

Web Annex F

Report of the systematic review on potential benefits of accessible home environments for people with functional impairments

**Malcolm MacLachlan, Hea Young Cho, Mike Clarke,
Hasheem Mannan, Bonnix Kayabu, Ramona Ludolph
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WHO Housing and health guidelines

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Introduction

This report assesses the potential benefits of an accessible home environment for people with functional impairments. We have conducted a systematic review of this topic to support the development of the World Health Organization's (WHO) Housing and health guidelines. The aim of this systematic review is to provide the best available evidence from existing research to contribute to the deliberations of the Guideline Development Group (GDG). This review has a specific focus on (1) people with functional impairments for whom accessibility modifications in their home environment may be beneficial; (2) a variety of home accessibility features; and (3) the health and social effects of modifications to enhance the accessibility of the home environment.

The structure of this report is as follows:

- Background: provides a brief contextualization of the home environment and disability, and the rationale for this systematic review.
- Eligibility criteria and Population, Intervention, Comparator, Outcome (PICO): outlines the PICO for this systematic review, and provides detailed inclusion and exclusion criteria.
- Search strategies and checking of articles: presents the process of searching and identifying articles.
- Extraction of information, preparation of narrative summaries, Evidence Profiles and Summary of Findings tables: provides the process of data extraction, quality assessment, and outcomes and findings presentation.
- Findings and discussions: summarises the results and discusses the findings.
- Comprehensive Appendices 1-11 present detailed information in relation to this systematic review.

Background

The United Nations (UN) Convention on the Rights of Persons with Disabilities, Article 9 safeguards the rights of persons with disabilities to live in an accessible physical environment, as well as the right to equal access to information and communications (UN 2006). Among physical environments, there is little doubt that the accessible domestic home is fundamental to enabling independent living for persons with disabilities. Home environments without the basic accessibility components can negatively impact on the daily activities of persons with disabilities. Those dependent on mobility devices may be confined indoors or even to very limited spaces within the dwelling, consequently violating their human rights and diminishing their quality of life. It is often assumed that persons with disabilities are a small proportion of the total population, but this is not so, and the World Report on Disability has estimated that more than a billion people, or 15% of the world's population, are believed to have some form of disability (WHO 2014).

The relationship between ageing and disability, and associated functional impairments is also becoming increasingly important (Crews & Zavotka 2006). The prolonged life expectancy over recent decades has resulted in a proportionately larger ageing of the population, especially in high-income countries (UN 2002). However, some of the fastest rates of population ageing are to be found in low- and middle-income countries (UN 2002). It

has been estimated that the current growth rate of the older population is significantly more rapid than the total population. More than 20% of the world population is predicted to be aged 60 years or over by the year 2050, with the European region having the highest proportion, at an estimated 37% (UN 2002). Due to ageing related functional impairments, many older adults face the prospect of living with poor access to their own home environments; threatening their safety, and undermining their quality of life and possibilities to continue living in communities of their preference. It is well established that the majority of older adults wish to continue living in their own home independently (Gitlin 2003). However, they are often forced to move into nursing homes or other institutional settings, due to an increasing lack of accessibility to their home environments. Apart from diminishing people's quality of life, such institutional settings are also associated with higher economic costs to the individual and society (Smith et al. 2008).

According to the International Classification of Functioning, Disability and Health (ICF), disability is an umbrella term to indicate a decrement at each level consisting of impairments, activity limitations or participation restrictions (WHO 2002). Impairments refer to problems in body function that include physical and psychological features, or body structures (WHO 2002). It is important to note that disability is the experience that results from barriers that diminish activities and participation in society. Disability is an experience, not an attribute; how society is organised (for instance in terms of accessibility) determines whether someone with a functional impairment is 'disabled', or not. An accessible home can therefore prevent someone with impairments experiencing disability, at least whilst at home.

Although body functions and structures contain a broad range of categories including sensory and voice functions as per the ICF, functional impairments are often operationalized in terms of whether a person can accomplish Activities of Daily Living (ADL) and Instrumental Activities of Daily Living (IADL) (Freedman et al. 2004; Lakdawalla 2003). ADL applies to the basic tasks of everyday life such as bathing, dressing, transferring, toileting, continence and feeding (Katz et al. 1963; Katz 1983). While ADL is more related to personal self-care, IADL refers to a range of activities that are required for independent living in the community, such as preparing meals, housekeeping, taking medications, shopping, managing own finances, traveling, and using the telephone (Fillenbaum et al. 1978; Scotts 2007).

There are various labels that are used for access or accessibility in relation to home environments (Scotts 2007). For example, Universal Design is defined as the design, construction and adaptation of standard housing that can be used by all people regardless of their age, size or ability (Scotts 2007). On the other hand, Life Span Housing refers to housing that can accommodate changing capabilities of a person over his/her lifetime, also known as Lifetime Homes in the United Kingdom and Adaptable Housing in Australia (Scotts 2007). For the purpose of this review, the accessible home environment is defined as *one which allows a person with functional impairments to get into, out of, and circulate within the home, and to function independently*. An accessible home can be built on the principles of Universal Design or can be achieved through home modifications.

The relationship between the built environment and its effects on health and wellbeing has been widely studied (Humpel et al. 2002; Evans et al. 2003; Thomas et al. 2007). However, there has been little attention to the issue of the accessible home environment in the domestic context for persons with functional impairments. The environmental docility

hypothesis suggests that persons with low functional capacity are more likely to be vulnerable concerning environmental demands than are those with higher functional capacity (Lawton 1974). Home environments with barriers will create additional strains for persons with functional impairments. Home environments without accessibility features may consequently cause people with functional impairments to suffer a risk of falls and injuries as well as restriction of their social participation (Close et al. 1999). Furthermore, such environments increase the burden on caregivers and external social services, and negatively affect the quality of life and wellbeing of persons with impairments (Close et al. 1999; Whiteford 2000).

It has been estimated that there is a 60% probability that any new house in the United States of America (USA) will be resided by a person with a physical functional impairment over its lifespan (Smith et al. 2008). This issue of home accessibility does not only affect persons with ageing related functional impairments or other disabilities. Their caregivers and visitors will also greatly benefit from the accessible home environment (Saville-Smith & Fraser 2007). The importance of an accessible home environment is most likely to grow due to the prevalence of functional impairments in an increasingly ageing population. It is therefore important to evaluate the effects of interventions intended to make homes more accessible. This is the purpose of the present systematic review of the existing literature on this topic.

Eligibility criteria and PICO

The research question had originally been designed as a PECO study; comparing a group of people with functional impairments who are exposed to living in home environments without accessibility modifications, to those living in home environments that had accessibility modifications. Following preliminary scoping of the topic, it was clear that there were very few, if any, PECO studies. Therefore, the research question was developed into a PICO question, comparing interventions, after consulting with the GDG.

PICO – Accessible home environments for people with functional impairments

The finalized research question to be answered is:

Do residents with functional or cognitive impairments living in accessible/usable home environments have better health/social outcomes than residents with functional or cognitive impairments living in conventional or unmodified home environments?

The PICO used for this question, which composed the basis of the search strategies to identify studies to be considered for this systematic review was:

- Context: Domestic home in the community setting
- Participants: People with physical or cognitive functional impairments
- Intervention: Living in accessible home environments
- Comparison: Living in conventional or unmodified home environments
- Outcomes: Health or social related changes

More detailed eligibility criteria are shown in Table 1.

Table 1 Inclusion and exclusion criteria for the review

	Inclusion criteria	Exclusion criteria
Context	Domestic houses or flats in the community setting, regardless of household tenure Indoor and immediate outside of house, and public spaces and mutual corridors in the case of blocks of flats or buildings	Hospitals Assisted living facilities Nursing/medical/residential/group home Public facilities and outdoors
Participants	People of all age groups who have functional impairments whether physical or cognitive Frail older adults	People who do not have any functional impairment Older adults with no functional impairments specified Older adults with a history of fall or at fall risk but no functional impairments specified People with (chronic) medical conditions but no functional impairments specified
Intervention	Interventions implemented (1) in physical environment and/or structure of home building AND (2) to enhance accessibility: <ul style="list-style-type: none"> • Modification of specific furniture and fixtures in the house • Structural changes to the inside and immediate outside of the house • Assistive devices/technology related to accessibility and affixed to the home physical structure • Home occupational/safety/environmental interventions that include the accessibility component as above • Multicomponent interventions that include the accessibility component as above 	Interventions other than those implemented in physical environment or structure of home building to enhance accessibility: <ul style="list-style-type: none"> • Assistive devices/technology unrelated to building structure or accessibility • Home occupational/safety/environmental interventions that do not include the accessibility component • Multicomponent interventions that do not include the accessibility component
Comparison	Two groups living in accessible and conventional/unmodified home environments Before and after intervention	Two groups with and without functional impairments
Outcomes	Health or social related outcomes: <ul style="list-style-type: none"> • Injury rates (especially falls) • Well-being/quality of life • Mental health/depression • Dependency on external social or care services • Social participation 	Outcomes that are not related to health or social elements of participants Outcomes that are measured jointly from home accessibility features and participants' health or social changes

Search strategies and checking of articles

Tailored and sensitive search strategies were developed by the expert search coordinator from the Centre for Reviews and Dissemination in York University, the United Kingdom, in liaison with the research team. The search strategy for MEDLINE (Appendix 1) was used as the basis for search strategies in the other databases (Appendices 2–6). The following electronic databases were searched in the first round of searches in 2014, and these (with the exception of OT Seeker) were searched again for more recent articles in April 2018:

- MEDLINE
- Cumulative Index of Nursing and Allied Health Literature (CINAHL)
- Cochrane Database of Systematic Reviews (CDSR) (in the Cochrane Library)
- Cochrane Central Register of Controlled Trials (CENTRAL) (in the Cochrane Library)
- Database of Abstracts of Reviews of Effects (DARE) (in the Cochrane Library)
- Health Technology Assessment (HTA) Database (in the Cochrane Library)
- National Health Service Economic Evaluation Database (in the Cochrane Library)
- Embase
- OT Seeker
- PsycINFO

Searches were conducted in English but there was no language restriction for studies to be eligible. There was no restriction on the selection of study type in searching either. It was planned that we would limit ourselves to studies with a high level of evidence only, if the number of such studies were sufficient for this review. We originally planned and carried out our electronic database searches without any time restriction in order to obtain as many studies as possible, and identified 26,782 records in the searches in late 2014. However, the GDG later set date limits to focus on studies published since 2004. This was more feasible for our review, as the number of the initial results was beyond the scope of the time frame and budget. Identifying and removing records that were published prior to 2004 was done within EndNote library by the expert search coordinator. Duplicates of records were identified and removed within each database first. After all the results from the databases were added to EndNote library, another round of de-duplication was carried out by the expert search coordinator. The searches for the initial version of the review were performed from December 2014 to January 2015, and a total of 12,544 records were selected for consideration for this review. The updated searches were run in April 2018 by one of the updating authors (RL) and a total of 6162 records (7351 before deduplication) published in 2015 or later were selected for consideration. The number of records retrieved from each database is shown in Tables 2a and 2b for the initial and updated search respectively.

Table 2a Records retrieved from search strategies in December 2014

Database	Records identified from database with no date restriction	Records loaded into Endnote after de-duplication within each database	Records identified limited to 2004 onwards
CDSR	46	46	43
DARE	24	24	19
HTA	6	6	5
NHS EED	17	17	13
CENTRAL	1 593	1 593	991
MEDLINE	6 829	5 635	3 593
EMBASE	5 142	5 113	3 561
PSYCINFO	5 996	5 993	3 645
CINAHL	7 035	6 612	4 780
OT Seeker	94	81	60
Total	20 786	25 120	16 710

* Total records identified with no date restriction after de-duplication in each database: 14 685 records (CINAHL & OT Seeker records not included in this total)

* Total records identified with 2004 onwards date restriction after de-duplication within EndNote: **12 544** records

Table 2b Records retrieved from search strategies in April 2018

Database	Records identified from database with publication date of 2015 to 2018	Records after de-duplication within each database
Cochrane Library	1 067	973
MEDLINE	1 803	1 531
EMBASE	1 271	638
PSYCINFO	1 680	1 642
CINAHL	1 530	1 340
Total	7 351	6 162

In the initial search, two reviewers (HYC and MC) independently screened a total of 12 544 record titles or titles and abstracts based on the pre-defined eligibility criteria. They used the EndNote library software programme for the screening process, which made the process efficient as both titles and abstracts were shown on the computer screen. Records where the two reviewers had a discrepancy were re-screened by the reviewers. Where there was any disagreement or ambiguity, a third reviewer (MM) assessed those and consensus was reached between the three researchers. Furthermore, where it was unclear whether to include or exclude studies from abstract screening, we retrieved the full text of the report. In the updated search, one author (RL) screened the 6162 record titles and abstracts based on the original eligibility criteria. She sent all potentially eligible records to a second author (MC) and, together, reached consensus on whether to obtain the full text article. Where it was unclear whether to include or exclude studies based on the title and abstract screening, we retrieved the full text of the report.

Theoretical papers and economic evaluations were excluded. The aim of searching was to identify primary and secondary (review) studies, including: journal articles, technical reports and accessible dissertations. Commentaries, editorials and abstracts with no full paper were excluded. Book chapters, book reviews, conference proceedings and policy reports were all closely scrutinised as sources for potentially eligible studies. Authors of papers were also contacted when more information was required.

In 2015, 99 citations were identified in the initial search for the full text screening. Snowballing was performed and as a result we identified two citations by reference checks of 16 excluded systematic reviews (Appendix 7) that concerned home environmental interventions or home interventions on older adult populations. Two more citations were identified by checking the reference lists of full papers. Of 103 studies, five studies were found to be duplications (Anttila 2012; Stineman 2012; H. Wahl 2009; Werngren-Elgstrom 2008; Werngren-Elgstrom 2009), two oral/poster presentations with no full paper (Dumas 2009; Kelly 2009), one oral presentation based on a MSc thesis that was unavailable (Dean 2007), and one protocol for a randomised trial with the results not ready to be disclosed (Waterman H VIP2UK). A total of 94 articles were judged by the researchers to be potentially eligible and full text assessments were completed of these. After the full text screening, we excluded 80 articles as shown in Appendix 8 (where reasons for exclusion are indicated). All three reviewers (HYC, MC and MM) agreed on the eligibility of the remaining papers. In 2018, two reviewers (MC and RL) agreed on the potential eligibility of seven additional papers, of which six were included and one was excluded because it focused on improvements in accessibility, rather than health outcomes (Granbom et al. 2016). Figure 1a shows the flow diagram for the identification of studies for this review in the initial round of searches and Figure 1b shows the data from the updated search.

Figure 1a Flow diagram for identification of studies up to May 2015

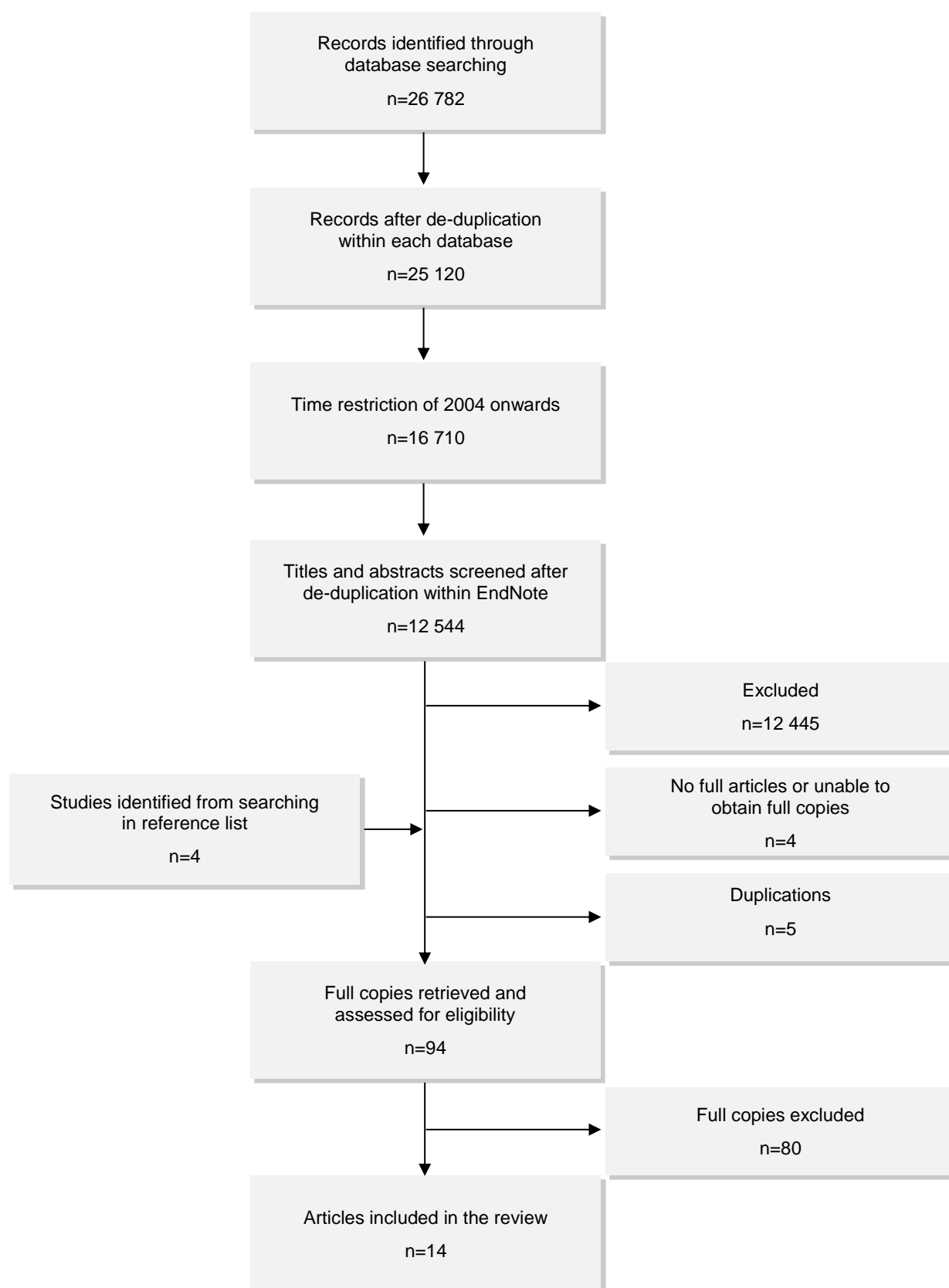
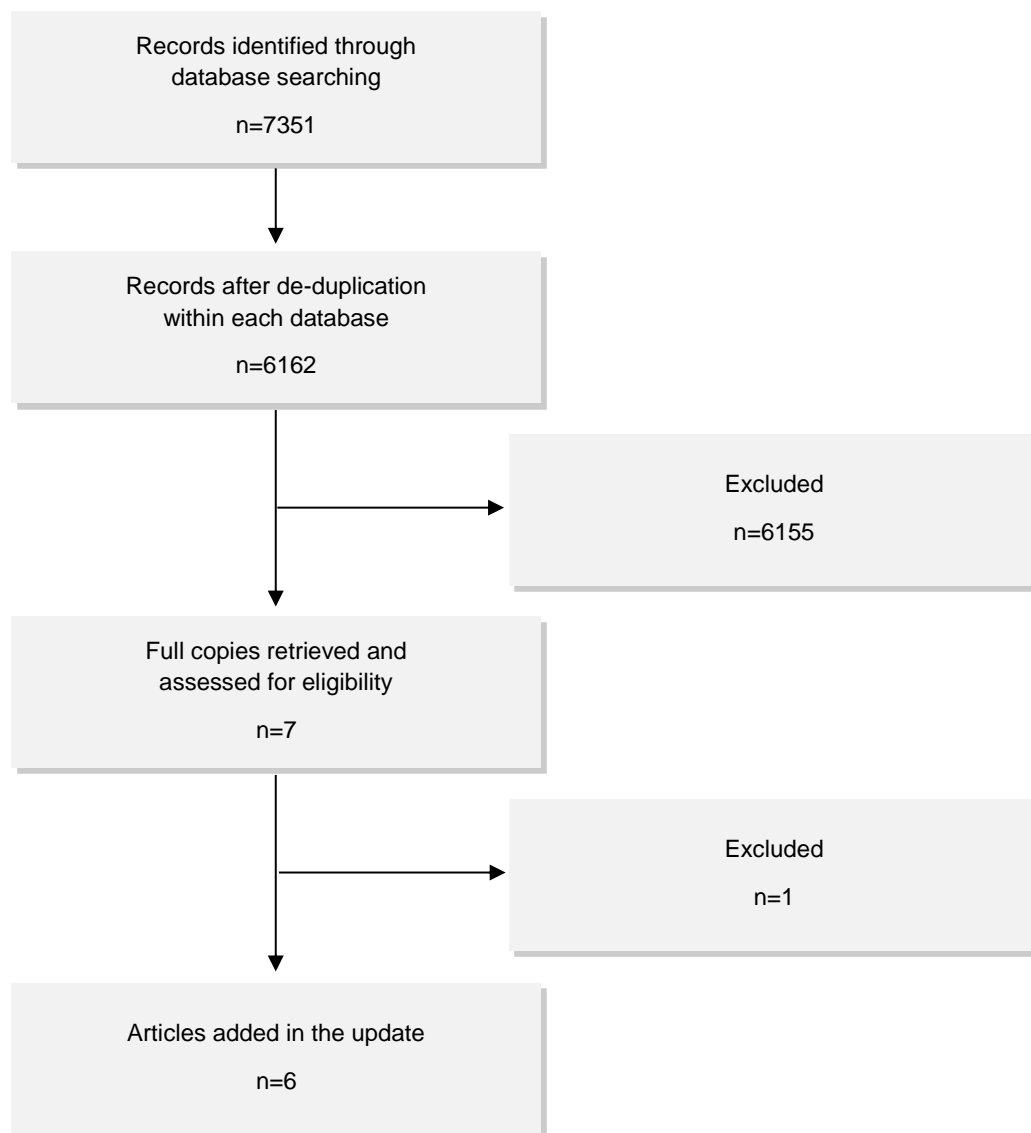


