: 3.7 (3.9) 3 months: 2.6 (4.1)	66	p>0.05 for intervention p=0.04 for comparator
	NPI -euphoria/elation (unadjusted mean (SD)) (lower scores = better)	Baseline: 1.2 (2.6) 3 months: 1.2 (2.7)	Baseline: 1.4 (3.1) 3 months: 0.6 (1.7)	66	p>0.05 for intervention p=0.04 for comparator
	NPI -disinhibition (unadjusted mean (SD)) (lower scores = better)	Baseline: 2.0 (3.5) 3 months: 2.0 (3.0)	Baseline: 1.6 (3.5) 3 months: 1.4 (2.5)	66	p>0.05 for intervention p>0.05 for comparator
	NPI -irritability/lability (unadjusted mean (SD)) (lower scores = better)	Baseline: 4.7 (4.6) 3 months: 4.7 (3.7)	Baseline: 2.9 (4.0) 3 months: 1.9 (2.8)	66	p>0.05 for intervention p=0.05 for comparator
	NPI -abnormal motor behaviour (unadjusted mean (SD)) (lower scores = better)	Baseline: 9.0 (4.3) 3 months: 7.5 (5.0)	Baseline: 8.2 (4.7) 3 months: 6.9 (4.7)	66	p>0.05 for intervention p>0.05 for comparator
	NPI -sleep (unadjusted mean (SD))	Baseline: 4.8 (4.9) 3 months: 2.3 (3.1)	Baseline: 3.9 (4.2) 3 months: 1.7 (3.3)	66	p=0.01 for intervention p=0.02 for comparator

	(lower scores = better)				
	Cohen Mansfield Inventory (CMAI) (unadjusted mean, SD) (lower scores = better)	Baseline: 40.7 (24.6) 3 months: 36.4 (17.8)	Baseline: 31.2 (14.3) 3 months: 26.7 (11.8)	66	p>0.05 for intervention p>0.05 for comparator

Analysis 3.2. Comparison 3: Special-care units for dementia vs. traditional environment, Outcome 2: Function

Function

Study	Measure	Special care units	Traditional	Sample size	Reported significance
Frisoni 1998	Bedford Alzheimer's nursing severity scale (unadjusted mean (SD)) (higher scores = better)	Baseline: 13.5 (3.5) 3 months: 14.0 (4.3)	Baseline: 13.8 (3.9) 3 months: 14.1 (4.7)	66	P > 0.05 for intervention P > 0.05 for comparator
	Barthel Index (unadjusted mean (SD)) (higher scores = better)	Baseline: 60.7 (23.5) 3 months: 57.5 (26.3)	Baseline: 52.7 (28.1) 3 months: 45.9 (30.2)	66	P > 0.05 for intervention P > 0.05 for comparator

Analysis 3.3. Comparison 3: Special-care units for dementia vs. traditional environment, Outcome 3: Global cognitive function

Global cognitive function

Study	Measure	Special care units	Traditional	Sample size	Reported significance
Frisoni 1998	MMSE (unadjusted mean (SD)) (higher scores = better)	Baseline: 7.0 (5.2)3 months: 7.4 (5.8)	Baseline: 8.3 (5.1)3 months: 8.9 (6.2)	66	P > 0.05 for intervention P > 0.05 for comparator
	Clinical Dementia Rating (unadjusted mean (SD)) (lower scores = better)	Baseline: 2.8 (0.5) 3 months: 2.9 (0.5)	Baseline: 2.9 (0.5) 3 months: 3.0 (0.5)	66	P > 0.05 for intervention P > 0.05 for comparator

Comparison 4. Group living corridor vs. group living non-corridor design

Outcome or subgroup title	No. of studies	No. of participants	Statistical method	Effect size
4.1 Behaviour, mood and depression	1		Other data	No numeric data
4.1.1 Depression	1		Other data	No numeric data
4.1.2 Behaviour subdomains	1		Other data	No numeric data

Analysis 4.1. Comparison 4: Group living corridor vs. group living non-corridor design, Outcome 1: Behaviour, mood and depression

Behaviour, mood and depression

Study	Measure	Sample size	Adjusted OR (95% confidence interval)
Depression			
Elmstahl 1997	Organic Brain Syndrome (OBS) scale (lower scores = better)	105	8.82 (1.14 to 68.22)

Behaviour subdomains			
Elmstahl 1997	Organic Brain Syndrome (OBS) scale Aggressiveness (lower scores = better)	105	2.02 (0.56 to 7.27)
	Organic Brain Syndrome (OBS) scale Dyspraxia (lower scores = better)	105	4.57 (0.76 to 27.35)
	Organic Brain Syndrome (OBS) scale Hallucinations (lower scores = better)	105	1.06 (0.05 to 22.09)
	Organic Brain Syndrome (OBS) scale Lack of vitality (lower scores = better)	105	0.23 (0.04 to 1.47)
	Organic Brain Syndrome (OBS) scale Dysphasia (lower scores = better)	105	0.87 (0.08 to 9.73)
	Organic Brain Syndrome (OBS) scale Paranoia (lower scores = better)	105	0.12 (0.01 to 1.24)
	Organic Brain Syndrome (OBS) scale Restlessness (lower scores = better)	105	0.21 (0.04 to 1.00)
	Organic Brain Syndrome (OBS) scale Disorientation, recent memory (lower scores = better)	105	0.87 (0.31 to 2.42)
	Organic Brain Syndrome (OBS) scale Disorientation, time (lower scores = better)	105	0.66 (0.22 to 2.01)
	Organic Brain Syndrome (OBS) scale Disorientation, identity (lower scores = better)	105	1.23 (0.56 to 2.68)

Comparison 5. Lighting intervention vs. control lighting

Outcome or subgroup title	No. of studies	No. of participants	Statistical method	Effect size
5.1 Behaviour, mood and depression	2		Other data	No numeric data
5.1.1 Global behaviour	1		Other data	No numeric data
5.1.2 Depression	1		Other data	No numeric data
5.1.3 Behaviour subdomains	2		Other data	No numeric data
5.2 Behaviour, mood and depression: depression 4-6 weeks	3	291	Std. Mean Difference (IV, Fixed, 95% CI)	-0.22 [-0.45, 0.01]
5.3 Behaviour, mood and depression: agitation 4-6 weeks	2	179	Std. Mean Difference (IV, Fixed, 95% CI)	-0.16 [-0.45, 0.14]
5.4 Function 4-6 weeks	2	179	Std. Mean Difference (IV, Fixed, 95% CI)	-0.29 [-0.59, 0.00]
5.5 Function	1		Other data	No numeric data