Figure 1b. Flow diagram for identification of studies in 2018



Extraction of information, preparation of narrative summaries, evidence profiles and summary of findings tables

After the full text screening process, if a study was judged to be potentially eligible for this review, necessary information was extracted, such as study type and setting, number of participants and types of functional impairments they had, inclusion and exclusion criteria, recruitment procedures, details of interventions and any comparators, outcome measures and results reported. Then, potentially eligible studies were discussed among all the researchers regarding their relevance to the PICO. When studies were confirmed to be included in this review, quality assessments were performed in relation to risk of bias, and other components such as inconsistency, indirectness and imprecision (Schünemann et al. 2011; Meader 2014).

As will be explained in the following section, one of the special characteristics of this review is that all types of study designs are included, such as studies with no comparison groups, correlation studies looking at the association between home accessibility features and outcomes, and a mixed-method study for which results are presented as qualitative themes. Therefore, domains of the Cochrane risk of bias tool did not seem applicable to some of the included studies for the quality assessment. The research team therefore chose the Mixed Method Appraisal Tool (MMAT), version 2011 (Appendix 9), in order to have coherence throughout all included studies when assessing their quality. The MMAT has been designed to appraise the methodological quality of studies included in complex systematic reviews that incorporate qualitative, quantitative and mixed-method studies (Pluye et al. 2009; Souto et al. 2015). The MMAT has a scoring metric whereby each study is scored between 1 as the lowest quality and 4 as the highest quality. The MMAT was used for the 14 included studies identified for the original review but, for consistency with other reviews in the updating, a simpler risk of bias assessment was done for the six studies added in the update.

The summary of findings and evidence profile table (Appendix 10) was completed using the information extracted and data from the quality assessment. The researchers reviewed and discussed the quality assessment results, the evidence table and summary of findings, easily reaching consensus.

Findings

Only a small number of studies were identified; thus all study types were included in this review: experimental, observational and descriptive studies; and quantitative and qualitative studies. We did not identify any meta-analysis or systematic review directly relevant to this PICO. Twenty studies were appropriate to be included in the review: seven randomised controlled trials (RCTs) (Ahmed 2013; Brunnström 2004; Campbell 2005; Edgren 2015; Giltlin 2006¹, 2006² & 2009), five quasi-experimental pre-/post-test (Carlsson 2017; Maggi 2018; Petersson 2008 & 2009; Tongsiri 2017), two non-randomised before and after (Fänge 2005; Stark 2004), one cohort (Tchalla 2012), four cross-sectional (Gitlin 2014; Norin 2017; Slaug 2017; Stineman 2007) and one mixed-method study (Heywood 2004). Among the 14 studies in the original review, there were four studies with the maximum MMAT score of 4, which indicates a low risk of bias. Six studies were given the MMAT score of 3 and four the score of 2. In the update, the six studies were assessed as having low or moderate risk of bias.

Full details of characteristics of included studies are presented in Appendix 11. Table 3 outlines the included studies.

Table 3 Studies presented to Guidelines Development Group

No.	Study	Location	Study type	Outcomes
1	Ahmed 2013	Pakistan	RCT	Quality of life
2	Brunnström 2004	Sweden	RCT	Certainty in performing activities, quality of life
3	Campbell 2005	New Zealand	RCT	Falls and injuries, economic evaluation
4	Carlsson 2017	Sweden	Quasi-experimental pre/post-test	Falls and fear of falling
5	Edgren 2015	Finland	RCT	ADL
6	Fänge 2005	Sweden	Longitudinal before/after	Dependence in ADL/IADL, usability
7	Gitlin 2006 ¹	USA	RCT	Difficulty and self-efficacy in ADL/IADL/mobility/transfer, fear of falling, home hazards and control-oriented strategy use
8	Gitlin 2006 ²	USA	RCT	Mortality
9	Gitlin 2009	USA	RCT	Mortality
10	Gitlin 2014	USA	Cross-sectional	N/A
11	*Heywood 2004	the United Kingdom	Mixed method	Health gains and benefits
12	Maggi 2018	Belgium	Quasi-experimental pre/post-test	Falls
13	Norin 2017	Sweden	Cross-sectional	Participation in society
14	Petersson 2008	Sweden	Quasi-experimental pre/post-test	Independence, difficulty and safety in ADL/IADL/mobility/leisure
15	Petersson 2009	Sweden	Quasi-experimental pre/post-test	Difficulty in ADL/IADL/mobility/leisure
16	Slaug 2017	Germany and Sweden	Cross-sectional	ADL
17	Stark 2004	USA	Non-randomised before/after	Occupational performance
18	Stineman 2007	USA	Cross-sectional	N/A
19	Tchalla 2012	France	Cohort	Falls
20	Tongsiri 2017	Thailand	Quasi-experimental pre/post-test	Functional dependence and health-related quality of life

* This is an additional report focusing on health related outcomes following the primary report (Heywood, 2001) of the research study.

Participants

Although all the study participants were adults or older adults (except for one study that included children (Heywood 2004)), studies had participants whose average age varied. Types of functional impairments also varied, although the majority of study participants were those with physical impairments; one cross-sectional study (Gitlin 2014) had participants with cognitive impairments. While some studies reported participants with specific functional impairments (such as paraplegia and visual impairments), the majority used diverse terms for and definitions of functional impairments in general, as can be seen in Table 4:

Table 4 Descriptions of functional impairments in studies included

Types of or terms used for functional impairment	Definition provided	Age group
Low vision ²	Visual acuity ≤ 0.3 (equal to 6/18)	Adults: no minimum age specified
Severe visual impairment ³	Visual acuity $\leq 6/24$	Older adults ≥ 75 years
Paraplegia ¹	N/A	Adult: no minimum age specified
Functional limitation ⁶	Being considered for housing adaptation	Adults >18 years
Functional impairment ¹⁷	Problems in one or more areas of the functional independence measure motor scale	Older adults: no minimum age specified
Functional difficulty ^{7,8,9}	Self-reported difficulties or need for help in at least one in ADL, and at least two in IADL	Older adults ≥ 70
Disability ^{4,5,11,14,15,18, 20}	Recipients of housing adaptation	Adults >20 years and all age groups
	Operated for hip fracture	Adults >60 years
	Problems in everyday life and requesting home modifications related to at least one of areas: getting in and out of the home, mobility indoors, self-care in the bathroom	Adults ≥ 40 years
	Limitations in kind and amount of activities or work, receipt of any form of insurance or financial support because of disability, limitation in sensation or communication, or use of mobility devices, artificial limb, etc.	Adults >18 years
Frail older ^{12,19}	Fried frailty criteria ≥ 3 , and losing functional autonomy as per functional autonomy measure system profile	Older adults ≥ 65 years
Dementia ¹⁰	Not provided	Adults: no minimum age specified

* Number refers to study ID number according to Table 3.

Interventions and home accessibility features

Interventions implemented to enhance home accessibility features were home modifications, described as housing adaptations or in some studies home safety programmes. Home modifications were carried out either as a sole intervention (Ahmed 2013; Brunnström; Fänge 2005; Petersson 2008 & 2009; Heywood 2004; Norin 2017; Slaug 2017; Stark 2004) or part of the multicomponent programme (Carlsson 2017; Edgren 2015; Gitlin 2006¹, 2006² and 2009; Maggi 2018; Tchalla 2012; Tongsiiri 2017). Furthermore, the safety component of these, such as hazard reduction, tended to be integrated with the accessibility interventions. Home modifications were mainly focused on architectural changes or fitted devices such as grab bars, targeting mobility issues; a few focused on lighting improvements or adjustments targeting vision. One cohort study (Tchalla 2012) had a distinctive intervention that was the installation of a light path near the bed, coupled with tele-assistance: this aimed to reduce falls at night among frail older adults. One RCT (Campbell 2005) had a factorial design that allowed for evaluating the effect of each intervention, and any possible interactions between interventions: home safety programmes; exercise programme; and social visits. Two cross-sectional studies (Gitlin 2014; Stineman 2007) reported the association between accessible home environments, ADL and quality of life. Table 5 provides descriptions of accessibility features identified from each study included in the original version of this review:

Table 5 Descriptions of accessibility features in each study included

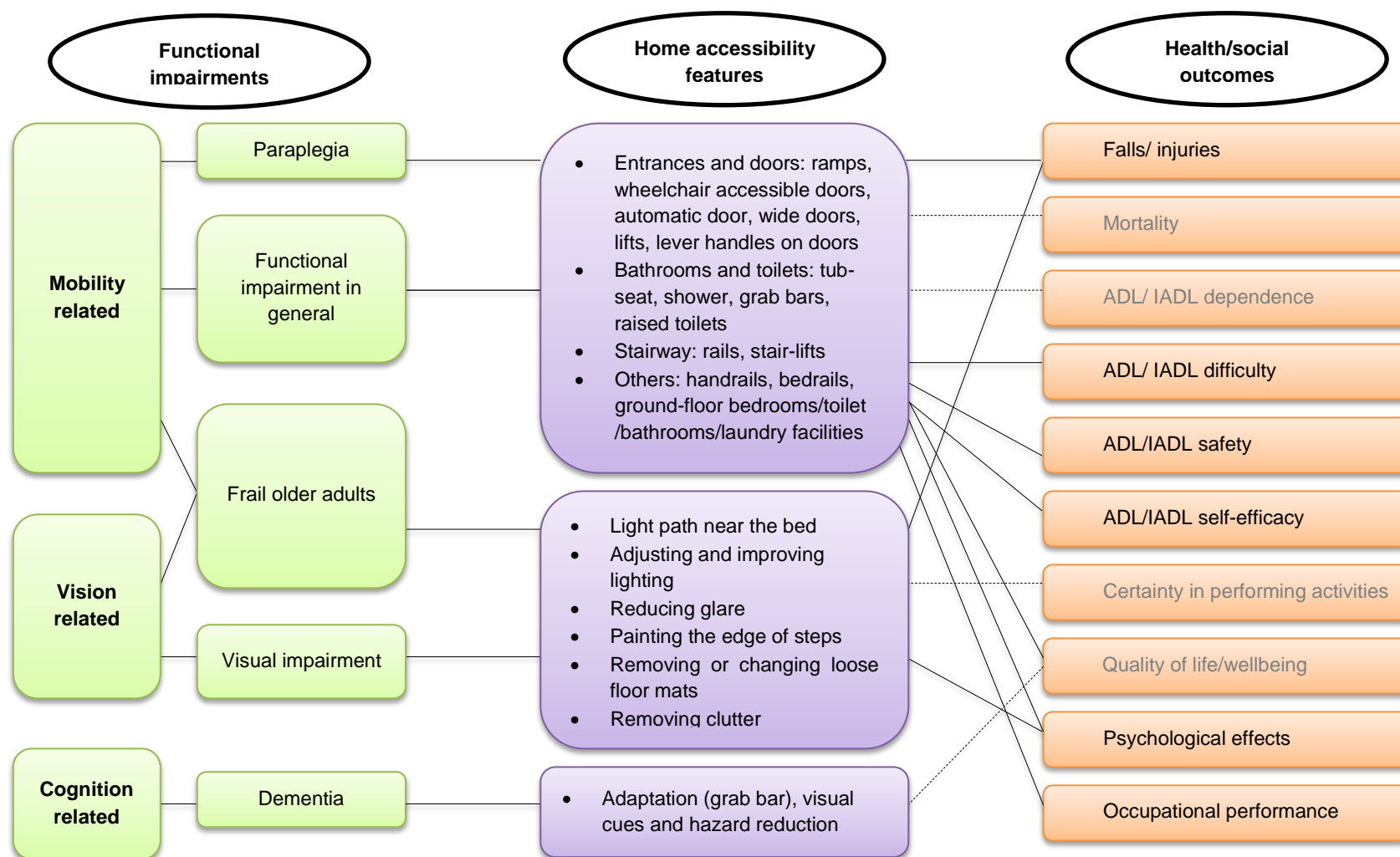
Intervention	Accessibility features	Related function
Home modification as a sole intervention	Targeting hygiene facilities (installation of grab bars in the bathtub or shower, replacing the bathtub with a shower), entrances including balcony and patio, stairways and doors (automatic door openers). A few adaptations targeting floor surfaces in bathrooms.	Mobility ^{6,14,15}
	Wheelchair accessible doors, ramps, rails, tub seat in bathrooms, non-slip surface	Mobility ¹
	Handrails, grab bars, ramps, hand-held shower, raised toilet, roll-in shower, widened door, relocating laundry facilities to ground floor, bed rail, designated parking area on street Lever handles on doors Additional lighting Safety features (deadbolts, smoke detectors) and adaptive equipment (reachers, tub benches) included	Mobility & vision ¹⁷
	Lighting adjustments in the kitchen, bathroom, hall and living room	Vision ²
	Reducing glare, improving lighting Painting the edge of steps Installation of grab bars, stair rails Removing or changing loose floor mats, removing clutter	Vision & mobility ³
	Minor adaptations: handrails, grab-rails Major adaptations: stair-lifts, bathroom conversions providing level-access shower, extensions to provide ground-floor bedroom, bathroom or both, stair-and through-floor lifts, installations of downstairs toilets, door widening, ramps, kitchen alteration Heating included	Mobility ¹¹
Multi-component interventions	Installation of grab bars, rails, raised toilet seats Occupational therapy sessions (training of problem solving strategies, energy conservation, safe performance, fall recovery technique) and physiotherapy sessions	Mobility ^{7,8,9}
	Light path installed near the bed with tele-assistance	Vision ¹⁹
N/A (cross-sectional studies)	Home environmental assessment protocol: hazards (access to dangerous objects), adaptation (grab bars, visual cues)	Cognition ¹⁰
	Environmental accessibility barriers: wide doorways, ramps, railings, automatic doors, elevators, bathroom, kitchen or other modification	Mobility ¹⁸

* Number refers to study ID number according to Table 3.

Effects of interventions on outcomes

Several different outcomes of home accessibility interventions were identified. Some of the outcomes were directly related to physical health, such as falls and mortality, and some were related to quality of life and psychological health. Occupational performance was also reported as an outcome of home modifications. Outcomes were almost always collected via self-report, but mortality was obtained from the National Death Index (Gitlin 2006² & 2009), and fall induced serious injuries were obtained from hospital and general practice records (Campbell 2005). The Evidence Table (Appendix 10) provides more detailed information on the effects of interventions on outcomes, along with the level of quality of the evidence. Associations between types of functional impairments, home accessibility features, and effects identified from the included studies are schematically illustrated in Figure 2.

Figure 2 Associations between functional impairments, home accessibility features and outcomes



* Note: shows no significant or inconsistent associations/effects.

Activities of daily living

Eight studies reported the effects of interventions on ADL/IADL related outcomes. In addition, one population-based survey identified a strong association between self-recognised difficulty managing ADL and perceived unmet needs for home accessibility features among people with physical impairments, after adjusting for severity of their physical limitations (Stineman 2007). Considerable decreases in perceived difficulties performing ADL/IADL were identified after home modifications and a multicomponent programme (Petersson 2008 & 2009; Gitlin 2006¹), whereas difficulty with mobility/transfer did not significantly change (Gitlin 2006¹). Besides perceived difficulty, several other aspects in performing ADL/IADL were reported: safety, dependence, self-efficacy and certainty. Self-efficacy, which was defined as confidence in managing difficulty, was improved in the intervention group after the multicomponent programme among older adults with functional impairments (Gitlin 2006¹). Increased safety with ADL/IADL was also identified two months after home modifications among adults with impairments (Petersson 2008). In particular, the greatest benefits were identified to be regarding difficulty and safety in bathroom use and entry access (Petersson 2008). Gitlin 2006¹ also found that the biggest benefit was in relation to difficulty in bathing and toileting. A quasi-experimental study conducted in Thailand found that home modifications improved abilities in all function areas except for participants with severe degrees of difficulties (Tongsiri 2017), and a cross-sectional study involving participants from Sweden and Germany showed improvements in various aspects of ADL (Slaug 2017).