Outcome or subgroup title	No. of studies	No. of participants	Statistical method	Effect size
5.6 Global cognitive function	1		Other data	No numeric data

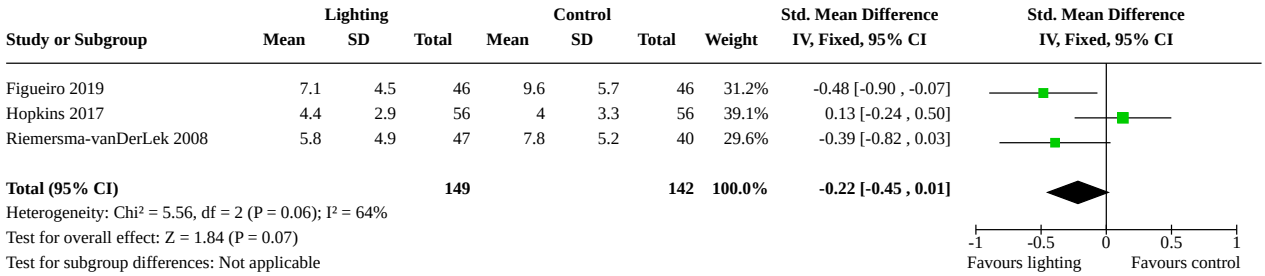
Analysis 5.1. Comparison 5: Lighting intervention vs. control lighting, Outcome 1: Behaviour, mood and depression

Behaviour, mood and depression

Study	Measure	Lighting intervention	Control lighting	Sample size	Effect estimate
Global behaviour					
Riemersma-vanDerLek 2008	Questionnaire format of the NPI (NPI-Q) (mean (SD)) (lower scores = better)	6 weeks: 4.7 (5.0) 6 months: 5.7 (5.7) 12 months: 5.8 (5.7) 18 months: 4.0 (4.6) 24 months: 4.9 (5.8)	6 weeks: 6.4 (5.3) 6 months: 5.2 (4.4) 12 months: 6.1 (3.5) 18 months: 6.8 (5.0) 24 months: 8.2 (3.9)	6 weeks: 87 6 months: 74 12 months: 55 18 months: 41 24 months: 26	MD (95% confidence interval): 6 weeks: -1.70 (-3.88 to 0.48) 6 months: 0.50 (-1.80 to 2.80) 12 months: -0.30 (-2.73 to 2.13) 18 months: -2.80 (-5.78 to 0.18) 24 months: -3.30 (-7.27 to 0.67)
Depression					
Riemersma-vanDerLek 2008	Cornell Scale for Depression in Dementia (CSDD) , (mean, SD) (lower scores = better)	6 months: 7.9 (5.6) 12 months: 11.0 (7.7) 18 months: 9.9 (5.9) 24 months: 10.7 (7.3)	6 months: 9.3 (6.1) 12 months: 11.3 (7.4) 18 months: 12.0 (7.5) 24 months: 15.1 (8.6)	6 months: 74 12 months: 55 18 months: 41 24 months: 26	MD (95% confidence interval): 6 months: -0.24 (-0.70 to 0.23) 12 months: -0.04 (-0.58 to 0.50) 18 months: 0.31 (-0.93 to 0.31) 24 months: -0.55 (-1.35 to 0.26)
Behaviour subdomains					
Hopkins 2017	Anxiety Anxiety subset of the hospital anxiety and depression (HADA) scale (mean (SD)) (lower scores = better)	4 weeks: 4.5 (2.5)	4 weeks: 4.7 (2.7)	42	MD (95% confidence interval): -0.10 (-1.67 to 1.47)
Riemersma-vanDerLek 2008	Distress Questionnaire format of the NPI (NPI-Q) distress subdomain (mean (SD)) (lower scores = better)	6 weeks: 5.1 (6.0) 6 months: 6.1 (7.4) 12 months: 6.0 (7.2) 18 months: 4.2 (5.3) 24 months: 5.4 (6.8)	6 weeks: 6.0 (5.9) 6 months: 3.6 (4.6) 12 months: 3.2 (3.5) 18 months: 4.2 (4.6) 24 months: 7.4 (4.5)	6 weeks: 87 6 months: 74 12 months: 55 18 months: 41 24 months: 26	MD (95% confidence interval): 6 weeks: -0.90 (-3.41 to 1.61) 6 months: 2.50 (-0.24 to 5.24) 12 months: 2.80 (-0.06 to 5.66) 18 months: -0.00 (-3.03 to 3.03) 24 months: -2.00 (-6.35 to 2.35)

Withdrawn behaviour Multi Observational Scale for Elderly Subjects (MOSES) (mean (SD)) (lower scores = better)	6 weeks: 17.5 (5.9) 6 months: 19.0 (6.1) 12 months: 17.6 (6.2) 18 months: 15.5 (4.7) 24 months: 16.4 (6.2)	6 weeks: 16.6 (6.1) 6 months: 17.9 (6.0) 12 months: 17.0 (4.1) 18 months: 19.8 (5.4) 24 months: 19.9 (5.0)	6 weeks: 87 6 months: 74 12 months: 55 18 months: 41 24 months: 26	MD (95% confidence interval): 6 weeks: 0.90 (-1.63 to 3.43) 6 months: 1.10 (-1.69 to 3.89) 12 months: 0.60 (-2.12 to 3.32) 18 months: -4.30 (-7.45 to -1.15) 24 months: -3.50 (-7.84 to 0.84)
Positive mood Philadelphia Geriatric Centre Affect Rating Scale (PGCARS) (mean (SD)) (higher scores = better)	6 weeks: 10.7 (3.5) 6 months: 10.9 (3.2) 12 months: 11.6 (3.1) 18 months: 11.5 (2.2) 24 months: 11.5 (2.4)	6 weeks: 11.3 (2.4) 6 months: 10.5 (2.6) 12 months: 11.9 (2.6) 18 months: 10.6 (2.9) 24 months: 11.0 (1.0)	6 weeks: 87 6 months: 74 12 months: 55 18 months: 41 24 months: 26	MD (95% confidence interval): 6 weeks: -0.60 (-1.85 to 0.65) 6 months: 0.40 (-0.92 to 1.72) 12 months: 0.30 (-1.82 to 1.22) 18 months: 0.90 (-0.71 to 2.51) 24 months: 0.50 (-0.83 to 1.83)
Negative mood Philadelphia Geriatric Centre Affect Rating Scale (PGCARS) (mean (SD)) (lower scores = better)	6 weeks: 5.8 (2.3) 6 months: 6.1 (2.6) 12 months: 7.3 (3.2) 18 months: 6.3 (3.1) 24 months: 6.4 (2.9)	6 weeks: 7.0 (2.9) 6 months: 6.7 (2.6) 12 months: 6.2 (2.0) 18 months: 6.6 (2.2) 24 months: 9.1 (2.5)	6 weeks: 87 6 months: 74 12 months: 55 18 months: 41 24 months: 26	MD (95% confidence interval): 6 weeks: -1.20 (-2.31 to -0.09) 6 months: -0.60 (-1.80 to 0.60) 12 months: 1.10 (-0.27 to 2.47) 18 months: -0.30 (-1.92 to 0.32) 24 months: -2.70 (-4.80 to -0.60)
Agitation Cohen-Mansfield Agitation Inventory (CMAI) (mean (SD)) (lower scores = better)	6 weeks: 37.1 (11.1) 6 months: 44.0 (18.0) 12 months: 46.0 (18.0) 18 months: 42.0 (14.0) 24 months: 49.0 (15.0)	6 weeks:37.1 (10.9) 6 months: 47.0 (19.0) 12 months: 48.0 (18.0) 18 months: 47.0 (15.0) 24 months: 58.0 (16.0)	6 weeks: 87 6 months: 74 12 months: 55 18 months: 41 24 months: 26	MD (95% confidence interval): 6 weeks: -0.16 (-0.45 to 0.14) 6 months: -0.16 (-0.62 to 0.30) 12 months: -0.11 (-0.65 to 0.43) 18 months:-0.34 (-0.96, 0.28) 24 months: -0.57 (-1.37, 0.24)

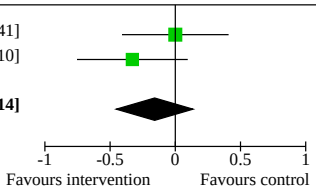
Analysis 5.2. Comparison 5: Lighting intervention vs. control lighting, Outcome 2: Behaviour, mood and depression: depression 4-6 weeks



Analysis 5.3. Comparison 5: Lighting intervention vs. control lighting, Outcome 3: Behaviour, mood and depression: agitation 4-6 weeks

Study or Subgroup	Lighting Mean	Lighting SD	Lighting Total	Control Mean	Control SD	Control Total	Weight	Std. Mean Difference IV, Fixed, 95% CI
Figueiro 2019	37.1	11.1	46	37.1	10.9	46	51.9%	0.00 [-0.41 , 0.41]
Riemersma-vanDerLek 2008	41	12	47	46	18	40	48.1%	-0.33 [-0.75 , 0.10]
Total (95% CI)			**93**			**86**	**100.0%**	**-0.16 [-0.45 , 0.14]**

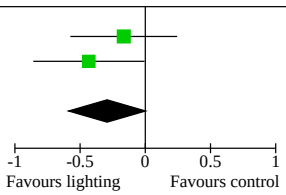
Heterogeneity: Chi² = 1.20, df = 1 (P = 0.27); I² = 17%
Test for overall effect: Z = 1.05 (P = 0.29)
Test for subgroup differences: Not applicable



Analysis 5.4. Comparison 5: Lighting intervention vs. control lighting, Outcome 4: Function 4-6 weeks

Study or Subgroup	Lighting Mean	Lighting SD	Lighting Total	Control Mean	Control SD	Control Total	Weight	Std. Mean Difference IV, Fixed, 95% CI
Figueiro 2019	10.1	7.5	46	11.4	8.1	46	52.1%	-0.17 [-0.57 , 0.24]
Riemersma-vanDerLek 2008	15	11	47	20	12	40	47.9%	-0.43 [-0.86 , -0.01]
Total (95% CI)			**93**			**86**	**100.0%**	**-0.29 [-0.59 , 0.00]**

Heterogeneity: Chi² = 0.78, df = 1 (P = 0.38); I² = 0%
Test for overall effect: Z = 1.94 (P = 0.05)
Test for subgroup differences: Not applicable



Analysis 5.5. Comparison 5: Lighting intervention vs. control lighting, Outcome 5: Function

Function

Study	Measure	Lighting intervention	Control	Sample size	Effect estimate
Riemersma-vanDerLek 2008	Nurse-informant adaptation (NI-ADL) of the scale by Katz et al (mean (SD)) (lower scores = better)	6 months: 20.0 (14.0) 12 months: 17.0 (12.0) 18 months: 17.0 (14.0) 24 months: 13.0 (11.0)	6 months: 22.0 (12.0) 12 months: 22.0 (11.0) 18 months: 27.0 (14.0) 24 months: 29.0 (14.0)	6 weeks: 87 6 months: 74 12 months: 55 18 months: 41 24 months: 26	MD (95% confidence interval): 6 months: -0.15 (-0.61 to 0.31) 12 months: -0.42 [-0.97, 0.12] 18 months: -0.70 (-1.34 to -0.06) 24 months: -1.27 (-2.14 to -0.39)

Analysis 5.6. Comparison 5: Lighting intervention vs. control lighting, Outcome 6: Global cognitive function

Global cognitive function

Study	Measure	Lighting intervention	Control	Sample size	Effect estimate
Riemersma-vanDerLek 2008	Mini-mental state examination (MMSE) (mean (SD)) (higher scores = better)	6 weeks: 14.5 (6.2) 6 months: 16.6 (5.5) 12 months: 15.6 (5.2) 18 months: 16.2 (4.5) 24 months: 17.4 (3.7)	6 weeks: 14.3 (7.0) 6 months: 15.4 (7.3) 12 months: 15.6 (6.4) 18 months: 14.5 (5.4) 24 months: 13.7 (7.4)	6 weeks: 87 6 months: 74 12 months: 55 18 months: 41 24 months: 26	MD (95% confidence interval): 6 weeks: 0.20 (-2.48 to 2.88) 6 months: 1.20 (-1.56 to 3.96) 12 months: 0.00 (-2.74 to 2.74) 18 months: 1.70 (-1.03 to 4.43) 24 months: 3.70 (-0.04 to 7.44)