On the other hand, three studies found no significant change in dependence with ADL/IADL after home modifications (Edgren 2015; Fänge 2005; Petersson 2008). However, it was noted that dependence in bathing was significantly decreased between 2-3 months and 8-9 months after home modifications (Fänge 2005). Furthermore, one RCT (Brunnström 2004) did not identify a significant improvement overall in self-rated certainty in performing specific activities six months after lighting adjustments. Only certainty in performing activities of 'pour drink' and 'slice bread' on the working surface of the kitchen improved significantly six months after the intervention.

Falls/injuries and mortality

Four studies reported on the effectiveness of interventions to reduce the likelihood of falls and injuries (Campbell 2005; Carlsson 2017; Maggi 2018; Tchalla 2012). One RCT (Campbell 2005) reported 41% fewer falls in one year follow-up in the home safety programme with a group of older adults with severe visual impairments, compared with those who did not receive this programme. Tchalla 2012 identified a significant reduction in falls at home and post-fall hospitalisations among frail older adults after the use of a light path coupled with tele-assistance. Carlsson 2017 found a clearer reduction in the number of falls in the intervention group than the control group. While a study of more than 1500 frail older adults in Belgium found that interventions offering home modifications and advice by occupation therapists produced a significant reduction in falls (Maggi 2018).

Two studies (Gitlin 2006² & 2009) reported a significantly lower mortality rate of up to two years in the intervention group over the control group after the implementation of the multicomponent programme, which included home modifications as well as training control-oriented strategies to promote healthy behaviours. However, there was no statistically significant effect on survival at three years post intervention.

Quality of life

Two RCTs (Ahmed 2013; Brunnström 2004) identified the positive effect of interventions on the quality of life. Ahmed 2013 found that quality of life was significantly enhanced in the intervention group, compared to the control group two months after home modifications among paraplegic wheelchair users. Also, additional lighting adjustments in the living room were found to increase quality of life and wellbeing among adults with low vision. Conversely, one cross-sectional study found no associations between the quality of life, and home safety and accessibility factors such as hazards, grab bars and visual cues among adults with dementia (Gitlin 2014).

Psychological effects

Psychological effects of home accessibility interventions were identified (Gitlin 2006¹; Heywood 2004). For instance, significantly less fear of falling was identified among older adults with functional difficulties following a multicomponent home intervention (Gitlin 2006¹) and at three months (but not at six months) in adults who had received housing adaptation (Carlsson 2017). One mixed-method study (Heywood 2004), which presented findings as themes from the qualitative part of the study, also identified a reduced fear of accidents: 62% of the recipients of minor adaptations, mainly handrails and grab-rails, reported 'feeling safer from accidents', as well as recipients of major adaptations expressing the relief of feeling safer. In addition, 'ending depression' was identified in the theme of health gains from good quality adaptations for people with physical impairments.

Occupational performance

Stark 2004 reported a significant increase in self-perceived occupational performance up to six months after home modifications among low-income adults with functional impairments. The outcome measurement included self-care (personal care, functional mobility and community management), productivity in work, household and play/school, and leisure (quiet recreation, active recreation and socialisation) (Law et al. 1990).

Participation

One cross-sectional study conducted in Sweden concluded that accessibility problems were significantly associated with less participation and autonomy and more participation problems (Norin 2017).

Discussion

The aim of this systematic review was to present the best available evidence on the health and social effects of the accessible home environment for people with functional impairments for consideration by the GDG. To the best of our knowledge, this is the first systematic review of such a topic, particularly on a population with impairments in general. This review found evidence for the positive effect of accessible home environments among people with either ageing related functional impairments or other impairments from other causes. Although this review contains studies with a low level of quality of evidence, it is important to gather and synthesise the existing evidence in order to guide further research and develop guidelines based on the best evidence available.

Overall findings of this review suggest that, in general, people with disabilities living in accessible home environments have better health, well-being and ADL/IADL than those living in conventional or inaccessible home environments. Physical health benefits were identified, such as reductions in falls and injuries. Lower mortality rates were also identified among older adults with functional impairments up to two years after a multicomponent home intervention. Self-perceptions of increased quality of life and general wellbeing were found, along with psychological effects such as less fear of falling/accidents and reduced feeling of depression. As fear of falling is known to be a strong risk factor for functional decline and falls (Gitlin 2006¹) this reduction in fear is an important finding. Furthermore, home modifications decreased difficulties and increased safety and self-efficacy in ADL/IADL outcome measures (Gitlin 2006¹; Pettersson 2008 & 2009). This suggests that people who already have difficulties functioning in everyday life can benefit from home accessibility features, possibly delaying deterioration of their already limited functions.

The GDG directed us towards five outcomes of particular interest to them. However, not all of these outcomes were identified from the studies included in this review. First, no study reported dependency on external social care services when assessing the effects of the interventions. Instead, the majority of the outcomes were elements in performing ADL/IADL. It seems that longitudinally, improvements in managing ADL/IADL, such as safety, may delay people with impairments being reliant on caregivers or social services. Some psychometric instruments used in the included studies seem to contain rather broad components. For example, occupational performance was reported in one study (Stark 2004) in terms of performance, and satisfaction with performance in work and leisure. Also, the 'C-CAP part 1', which was used in two studies (Pettersson 2008 and 2009), contains a leisure and social activities component, although the remainder is related to ADL, IADL and mobility. Furthermore, one of the studies identified in the updating of the review showed improvements in social participation with increased accessibility of housing (Norin 2017).

It is noticeable that some studies found no significant change in perceived dependence with ADL/IADL after home modifications (Edgren 2015; Fänge 2005; Petersson 2008). This is a critical finding, as one of the purposes for providing interventions that enhance home accessibility features is to increase the functional independence of people with impairments. However, the participants in these studies were ageing populations, and one study focused on those recovering from surgery following a hip fracture. Thus, their functions may rapidly decline, which means specific home modifications might have an effect for a short period of time only (Gitlin 1998). Furthermore, the primary goal of home modifications for older adults with impairments may be to enable them to live in their home, rather than increasing their independence per se (Petersson 2008).

Several studies indicated that people with functional impairments received the greatest benefits from interventions in terms of bathroom use, such as bathing, showering and toileting (Fänge 2005; Gitlin 2006¹; Petersson 2008). This may be because half of ADL tasks focus on the bathroom; also a large number of home adaptations have targeted hygiene facilities (Fänge 2005). Nonetheless, this is an important finding because it can inform planning for home modifications for people with impairments. Furthermore, Heywood 2004 identified from their interviews with participants that home modifications which were inadequately implemented due to bad planning or administrative errors, actually had a negative impact on physical and mental health of persons with impairments. This indicates

that home modification planning should consult with service users as well as health and architectural professionals.

The search strategy was not restricted to any type of functional impairment. Nonetheless, all included studies, except for one, were with participants who had physical impairments. During the screening process it was clear that studies on home environments for people with cognitive impairments were concerned with other environmental matters, for instance, 'the creation of safe and secure, simple and well-structured, and familiar environments' for older adults with dementia (Van Hoof et al. 2010). Nevertheless, those environmental factors may not necessarily be related to the quality of life: no association was found between patient-perceived quality of life and home accessibility and safety factors among adults with dementia (Gitlin 2014). However, having more unmet assistive device/navigation needs and health conditions were associated with lower quality of life.

There are methodological limitations in the studies included in this review. First, this systematic review culminated in focusing on a relatively small number of papers with relatively small sample sizes in most instances; thus drawing any generalised conclusions is not feasible. Furthermore, the quality of the evidence compiled in this review is quite uneven. Non-randomised studies were included and only five RCTs of good quality were identified. However, it can be ethically questionable to randomise persons (and delay or not provide interventions) where intuitively an intervention seems to be of obvious benefit. It is also important to note that most of the studies included in this review were conducted in the USA and Sweden. While there is no comprehensive national programme and only a few local programmes for home modifications in the USA (Scotts et al. 2007), every local authority in Sweden has to provide home modifications for people with impairments by law (Petersson 2008). Therefore, the country and systems context in which interventions are evaluated may be quite different. For instance, allocating people to the comparison group, who have been scheduled for home modifications, may not be a possibility.

A further limitation is that most of the primary study outcomes were subjective self-reports (e.g. ADL/IADL), not objective performance-based measures. However, self-rated function has been found to be useful in clinical assessment as it is predictive of negative health consequences (Greiner et al. 1996). In addition, although outcomes are grouped in categories for the reason of convenience, it is important to acknowledge that ADL/IADL related outcomes – such as safety and self-efficacy – are not distinct from the psychological effects identified. Lastly, there are reliability and validity issues of some psychometric instruments used for ADL/IADL related outcomes, as noted in several papers (Brunnström 2004; Petersson 2008 & 2009).

Studies included in this review differ greatly in terms of the type of design and there is considerable heterogeneity in relation to participants, interventions and outcomes. Participants varied with regards to age, and the type and level of functional impairments. Elements of interventions were remarkably diverse. Despite the fact that mobility related modifications were the most common, some home modifications also included heating or lighting. In addition, for the multicomponent intervention it is not clear if the effect was directly from the accessibility component, and which part of the intervention was more effective. Numerous different psychometric instruments were used to measure the same outcomes such as quality of life and changes in ADL/IADL. This methodological and statistical heterogeneity made it unfeasible to perform a meta-analysis of the findings. Thus, we adopted a narrative approach

to synthesise the findings. While efforts were made to reduce the potential bias that a narrative approach might be prone to, this possibility still exists.