Comparison 6. Dining space redesign vs. traditional environment

Outcome or subgroup title	No. of studies	No. of participants	Statistical method	Effect size
6.1 Quality of life	2		Other data	No numeric data
6.2 Behaviour, mood and depression	1		Other data	No numeric data
6.3 Function	1		Other data	No numeric data
6.4 Global cognitive function	1		Other data	No numeric data
6.5 Serious adverse effects	1		Other data	No numeric data

Analysis 6.1. Comparison 6: Dining space redesign vs. traditional environment, Outcome 1: Quality of life

Quality of life

Study	Measure	Dining space redesign	Traditional	Sample size	Effect estimate or reported significance
Mathey 2001	Sickness Impact Profile (SIP) (mean percentage change (SD)) (higher scores = better)	-2% (11%)	-13% (12%)	16	P < 0.05 in control group Authors reported values "stayed stable" in intervention group
	Dutch version of the Philadelphia Geriatric Center Moral Scale (PGCMS) (mean percentage change (SD)) (higher scores = better)	-3% (20%)	-2% (19%)	16	Authors reported values remained "relatively stable", no P values reported
Nijs 2006	Dutch quality of life of somatic nursing home residents questionnaire (higher scores = better)	N/R	N/R	178	MD (95% confidence interval): 6.10 (2.10 to 10.10)

Analysis 6.2. Comparison 6: Dining space redesign vs. traditional environment, Outcome 2: Behaviour, mood and depression

Behaviour, mood and depression

Study	Measure	Dining space redesign	Traditional	Sample size	Reported significance
Kenkmann 2010	Hospital Anxiety and Depression Scale (HADS), (unadjusted mean (SD)) (lower scores = better)	Baseline: 4.07 (3) 12 months: 4.86 (4.61)	Baseline: 6.3 (4.45) 12 months: 6.78 (3.83)	120	N/R

Analysis 6.3. Comparison 6: Dining space redesign vs. traditional environment, Outcome 3: Function

Function

Study	Measure	n	Effect estimate
Nijs 2006	Nursing home physical performance test (higher scores = better)	178	MD (95% confidence interval): 3.20 (0.90 to 5.50)

Analysis 6.4. Comparison 6: Dining space redesign vs. traditional environment, Outcome 4: Global cognitive function

Global cognitive function

Study	Measure	Dining space redesign	Traditional	Sample size	Reported significance
Kenkmann 2010	Mini-Mental State Examination (MMSE) (unadjusted mean (SD)) (higher scores = better)	Baseline: 19 (5.6) 12 months: 17 (6.2)	Baseline: 17 (6.2) 12 months: 15 (7.9)	56	P > 0.05
Kenkmann 2010	MMSE, cognitive impairment <= 23, %	Baseline: 83.3% 12 months: 81.5%	Baseline: 87.5% 12 months: 79.2%	54	P > 0.05

Analysis 6.5. Comparison 6: Dining space redesign vs. traditional environment, Outcome 5: Serious adverse effects

Serious adverse effects

Study	Measure	Dining space redesign	Traditional	Sample size	Effect estimate or reported significance
Kenkmann 2010	Fall within previous year, %	Baseline: 60% 12 months: 60%	Baseline: 56% 12 months: 50%	105	P > 0.05
	Rate of falls	N/R	N/R	105	Rate ratio (95% confidence interval): 0.76 (0.57 to 1.01)

Comparison 7. Garden vignette vs. traditional environment

Outcome or subgroup title	No. of studies	No. of participants	Statistical method	Effect size
7.1 Behaviour, mood and depression	1		Other data	No numeric data

Analysis 7.1. Comparison 7: Garden vignette vs. traditional environment, Outcome 1: Behaviour, mood and depression

Behaviour, mood and depression

Study	Measure	Garden vignette	Traditional	Sample size	Effect estimate
Marcy-Edwards 2011	Neuropsychiatric Inventory-Nursing Homes (NPI, NH), (mean change (SD)) (lower scores = better)	12.4 (66.1)	-0.4 (19)	33	MD (95% confidence interval): 12.8 (-10.7 to 36.3)

APPENDICES

Appendix 1. Search strategies

MEDLINE

OVID

1.	aged/

(Continued)

2.	"aged, 80 and over"/
3.	frail elderly/
4.	(geriatric? or senior? or elderly or aged).ti,ab.
5.	(older adult? or older person? or older people or older patient?).ti,ab.
6.	geriatrics/
7.	*geriatric dentistry/
8.	*geriatric nursing/
9.	geriatric assessment/
10.	*geriatric psychiatry/
11.	"health services for the aged"/
12.	or/1-11
13.	long-term care/
14.	long-term care.ti,ab.
15.	(long stay adj2 (care or healthcare or service? or treatment? or patient? or resident?)).ti,ab.
16.	(function* adj2 (dependen* or independen* or limit* or decline* or status or impair*)).ti,ab.
17.	(candidate? adj3 (institution* or deinstitution* or home or place*)).ti,ab.
18.	(residential adj3 (care or healthcare or facilit*)).ti,ab.
19.	residential facilities/
20.	assisted living facilities/
21.	group homes/
22.	(group? adj (home? or living)).ti,ab.
23.	halfway houses/
24.	halfway hous*.ti,ab.
25.	homes for the aged/
26.	intermediate care facilities/
27.	skilled nursing facilities/
28.	hospice?.ti,ab.
29.	hospices/

(Continued)

30.	or/13-29
31.	nursing homes/
32.	nursing home?.ti,ab.
33.	12 and 30
34.	or/31-33
35.	exp health facility environment/
36.	exp "facility design and construction"/
37.	(environment* adj2 (person-centered or person-centred or attribute* or model? or change? or built or scale or modif* or special* or design* or physical or safe or stimul* or home* or house* or access* or improv* or facilit* or residential* or infrastructur* or adjust* or adapt* or living)).ti,ab.
38.	((men* or communit*) adj2 shed?).ti,ab.
39.	(architectur* or cottage model? or green house or home-like or homelike or person-centered or person-centred or outdoor* or garden* or private room* or quiet room* or lighting or paint* or colour? or color? or floor* or dining or kitchen* or reminiscen* or small-scale or large-scale or furnishing*).ti,ab.
40.	or/35-39
41.	34 and 40
42.	randomized controlled trial.pt.
43.	controlled clinical trial.pt.
44.	multicenter study.pt.
45.	pragmatic clinical trial.pt.
46.	(randomis* or randomiz* or randomly).ti,ab.
47.	groups.ab.
48.	(trial or multicenter or multi center or multicentre or multi centre).ti.
49.	(intervention? or effect? or impact? or controlled or control group? or (before adj5 after) or (pre adj5 post) or ((pretest or pre test) and (posttest or post test)) or quasiexperiment* or quasi experiment* or pseudo experiment* or pseudoexperiment* or evaluat* or time series or time point? or repeated measur*).ti,ab.
50.	non-randomized controlled trials as topic/
51.	interrupted time series analysis/
52.	controlled before-after studies/
53.	or/42-52

(Continued)

54.	exp animals/
55.	humans/
56.	54 not (54 and 55)
57.	review.pt.
58.	meta analysis.pt.
59.	news.pt.
60.	comment.pt.
61.	editorial.pt.
62.	cochrane database of systematic reviews.jn.
63.	comment on.cm.
64.	(systematic review or literature review).ti.
65.	or/56-64
66.	53 not 65
67.	41 and 66

Embase

OVID

1.	exp aged/
2.	geriatrics/
3.	exp elderly care/
4.	(older adult? or older person? or older people or older patient?).ti,ab,kw.
5.	(geriatric? or senior? or elderly or aged).ti,ab,kw.
6.	or/1-5
7.	long term care/
8.	(long-term adj2 (care or healthcare or service? or treatment? or patient? or resident?)).ti,ab,kw.
9.	(long stay adj2 (care or healthcare or service? or treatment? or patient? or resident?)).ti,ab,kw.
10.	(function* adj2 (dependen* or independen* or limit* or decline* or status or impair*)).ti,ab,kw.

(Continued)

11.	(candidate? adj3 (institution* or deinstitution* or home or place*)).ti,ab,kw.
12.	(residential adj3 (care or healthcare or facilit*)).ti,ab,kw.
13.	residential home/
14.	assisted living facility/
15.	(assisted living facilit* or assisted care facilit*).ti,ab,kw.
16.	(group? adj (home? or living)).ti,ab,kw.
17.	halfway house/
18.	halfway hous*.ti,ab,kw.
19.	hospice/
20.	hospice?.ti,ab,kw.
21.	or/7-20
22.	home for the aged/
23.	nursing home/
24.	nursing home?.ti,ab,kw.
25.	6 and 21
26.	or/22-25
27.	(facilit* adj2 (design or designed or designing or designs)).ti,ab,kw.
28.	(single adj2 room?).ti,ab,kw.
29.	built environment?.ti,ab,kw.
30.	(environment* adj2 (person-centered or person-centred or attribute* or model? or change? or built or scale or modif* or special* or design* or physical or safe or stimul* or home* or house* or access* or improv* or facilit* or residential* or infrastructur* or adjust* or adapt* or living)).ti,ab,kw.
31.	((men* or communit*) adj2 shed?).ti,ab,kw.
32.	(architectur* or cottage model? or green house or home-like or homelike or person-centered or person-centred or outdoor* or garden* or private room* or quiet room* or lighting or paint* or colour? or color? or floor* or dining or kitchen* or reminiscen* or small-scale or large-scale or furnishing*).ti,ab,kw.
33.	environmental planning/
34.	or/27-33
35.	26 and 34
36.	randomized controlled trial/

(Continued)

37.	controlled clinical trial/
38.	quasi experimental study/
39.	pretest posttest control group design/
40.	time series analysis/
41.	experimental design/
42.	multicenter study/
43.	(randomis* or randomiz* or randomly).ti,ab.
44.	groups.ab.
45.	(trial or multicentre or multicenter or multi centre or multi center).ti.
46.	(intervention? or effect? or impact? or controlled or control group? or (before adj5 after) or (pre adj5 post) or ((pretest or pre test) and (posttest or post test)) or quasiexperiment* or quasi experiment* or pseudo experiment* or pseudoexperiment* or evaluat* or time series or time point? or repeated measur*).ti,ab.
47.	or/36-46
48.	(systematic review or literature review).ti.
49.	"cochrane database of systematic reviews".jn.
50.	exp animals/ or exp invertebrate/ or animal experiment/ or animal model/ or animal tissue/ or animal cell/ or nonhuman/
51.	human/ or normal human/ or human cell/
52.	50 not (50 and 51)
53.	48 or 49 or 52
54.	47 not 53
55.	35 and 54

Cochrane Library

Wiley

#1.	[mh aged]
#2.	[mh "aged, 80 and over"]
#3.	[mh "frail elderly"]

(Continued)

#4.	(geriatric? or senior? or elderly or aged):ti,ab
#5.	(older next adult? or older next person? or older next people or older next patient?):ti,ab
#6.	[mh geriatrics]
#7.	[mh "health services for the aged"]
#8.	{or #1-#7}
#9.	[mh "long-term care"]
#10.	(long-term near/2 (care or healthcare or service? or treatment? or patient? or resident?)):ti,ab
#11.	(long stay near/2 (care or healthcare or service? or treatment? or patient? or resident?)):ti,ab
#12.	(function* near/2 (dependen* or independen* or limit* or decline* or status or impair*)):ti,ab
#13.	(candidate? near/3 (institution* or deinstitution* or home or place*)):ti,ab
#14.	(residential near/3 (care or healthcare or facilit*)):ti,ab
#15.	[mh "residential facilities"]
#16.	[mh "assisted living facilities"]
#17.	(assisted living facilit* or assisted care facilit*):ti,ab
#18.	[mh "group homes"]
#19.	(group? next (home? or living)):ti,ab
#20.	[mh "halfway houses"]
#21.	halfway next hous*:ti,ab
#22.	[mh "intermediate care facilities"]
#23.	[mh "skilled nursing facilities"]
#24.	hospice?:ti,ab
#25.	[mh hospices]
#26.	{or #9-#25}
#27.	[mh "homes for the aged"]
#28.	[mh "nursing homes"]
#29.	nursing next home?:ti,ab
#30.	#8 and #26
#31.	{or #27-#30}