This systematic review was conducted to gather evidence on the effects of the accessible home environment for people with functional impairments, but the findings reach beyond this group. Benefits of accessibility features in the home environments were also apparent for caregivers and family members, who gained positive health impacts, such as greater safety, and prevention of falls and injuries (Heywood 2004). Furthermore, it was clear that a second person – usually also an older adult – in the household would also use the accessibility features such as rails or in the shower (Heywood 2004). From the public health point of view, this indicates that providing home accessibility interventions to persons with impairments may have additional benefits for others and prevent the development of impairments, thus enhancing quality of life and lowering the costs of health care.

In summary, home environments that lack accessibility modifications appropriate to the needs of their users are likely to result in people with physical impairments becoming disabled at home. With an increasingly ageing population this is a major concern and also related to the fundamental rights of persons with disabilities. This systematic review has provided an indication that, in general, interventions to enhance the accessibility of homes can have beneficial effects. However, the currently available research cannot yet be considered robust as a body of evidence but rather should be considered as providing some support for this finding, albeit with some exceptions. Future research may need to be more specific about the type of functional impairments, as different accessibility features may apply to mobility or cognitive impairments, for instance. As researchers cannot entirely control the home modification process, it is problematic to conduct controlled studies in the home environment. However, high-quality research is needed, especially longitudinal studies, using standardised outcome measurements, in order to obtain a stronger evidence base for the benefits of home accessibility interventions. As it is unlikely that improvements to accessibility in the home will be instigated one modification at a time, researchers will need to develop more sophisticated designs and analyses in order to partial out the effects of multiple interventions in different types of settings, and health and welfare systems.

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* Indicates the studies included in this systematic review.

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Appendices

Appendix 1a Search strategy for Ovid MEDLINE (2014)

***In-process and other non-indexed citations and Ovid MEDLINE(R) <1946 to present>
Search date: 22 December 2014***

Records identified: 6829 (5635 after de-duplication)

- 1 exp disabled persons/ (48958)
- 2 exp housing/ (26214)
- 3 1 and 2 (426)
- 4 (home or homes or house or houses or housing or residen\$ or built environment or living environment).ti. (111898)
- 5 1 and 4 (1382)
- 6 architectural accessibility/ or "facility design and construction"/ or residence characteristics/ or environment design/ (34524)
- 7 1 and 6 (1156)
- 8 ((home or homes or house\$ or housing or residen\$) adj2 (adapt\$ or modif\$ or access\$ or usability)).ti,ab. (2117)
- 9 (smart home\$ or smart home technolog\$).ti,ab. (193)
- 10 (assistive technolog\$ and (home or homes or house or houses or housing or residence\$ or built environment\$ or living situation)).ti,ab. (163)
- 11 environmental barrier\$.ti,ab. (430)
- 12 universal design.ti,ab. (148)
- 13 (disability or disabled or handicap\$).ti,ab. (129312)
- 14 2 and 13 (410)
- 15 ((disability or disabled or handicap\$ or frail\$) adj2 (home or homes or house or houses or housing or residen\$ or environment)).ti,ab. (592)
- 16 (home environment\$ adj2 intervention\$).ti,ab. (15)
- 17 (environment\$ intervention\$ adj2 home\$).ti,ab. (26)
- 18 person environment\$ fit.ti,ab. (139)
- 19 person-environment\$ fit.ti,ab. (139)
- 20 person environment\$-fit.ti,ab. (139)
- 21 person-environment\$-fit.ti,ab. (139)

- 22 (home or homes or house or houses or housing or residen\$ or built environment or living environment).ti,ab. (378471)
- 23 (functional\$ adj (handicap\$ or impair\$ or limit\$ or decline\$ or deficit\$ or disable\$ or disability)).ti,ab. (28806)
- 24 (cognitive\$ adj (handicap\$ or impair\$ or limit\$ or decline\$ or deficit\$ or disable\$ or disability)).ti,ab. (57923)
- 25 (mental\$ adj (handicap\$ or impair\$ or limit\$ or decline\$ or deficit\$ or disable\$ or disability)).ti,ab. (5162)
- 26 (physical\$ adj (handicap\$ or impair\$ or limit\$ or decline\$ or deficit\$ or disable\$ or disability)).ti,ab. (8385)
- 27 (motor adj (handicap\$ or impair\$ or limit\$ or decline\$ or deficit\$ or disable\$ or disability)).ti,ab. (11157)
- 28 (hearing adj (reduc\$ or loss or handicap\$ or impair\$ or limit\$ or decline\$ or deficit\$ or disable\$ or disability)).ti,ab. (39532)
- 29 ((vision or visual or sight) adj (reduc\$ or loss or handicap\$ or impair\$ or limit\$ or decline\$ or deficit\$ or disable\$ or disability)).ti,ab. (21276)
- 30 (blind or deaf or frail\$).ti,ab. (173515)
- 31 wheelchair user\$.ti,ab. (856)
- 32 amputee\$.ti,ab. (4124)
- 33 23 or 24 or 25 or 26 or 27 or 28 or 29 or 30 or 31 or 32 (338691)
- 34 2 and 33 (331)
- 35 (((functional\$ adj (handicap\$ or impair\$ or limit\$ or decline\$ or deficit\$ or disable\$ or disability)) or (cognitive\$ adj (handicap\$ or impair\$ or limit\$ or decline\$ or deficit\$ or disable\$ or disability)) or (mental\$ adj (handicap\$ or impair\$ or limit\$ or decline\$ or deficit\$ or disable\$ or disability)) or (physical\$ adj (handicap\$ or impair\$ or limit\$ or decline\$ or deficit\$ or disable\$ or disability)) or (motor adj (handicap\$ or impair\$ or limit\$ or decline\$ or deficit\$ or disable\$ or disability)) or (hearing adj (reduc\$ or loss or handicap\$ or impair\$ or limit\$ or decline\$ or deficit\$ or disable\$ or disability)) or ((vision or visual or sight) adj (reduc\$ or loss or handicap\$ or impair\$ or limit\$ or decline\$ or deficit\$ or disable\$ or disability)) or (blind or deaf) or wheelchair user\$ or amputee\$) adj (home or homes or house or houses or housing or residen\$ or built environment)).ti,ab. (170)
- 36 wheelchairs/ (3833)
- 37 2 and 36 (27)
- 38 22 and 36 (246)
- 39 communication aids for disabled/ (2187)

- 40 2 and 39 (6)
- 41 22 and 39 (82)
- 42 (mobility adj (impair\$ or device\$ or aid\$)).ti,ab. (934)
- 43 2 and 42 (6)
- 44 22 and 42 (171)
- 45 3 or 5 or 7 or 8 or 9 or 10 or 11 or 12 or 14 or 15 or 16 or 17 or 18 or 19 or 20 or 21 or 34 or 35 or 37 or 38 or 40 or 41 or 43 or 44 (6931)
- 46 (rat or rats or mouse or mice or poultry or pig or pigs or cat or cats or sheep or cow or cows).ti. (1370530)
- 47 45 not 46 (6829)

Appendix 1b Search strategy for Ovid MEDLINE (2018)

In-process and other non-indexed citations and Ovid MEDLINE(R) <1946 to present>
Search date: 10 April 2018

Records identified: 1803

Searches		Results
1	exp disabled persons/	58 754
2	exp housing/	29 635
3	1 and 2	467
4	(home or homes or house or houses or housing or residen\$ or built environment or living environment).ti.	130 581
5	1 and 4	1 608
6	architectural accessibility/ or "facility design and construction"/ or residence characteristics/ or environment design/	42 959
7	1 and 6	1 421
8	((home or homes or house\$ or housing or residen\$) adj2 (adapt\$ or modif\$ or access\$ or usability)).ti,ab.	2 738
9	(smart home\$ or smart home technolog\$).ti,ab.	304
10	(assistive technolog\$ and (home or homes or house or houses or housing or residence\$ or built environment\$ or living situation)).ti,ab.	229
11	environmental barrier\$.ti,ab.	612
12	universal design.ti,ab.	268
13	(disability or disabled or handicap\$).ti,ab.	157 581
14	2 and 13	447
15	((disability or disabled or handicap\$ or frail\$) adj2 (home or homes or house or houses or housing or residen\$ or environment)).ti,ab.	696
16	(home environment\$ adj2 intervention\$).ti,ab.	25
17	(environment\$ intervention\$ adj2 home\$).ti,ab.	40
18	person environment\$ fit.ti,ab.	160
19	person-environment\$ fit.ti,ab.	160
20	person environment\$-fit.ti,ab.	160
21	person-environment\$-fit.ti,ab.	160
22	(home or homes or house or houses or housing or residen\$ or built environment or living environment).ti,ab.	454 471
23	(functional\$ adj (handicap\$ or impair\$ or limit\$ or decline\$ or deficit\$ or disable\$ or disability)).ti,ab.	34 885
24	(cognitive\$ adj (handicap\$ or impair\$ or limit\$ or decline\$ or deficit\$ or disable\$ or disability)).ti,ab.	75 285