(Continued)

#32.	[mh "health facility environment"]
#33.	[mh "facility design and construction"]
#34.	(facilit* near/2 (design or designed or designing or designs)):ti,ab
#35.	(single near/2 room?):ti,ab
#36.	built next environment?:ti,ab
#37.	(environment* near/2 (person-centered or person-centred or attribute* or model? or change? or built or scale or modif* or special* or design* or physical or safe or stimul* or home* or house* or access* or improv* or facilit* or residential* or infrastructur* or adjust* or adapt* or living)):ti,ab
#38.	((men* or communit*) near/2 shed?):ti,ab
#39.	(architectur* or (cottage next model?) or (green next house) or home-like or homelike or person-centered or person-centred or outdoor* or garden* or (private next room*) or (quiet next room*) or lighting or paint* or colour? or color? or floor* or dining or kitchen* or reminiscen* or small-scale or large-scale or furnishing*):ti,ab
#40.	{or #32-#39}
#41.	#31 and #40

CINAHL PLUS

EBSCO

S1.	(MH "Aged+")
S2.	(MH "Geriatrics")
S3.	(MH "Health Services for the Aged")
S4.	geriatric? or senior? or elderly or aged
S5.	older adult? or older person? or older people or older patient?
S6.	S1 OR S2 OR S3 OR S4 OR S5
S7.	(MH "Long Term Care")
S8.	(MH "Residential Facilities")
S9.	(MH "Halfway Houses")
S10.	(MH "Skilled Nursing Facilities")
S11.	long-term N2 (care or healthcare or service? or treatment? or patient? or resident?)

(Continued)

S12.	long stay N2 (care or healthcare or service? or treatment? or patient? or resident?)
S13.	function* N2 (dependen* or independen* or limit* or decline* or status or impair*)
S14.	candidate? N3 (institution* or deinstitution* or home or place*)
S15.	residential N3 (care or healthcare or facilit*)
S16.	assisted living facilit* or assisted care facilit*
S17.	group? N (home? or living)
S18.	halfway hous*
S19.	hospice
S20.	(MH "Hospices")
S21.	S7 OR S8 OR S9 OR S10 OR S11 OR S12 OR S13 OR S14 OR S15 OR S16 OR S17 OR S18 OR S19 OR S20
S22.	(MH "Nursing Home Patients")
S23.	(MH "Nursing Homes")
S24.	nursing home
S25.	S6 AND S21
S26.	S22 OR S23 OR S24 OR S25
S27.	(MH "Nursing Home Design and Construction")
S28.	(MH "Facility Design and Construction+")
S29.	(MH "Health Facility Environment")
S30.	facilit* N2 (design or designed or designing or designs)
S31.	single N2 room?
S32.	built environment
S33.	environment* N2 (person-centered or person-centred or attribute* or model? or change? or built or scale or modif* or special* or design* or physical or safe or stimul* or home* or house* or access* or improv* or facilit* or residential* or infrastructur* or adjust* or adapt* or living)
S34.	(men* or communit*) N2 shed?
S35.	architectur* or cottage model? or green house or home-like or homelike or person-centered or person-centred or outdoor* or garden* or private room* or quiet room* or lighting or paint* or colour? or color? or floor* or dining or kitchen* or reminiscen* or small-scale or large-scale or furnishing*
S36.	S27 OR S28 OR S29 OR S30 OR S31 OR S32 OR S33 OR S34 OR S35
S37.	S26 AND S36

(Continued)

S38.	PT randomized controlled trial
S39.	PT clinical trial
S40.	PT research
S41.	(MH "Randomized Controlled Trials")
S42.	(MH "Clinical Trials")
S43.	(MH "Intervention Trials")
S44.	(MH "Nonrandomized Trials")
S45.	(MH "Experimental Studies")
S46.	(MH "Pretest-Posttest Design+")
S47.	(MH "Quasi-Experimental Studies+")
S48.	(MH "Multicenter Studies")
S49.	(MH "Health Services Research")
S50.	TI (randomis* or randomiz* or randomly) OR AB (randomis* or randomiz* or randomly)
S51.	TI (trial or effect* or impact* or intervention* or before N5 after or pre N5 post or ((pretest or "pre test") and (posttest or "post test")) or quasiexperiment* or quasi W0 experiment* or pseudo experiment* or pseudoexperiment* or evaluat* or "time series" or time W0 point* or repeated W0 measur*) OR AB (trial or effect* or impact* or intervention* or before N5 after or pre N5 post or ((pretest or "pre test") and (posttest or "post test")) or quasiexperiment* or quasi W0 experiment* or pseudo experiment* or pseudoexperiment* or evaluat* or "time series" or time W0 point* or repeated W0 measur*)
S52.	S38 OR S39 OR S40 OR S41 OR S42 OR S43 OR S44 OR S45 OR S46 OR S47 OR S48 OR S49 OR S50 OR S51
S53.	S37 AND S52
S54.	S53 Limiters - Exclude MEDLINE records

PsycINFO

EBSCO

S1.	(MH "Aged+")
S2.	(MH "Geriatrics")
S3.	(MH "Health Services for the Aged")

(Continued)

S4.	geriatric? or senior? or elderly or aged
S5.	older adult? or older person? or older people or older patient?
S6.	S1 OR S2 OR S3 OR S4 OR S5
S7.	(MH "Long Term Care")
S8.	(MH "Residential Facilities")
S9.	(MH "Halfway Houses")
S10.	(MH "Skilled Nursing Facilities")
S11.	long-term N2 (care or healthcare or service? or treatment? or patient? or resident?)
S12.	long stay N2 (care or healthcare or service? or treatment? or patient? or resident?)
S13.	function* N2 (dependen* or independen* or limit* or decline* or status or impair*)
S14.	candidate? N3 (institution* or deinstitution* or home or place*)
S15.	residential N3 (care or healthcare or facilit*)
S16.	assisted living facilit* or assisted care facilit*
S17.	group? N (home? or living)
S18.	halfway hous*
S19.	hospice
S20.	(MH "Hospices")
S21.	S7 OR S8 OR S9 OR S10 OR S11 OR S12 OR S13 OR S14 OR S15 OR S16 OR S17 OR S18 OR S19 OR S20
S22.	(MH "Nursing Home Patients")
S23.	(MH "Nursing Homes")
S24.	nursing home
S25.	S6 AND S21
S26.	S22 OR S23 OR S24 OR S25
S27.	(MH "Nursing Home Design and Construction")
S28.	(MH "Facility Design and Construction+")
S29.	(MH "Health Facility Environment")
S30.	facilit* N2 (design or designed or designing or designs)
S31.	single N2 room?

(Continued)

S32.	built environment
S33.	environment* N2 (person-centered or person-centred or attribute* or model? or change? or built or scale or modif* or special* or design* or physical or safe or stimul* or home* or house* or access* or improv* or facilit* or residential* or infrastructur* or adjust* or adapt* or living)
S34.	(men* or communit*) N2 shed?
S35.	architectur* or cottage model? or green house or home-like or homelike or person-centered or person-centred or outdoor* or garden* or private room* or quiet room* or lighting or paint* or colour? or color? or floor* or dining or kitchen* or reminiscen* or small-scale or large-scale or furnishing*
S36.	S27 OR S28 OR S29 OR S30 OR S31 OR S32 OR S33 OR S34 OR S35
S37.	S26 AND S36
S38.	PT randomized controlled trial
S39.	PT clinical trial
S40.	PT research
S41.	(MH "Randomized Controlled Trials")
S42.	(MH "Clinical Trials")
S43.	(MH "Intervention Trials")
S44.	(MH "Nonrandomized Trials")
S45.	(MH "Experimental Studies")
S46.	(MH "Pretest-Posttest Design+")
S47.	(MH "Quasi-Experimental Studies+")
S48.	(MH "Multicenter Studies")
S49.	(MH "Health Services Research")
S50.	TI (randomis* or randomiz* or randomly) OR AB (randomis* or randomiz* or randomly)
S51.	TI (trial or effect* or impact* or intervention* or before N5 after or pre N5 post or ((pretest or "pre test") and (posttest or "post test")) or quasiexperiment* or quasi W0 experiment* or pseudo experiment* or pseudoexperiment* or evaluat* or "time series" or time W0 point* or repeated W0 measur*) OR AB (trial or effect* or impact* or intervention* or before N5 after or pre N5 post or ((pretest or "pre test") and (posttest or "post test")) or quasiexperiment* or quasi W0 experiment* or pseudo experiment* or pseudoexperiment* or evaluat* or "time series" or time W0 point* or repeated W0 measur*)
S52.	S38 OR S39 OR S40 OR S41 OR S42 OR S43 OR S44 OR S45 OR S46 OR S47 OR S48 OR S49 OR S50 OR S51
S53.	S37 AND S52

ProQuest dissertations and theses

TI,AB(geriatric* or senior* or elderly or frail or older) AND TI,AB(nursing home* or residential or long term care) AND TI,AB(design* or environment*) AND (SU(health*) OR TI(effect OR effects OR impact OR influenc* OR random* OR study OR controlled OR trial OR effectiveness) OR ALL(random* OR intervention OR collaborat* OR team* OR multidisciplin* OR multi-disciplin* OR crossdisciplin* OR cross-disciplin* OR interdisciplin* OR community OR quasi*) OR ALL(before NEAR/10 after) OR ALL(before NEAR/10 during) OR ALL("time series" OR timeseries) OR ALL((control* NEAR/2 group) OR (control NEAR/2 study) OR (control NEAR/2 cohort)))

Science Citation Index and Conference Proceedings Citation Index-Science

#1	TS=((geriatric? OR senior? OR elderly OR older) NEAR/1 (adult? OR person? OR people OR patient?))
#2	TS=(long NEAR/3 (care OR healthcare OR service? OR treatment? OR patient? OR resident?))
#3	TS=(function* NEAR/2 (dependen* OR independen* OR limit* OR decline* OR status OR impair*))
#4	TS=(candidate? NEAR/3 (institution* OR deinstitution* OR home OR place*))
#5	TS=(residential NEAR/3 (care OR healthcare OR facilit*))
#6	TS=(assisted living facilit* OR assisted care facilit*)
#7	TS=(group? NEAR/0 (home? OR living))
#8	TS=(halfway hous* OR hospice?)
#9	#8 OR #7 OR #6 OR #5 OR #4 OR #3 OR #2
#10	#9 AND #1
#11	TS=nursing home?
#12	#11 OR #10
#13	TS=(facilit* NEAR/2 (design OR designed OR designing OR designs))
#14	TS=(single NEAR/2 room?)
#15	TS=built environment?
#16	TS=(environment* NEAR/2 (person-centered OR person-centred OR attribute* OR model? OR change? OR built OR scale OR modif* OR special* OR design* OR physical OR safe OR stimul* OR home* OR house* OR access* OR improv* OR facilit* OR residential* OR infrastructur* OR adjust* OR adapt* OR living))
#17	TS=((men* OR communit*) NEAR/2 shed?)
#18	TS=(architectur* OR cottage model? OR green house OR home-like OR homelike OR person-centered OR person-centred OR outdoor* OR garden* OR private room* OR quiet room* OR lighting

(Continued)

	OR paint* OR colour? OR color? OR floor* OR dining OR kitchen* OR reminiscen* OR small-scale OR large-scale OR furnishing*)
#19	#18 OR #17 OR #16 OR #15 OR #14 OR #13
#20	#19 AND #12
#21	TS=(randomis* OR randomiz* OR randomly OR groups)
#22	TS=(trial OR multicenter OR "multi center" OR multicentre OR "multi centre")
#23	TS=(intervention* OR effect* OR impact* OR controlled OR "control group*" OR (before near/5 after) OR (pre near/5 post) OR ((pretest OR "pre test") AND (posttest OR "post test")) OR quasiexperiment* OR "quasi experiment*" OR "pseudo experiment*" OR pseudoexperiment* OR evaluat* OR time series OR "time point*" OR "repeated measur*")
#24	#23 OR #22 OR #21
#25	#24 AND #20

Social Care Online (www.scie-socialcareonline.org.uk)

Title	nursing home
Title	OR residential
Title	OR long term care
Title	AND environment
Title	OR design
Title	OR architecture

WHO International Clinical Trials Registry Platform (ICTRP)

1.	nursing home AND environment
2.	nursing home AND design
3.	nursing home AND architecture
4.	residential AND environment
5.	residential AND design