Searches		Results
25	(mental\$ adj (handicap\$ or impair\$ or limit\$ or decline\$ or deficit\$ or disable\$ or disability)).ti,ab.	5 430
26	(physical\$ adj (handicap\$ or impair\$ or limit\$ or decline\$ or deficit\$ or disable\$ or disability)).ti,ab.	9 841
27	(motor adj (handicap\$ or impair\$ or limit\$ or decline\$ or deficit\$ or disable\$ or disability)).ti,ab.	13 470
28	(hearing adj (reduc\$ or loss or handicap\$ or impair\$ or limit\$ or decline\$ or deficit\$ or disable\$ or disability)).ti,ab.	46 601
29	((vision or visual or sight) adj (reduc\$ or loss or handicap\$ or impair\$ or limit\$ or decline\$ or deficit\$ or disable\$ or disability)).ti,ab.	26 771
30	(blind or deaf or frail\$).ti,ab.	195 554
31	wheelchair user\$.ti,ab.	1 052
32	amputee\$.ti,ab.	4 815
33	23 or 24 or 25 or 26 or 27 or 28 or 29 or 30 or 31 or 32	398 879
34	2 and 33	398
35	((functional\$ adj (handicap\$ or impair\$ or limit\$ or decline\$ or deficit\$ or disable\$ or disability)) or (cognitive\$ adj (handicap\$ or impair\$ or limit\$ or decline\$ or deficit\$ or disable\$ or disability)) or (mental\$ adj (handicap\$ or impair\$ or limit\$ or decline\$ or deficit\$ or disable\$ or disability)) or (physical\$ adj (handicap\$ or impair\$ or limit\$ or decline\$ or deficit\$ or disable\$ or disability)) or (motor adj (handicap\$ or impair\$ or limit\$ or decline\$ or deficit\$ or disable\$ or disability)) or (hearing adj (reduc\$ or loss or handicap\$ or impair\$ or limit\$ or decline\$ or deficit\$ or disable\$ or disability)) or ((vision or visual or sight) adj (reduc\$ or loss or handicap\$ or impair\$ or limit\$ or decline\$ or deficit\$ or disable\$ or disability)) or (blind or deaf) or wheelchair user\$ or amputee\$) adj (home or homes or house or houses or housing or residen\$ or built environment)).ti,ab.	175
36	wheelchairs/	4 277
37	2 and 36	33
38	22 and 36	293
39	communication aids for disabled/	2 434
40	2 and 39	7
41	22 and 39	96
42	(mobility adj (impair\$ or device\$ or aid\$)).ti,ab.	1 249
43	2 and 42	10
44	22 and 42	220
45	3 or 5 or 7 or 8 or 9 or 10 or 11 or 12 or 14 or 15 or 16 or 17 or 18 or 19 or 20 or 21 or 34 or 35 or 37 or 38 or 40 or 41 or 43 or 44	8 677
46	(rat or rats or mouse or mice or poultry or pig or pigs or cat or cats or sheep or cow or cows).ti.	1 472 868
47	45 not 46	8 556
48	limit 47 to yr="2015 -Current"	1 803

Appendix 2a Search strategy for CINAHL (2014)

Searched via EBSCO

Search date: 5 January 2015

Records retrieved: 6612

	Search ID#	Search terms	Search options	Actions
<input type="checkbox"/>	S29	S3 OR S5 OR S7 OR S8 OR S9 OR S10 OR S11 OR S13 OR S14 OR S15 OR S20 OR S21 OR S23 OR S24 OR S26 OR S27 OR S28	Search modes – Boolean/phrase	View Results (7 035) View Details Edit
<input type="checkbox"/>	S28	(mobility N (impair* or device* or aid*))	Search modes – Boolean/phrase	Rerun View Details Edit
<input type="checkbox"/>	S27	S16 AND S25	Search modes – Boolean/phrase	Rerun View Details Edit
<input type="checkbox"/>	S26	S2 AND S25	Search modes – Boolean/phrase	Rerun View Details Edit
<input type="checkbox"/>	S25	(MH "Communication Aids for Disabled")	Search modes – Boolean/phrase	Rerun View Details Edit
<input type="checkbox"/>	S24	S16 AND S22	Search modes – Boolean/phrase	Rerun View Details Edit
<input type="checkbox"/>	S23	S2 AND S22	Search modes – Boolean/phrase	Rerun View Details Edit
<input type="checkbox"/>	S22	(MH "Wheelchairs+")	Search modes – Boolean/phrase	Rerun View Details Edit
<input type="checkbox"/>	S21	S19 N s16	Search modes – Boolean/phrase	Rerun View Details Edit
<input type="checkbox"/>	S20	S2 AND S19	Search modes – Boolean/phrase	Rerun View Details Edit
<input type="checkbox"/>	S19	S17 OR S18	Search modes – Boolean/phrase	Rerun View Details Edit

	Search ID#	Search terms	Search options	Actions
<input type="checkbox"/>	S18	(motor* N (handicap* or impair* or limit* or decline* or deficit* or disable* or disability)) OR (hearing N (reduc* or loss or handicap* or impair* or limit* or decline* or deficit* or disable* or disability)) OR ((vision or visual or sight) N (reduc* or loss or handicap* or impair* or limit* or decline* or deficit* or disable* or disability)) OR ((blind or deaf or frail*)) OR wheelchair user*. OR amputee*	Search modes – Boolean/phrase	Rerun View Details Edit
<input type="checkbox"/>	S17	(functional* N (handicap* or impair* or limit* or decline* or deficit* or disable* or disability)) OR (cognitive* N (handicap* or impair* or limit* or decline* or deficit* or disable* or disability)) OR (mental* N (handicap* or impair* or limit* or decline* or deficit* or disable* or disability)) OR (physical* N (handicap* or impair* or limit* or decline* or deficit* or disable* or disability))	Search modes – Boolean/phrase	Rerun View Details Edit
<input type="checkbox"/>	S16	(home or homes or house or houses or housing or residen* or built environment or living environment)	Search modes – Boolean/phrase	Rerun View Details Edit
<input type="checkbox"/>	S15	(home environment*) N2 intervention* OR (environment* intervention*) N2 home* OR person environment* fit OR person-environment*-fit OR person-environment* fit OR person environment*-fit	Search modes – Boolean/phrase	Rerun View Details Edit
<input type="checkbox"/>	S14	(disability or disabled or handicap* or frail*) N2 (home or homes or house or houses or housing or residen* or environment)	Search modes – Boolean/phrase	Rerun View Details Edit
<input type="checkbox"/>	S13	S2 AND S12	Search modes – Boolean/phrase	Rerun View Details Edit
<input type="checkbox"/>	S12	(disability or disabled or handicap*)	Search modes – Boolean/phrase	Rerun View Details Edit
<input type="checkbox"/>	S11	environmental barrier* OR universal design	Search modes – Boolean/phrase	Rerun View Details Edit
<input type="checkbox"/>	S10	(assistive technolog*) AND ((home or homes or house or houses or housing or residence* or built environment* or living situation))	Search modes – Boolean/phrase	Rerun View Details Edit
<input type="checkbox"/>	S9	(smart home*) or (smart home technolog*)	Search modes – Boolean/phrase	Rerun View Details Edit

	Search ID#	Search terms	Search options	Actions
<input type="checkbox"/>	S8	(home or homes or house* or housing or residen*) N2 (adapt* or modif* or access* or usability)	Search modes – Boolean/phrase	Rerun View Details Edit
<input type="checkbox"/>	S7	S1 AND S6	Search modes – Boolean/phrase	Rerun View Details Edit
<input type="checkbox"/>	S6	(MH "Architectural Accessibility")	Search modes – Boolean/phrase	Rerun View Details Edit
<input type="checkbox"/>	S5	S1 AND S4	Search modes – Boolean/phrase	Rerun View Details Edit
<input type="checkbox"/>	S4	TI (home or homes or house or houses or housing or residen* or built environment or living environment)	Search modes – Boolean/phrase	Rerun View Details Edit
<input type="checkbox"/>	S3	S1 AND S2	Search modes – Boolean/phrase	Rerun View Details Edit
<input type="checkbox"/>	S2	(MH "Housing+")	Search modes – Boolean/phrase	Rerun View Details Edit
<input type="checkbox"/>	S1	(MH "Disabled+")	Search modes – Boolean/phrase	Rerun View Details Edit

Appendix 2b Search strategy for CINAHL (2018)

Searched via EBSCO

Search date: 10 April 2018

Records retrieved: 1530

Search ID#	Search terms		
S29	S3 OR S5 OR S7 OR S8 OR S9 OR S10 OR S11 OR S13 OR S14 OR S15 OR S20 OR S21 OR S23 OR S24 OR S26 OR S27 OR S28	Limiters – published date: 20150101–20181231 Search modes – Boolean/phrase	(1 530)
S28	(mobility N (impair* or device* or aid*))	Search modes – Boolean/phrase	(20)
S27	S16 AND S25	Search modes – Boolean/phrase	(76)
S26	S2 AND S25	Search modes – Boolean/phrase	(2)
S25	(MH "communication aids for disabled")	Search modes – Boolean/phrase	(1 373)
S24	S16 AND S22	Search modes – Boolean/phrase	(373)
S23	S2 AND S22	Search modes – Boolean/phrase	(53)
S22	(MH "wheelchairs+")	Search modes – Boolean/phrase	(4 179)
S21	S19 N s16	Search modes – Boolean/phrase	(733)
S20	S2 AND S19	Search modes – Boolean/phrase	(212)
S19	S17 OR S18	Search modes – Boolean/phrase	(57 923)
S18	(motor* N (handicap* or impair* or limit* or decline* or deficit* or disable* or disability)) OR (hearing N (reduc* or loss or handicap* or impair* or limit* or decline* or deficit* or disable* or disability)) OR ((vision or visual or sight) N (reduc* or loss or handicap* or impair* or limit* or decline* or deficit* or disable* or disability)) OR ((blind or deaf or frail*)) OR wheelchair user*. OR amputee*	Search modes – Boolean/phrase	(57 470)
S17	(functional* N (handicap* or impair* or limit* or decline* or deficit* or disable* or disability)) OR (cognitive* N (handicap* or impair* or limit* or decline* or deficit* or disable* or disability)) OR (mental* N (handicap* or impair* or limit* or decline* or deficit* or disable* or disability)) OR (physical* N (handicap* or impair* or limit* or decline* or deficit* or disable* or disability))	Search modes – Boolean/phrase	(489)
S16	(home or homes or house or houses or housing or residen* or built environment or living environment)	Search modes – Boolean/phrase	(186 272)
S15	(home environment*) N2 intervention* OR (environment* intervention*) N2 home* OR person environment* fit OR person-environment*-fit OR person-environment* fit OR person environment*-fit	Search modes – Boolean/phrase	(203)