(Continued)

6.	residential AND architecture
7.	long term care AND environment
8.	long term care AND design
9.	long term care AND architecture

US National Institutes of Health Ongoing Trials Register (Clinicaltrials.gov)

Other terms	nursing home OR long term care OR residential
Intervention / Treatment:	environment OR design OR architecture
age group	older adult (65+)
study type	interventional

ANZCTR (ANZCTR.org.au)

1.	nursing home AND environment
2.	nursing home AND design
3.	nursing home AND architecture
4.	residential AND environment
5.	residential AND design
6.	residential AND architecture
7.	long term care AND environment
8.	long term care AND design
9.	long term care AND architecture

HISTORY

Protocol first published: Issue 12, 2017

CONTRIBUTIONS OF AUTHORS

All authors contributed to design of the review protocol. SLH independently screened the abstracts and SMD, KEL and RKM screened abstracts in duplicate. SLH screened the full texts retrieved and SMD, KEL and RKM screened full-text articles in duplicate. SLH, SMD, KEL and RKM independently extracted data and assessed the risk of bias of included studies. SLH completed the GRADE summary tables and duplicate GRADE analysis was completed by SMD and KEL. SLH and SMD drafted the review and all authors reviewed and commented on drafts and approved the final version. All authors made substantial contributions to the conception and design of the work.

DECLARATIONS OF INTEREST

- SLH reports multiple academic publications on the topic of environmental design of aged care facilities. These publications are not included studies in the review.
- SMD reports employment managing a project examining models of residential aged care. The INSPIRED study was supported by funding from the National Health and Medical Research Council (NHMRC) Partnership Centre on Dealing with Cognitive and Related Functional Decline in Older People (CDPC, GNT9100000). Australian aged care service providers were partners in the NHMRC CDPC; they provided information on organisational structures of residential care and access to their facilities. SMD reports multiple academic publications on the topic of environmental design of aged care facilities and multiple unpaid conference presentations (oral and posters) on environmental design in aged care. These publications are not included studies in the review. SMD reports submissions to Australian government inquiries and research reports conducted for the Australian Aged Care Royal Commission that include information on the topic of environmental design in aged care. SMD also reports mainstream and social media dissemination of academic publications on environmental design of aged care facilities.
- KEL reports a fellowship from the Australian Research Council.
- RKM reports grant payments from ECH Inc., Helping Hand, Presbyterian Aged Care, Uniting and Uniting AgeWell. RKM is an author on multiple academic publications on the topic of environmental design of aged care facilities. These publications are not included studies in the review.
- RF reports consultancy payments from Richard Fleming and Associates which involves providing advice on environmental design for people living with dementia. RF is an author on an included study in the review, RF did not contribute to data extraction or assessment of risk of bias of this study.
- MC reports one grant from Amgen and a consultant role for the Royal Commission into Aged Care Quality and Safety. MC reports two academic publications on the topic of environmental design of aged care facilities. These publications are not included studies in the review. MC also works as a health professional (rehabilitation physician at Flinders Medical Centre).

SOURCES OF SUPPORT

Internal sources

- Flinders University, Australia

  SLH, SMD, KEL and MC are all staff at Flinders University and Flinders University provided the infrastructure for the project.
- Dementia Training Australia, Australia

  RF's funding was covered by Dementia Training Australia, a consortium of five universities and Alzheimer's Australia funded by the Australian Department of Health to develop, disseminate and implement new knowledge on the care of people with dementia.

External sources

- NHMRC Cognitive Decline Partnership Centre, Australia

  The salaries of SLH and SMD, and partly the salary of MC, are supported by funding provided by the National Health and Medical Research Council (NHMRC) Cognitive Decline Partnership Centre (grant no. GNT9100000).
- NHMRC-ARC Dementia Research Development Fellowship, Australia

  KEL is supported by a NHMRC-ARC Dementia Research Development Fellowship.
- NHMRC and Institute for Safety, Compensation and Recovery Research, Australia

  RKM is supported by grants from the NHMRC (grant nos. 1079542 and 1121334) and the Institute for Safety, Compensation and Recovery Research Collaborative Grant.

DIFFERENCES BETWEEN PROTOCOL AND REVIEW

In the protocol, we reported that secondary outcomes would include "dementia-specific measures (e.g. global behaviour measures with the Neuropsychiatric Inventory, depression as measured with the Cornell Scale for Depression in Dementia)". However, it is considered that these measures should not be examined separately to behaviour as some measures, including the Neuropsychiatric Inventory, may be

used for people not living with dementia and all depression measures should also be considered as one outcome. Therefore, we removed "dementia-specific measures" as a secondary outcome. We also omitted 'protection against contamination' as one of the EPOC criteria for risk of bias in the protocol, so this was corrected and added in the review.

For the search strategy, we stated we would search Index to Theses, but this was no longer available, and the content was merged into ProQuest dissertations and theses which was searched. We also stated we would search Health Management Information Consortium (HMIC) Ovid, but this was not available at the University of Oxford where the search was conducted.

In the protocol, we stated we would create a Summary of findings table for the main intervention: whole-facility model compared to usual care or alternative designs. In this review, we also created Summary of findings tables for the lighting and dining room interventions to provide a succinct summary for the smaller interventions which focused on a specific component of design that was analysed quantitatively. In the Summary of findings table, we also grouped the outcomes 'measures of basic function' and 'measures of instrumental function' under one outcome 'function'.

The protocol named "behaviour, mood and depression" as a primary outcome. As this outcome encompasses a large range of possible outcomes and measures, only the two considered most informative were included in the Summary of findings tables. These are: global behaviour measures (as these capture a range of these outcomes) and depression, as this is a common and important negative mood symptom in residents of aged care homes.

The protocol did not specify time points for any of the outcomes. The most important time points for outcomes are considered to be in the range three to six months, as this allows adequate time for an intervention to have an effect, but is not such an extended follow-up that it will be against a background of large functional or cognitive decline or increased mortality in residents.

NOTES

This review is based on standard text and guidance provided by Cochrane Effective Practice and Organisation of Care (EPOC).

INDEX TERMS

Medical Subject Headings (MeSH)

*Activities of Daily Living; Bias; Controlled Before-After Studies; Interrupted Time Series Analysis; *Quality of Life

MeSH check words

Aged; Humans