Search ID#	Search terms		
S14	(disability or disabled or handicap* or frail*) N2 (home or homes or house or houses or housing or residen* or environment)	Search modes – Boolean/phrase	(930)
S13	S2 AND S12	Search modes – Boolean/phrase	(901)
S12	(disability or disabled or handicap*)	Search modes – Boolean/phrase	(105 056)
S11	environmental barrier* OR universal design	Search modes – Boolean/phrase	(910)
S10	(assistive technolog*) AND ((home or homes or house or houses or housing or residence* or built environment* or living situation))	Search modes – Boolean/phrase	(982)
S9	(smart home*) or (smart home technolog*)	Search modes – Boolean/phrase	(101)
S8	(home or homes or house* or housing or residen*) N2 (adapt* or modif* or access* or usability)	Search modes – Boolean/phrase	(1 880)
S7	S1 AND S6	Search modes – Boolean/phrase	(1 002)
S6	(MH "architectural accessibility")	Search modes – Boolean/phrase	(1 904)
S5	S1 AND S4	Search modes – Boolean/phrase	(1 107)
S4	TI (home or homes or house or houses or housing or residen* or built environment or living environment)	Search modes – Boolean/phrase	(63 494)
S3	S1 AND S2	Search modes – Boolean/phrase	(552)
S2	(MH "housing+")	Search modes – Boolean/phrase	(8 566)
S1	(MH "disabled+")	Search modes – Boolean/phrase	(37 204)

Appendix 3a Search strategy for COCHRANE LIBRARY (2014)

Search name: WHO ACCESSIBILITY 22122014

Last saved: 22 December 2014

Records retrieved: CDSR 46 records, DARE 24 records, HTA 6 records, NHS EED 17 records, CENTRAL 1593

- #1 MeSH descriptor: [disabled persons] explode all trees
- #2 MeSH descriptor: [housing] explode all trees
- #3 #1 and #2
- #4 (home or homes or house or houses or housing or residen* or built environment or living environment):ti (word variations have been searched)
- #5 #1 and #4
- #6 MeSH descriptor: [architectural accessibility] explode all trees
- #7 MeSH descriptor: [facility design and construction] explode all trees
- #8 MeSH descriptor: [residence characteristics] explode all trees
- #9 MeSH descriptor: [environment design] explode all trees
- #10 #6 or #7 or #8 or #9
- #11 #1 and #10
- #12 (home or homes or house* or housing or residen*) near/2 (adapt* or modif* or access* or usability):ti,ab,kw (word variations have been searched)
- #13 (smart home* or smart home technolog*):ti,ab,kw (word variations have been searched)
- #14 (assistive technolog*) and (home or homes or house or houses or housing or residence* or built environment* or living situation):ti,ab,kw (word variations have been searched)
- #15 (environmental barrier*):ti,ab,kw (word variations have been searched)
- #16 (universal design):ti,ab,kw (word variations have been searched)
- #17 (disability or disabled or handicap*):ti,ab,kw (word variations have been searched)
- #18 #2 and #13
- #19 (disability or disabled or handicap* or frail*) near/2 (home or homes or house or houses or housing or residen* or environment):ti,ab,kw (word variations have been searched)
- #20 (home environment*) near/2 intervention*:ti,ab,kw (word variations have been searched)

- #21 (environment* intervention*) near/2 home*:ti,ab,kw (word variations have been searched)
- #22 person environment* fit:ti,ab,kw (word variations have been searched)
- #23 person-environment*-fit:ti,ab,kw (word variations have been searched)
- #24 person-environment* fit:ti,ab,kw (word variations have been searched)
- #25 person environment*-fit:ti,ab,kw (word variations have been searched)
- #26 (home or homes or house or houses or housing or residen* or built environment or living environment):ti,ab,kw (word variations have been searched)
- #27 functional* near (handicap* or impair* or limit* or decline* or deficit* or disable* or disability):ti,ab,kw (word variations have been searched)
- #28 cognitive* near (handicap* or impair* or limit* or decline* or deficit* or disable* or disability):ti,ab,kw (word variations have been searched)
- #29 mental* near (handicap* or impair* or limit* or decline* or deficit* or disable* or disability):ti,ab,kw (word variations have been searched)
- #30 physical near (handicap* or impair* or limit* or decline* or deficit* or disable* or disability):ti,ab,kw (word variations have been searched)
- #31 motor near (handicap* or impair* or limit* or decline* or deficit* or disable* or disability):ti,ab,kw (word variations have been searched)
- #32 hearing near (reduc* or loss or handicap* or impair* or limit* or decline* or deficit* or disable* or disability):ti,ab,kw (word variations have been searched)
- #33 (vision or visual or sight) near (reduc* or loss or handicap* or impair* or limit* or decline* or deficit* or disable* or disability):ti,ab,kw (word variations have been searched)
- #34 blind or deaf or frail*:ti,ab,kw (word variations have been searched)
- #35 wheelchair user*:ti,ab,kw (word variations have been searched)
- #36 amputee*:ti,ab,kw (word variations have been searched)
- #37 #27 or #28 or #29 or #30 or #31 or #32 or #33 or #34 or #35 or #36
- #38 #2 and #37
- #39 #37 near (home or homes or house or houses or housing or residen* or built environment or living environment)
- #40 MeSH descriptor: [wheelchairs] explode all trees
- #41 #2 and #40
- #42 #26 and #40

- #43 MeSH descriptor: [communication aids for disabled] explode all trees
- #44 #2 and #43
- #45 #26 and #43
- #46 mobility near (impair* or device* or aid*):ti,ab,kw (word variations have been searched)
- #47 #2 and #46
- #48 #26 and #46
- #49 #3 or #5 or #11 or #12 or #13 or #14 or #15 or #16 or #18 or #19 or #20 or #21 or #22 or #23 or #24 or #25 or #38 or #39 or #41 or #42 or #44 or #45 or #47 or #48

Appendix 3b Search strategy for COCHRANE LIBRARY (2018)

Search date: 10 April 2018

Records retrieved: Cochrane reviews 24, trials 1041, methods studies 32, technology assessment 2

ID	Search	Hits
#1	MeSH descriptor: [disabled persons] explode all trees	1 195
#2	MeSH descriptor: [housing] explode all trees	389
#3	#1 and #2	8
#4	(home or homes or house or houses or housing or residen* or built environment or living environment):ti (Word variations have been searched)	10 740
#5	#1 and #4	61
#6	MeSH descriptor: [architectural accessibility] explode all trees	13
#7	MeSH descriptor: [facility design and construction] explode all trees	214
#8	MeSH descriptor: [residence characteristics] explode all trees	1 318
#9	MeSH descriptor: [environment design] explode all trees	124
#10	#6 or #7 or #8 or #9	1 608
#11	#1 and #10	29
#12	(home or homes or house* or housing or residen*) near/2 (adapt* or modif* or access* or usability):ti,ab,kw (word variations have been searched)	323
#13	(smart home* or smart home technolog*):ti,ab,kw (word variations have been searched)	70
#14	(assistive technolog*) and (home or homes or house or houses or housing or residence* or built environment* or living situation):ti,ab,kw (word variations have been searched)	30
#15	(environmental barrier*):ti,ab,kw (word variations have been searched)	227
#16	(universal design):ti,ab,kw (word variations have been searched)	726
#17	(disability or disabled or handicap*):ti,ab,kw (word variations have been searched)	24 343
#18	#2 and #13	0
#19	(disability or disabled or handicap* or frail*) near/2 (home or homes or house or houses or housing or residen* or environment):ti,ab,kw (word variations have been searched)	193
#20	(home environment*) near/2 intervention*:ti,ab,kw (word variations have been searched)	32
#21	(environment* intervention*) near/2 home*:ti,ab,kw (word variations have been searched)	84
#22	person environment* fit:ti,ab,kw (word variations have been searched)	20
#23	person-environment*-fit:ti,ab,kw (word variations have been searched)	4
#24	person-environment* fit:ti,ab,kw (word variations have been searched)	4
#25	person environment*-fit:ti,ab,kw (word variations have been searched)	4
#26	(home or homes or house or houses or housing or residen* or built environment or living environment):ti,ab,kw (word variations have been searched)	37 769
#27	functional* near (handicap* or impair* or limit* or decline* or deficit* or disable* or disability):ti,ab,kw (word variations have been searched)	5 448
#28	cognitive* near (handicap* or impair* or limit* or decline* or deficit* or disable* or disability):ti,ab,kw (word variations have been searched)	9 133
#29	mental* near (handicap* or impair* or limit* or decline* or deficit* or disable* or disability):ti,ab,kw (word variations have been searched)	1 685
#30	physical near (handicap* or impair* or limit* or decline* or deficit* or disable* or disability):ti,ab,kw (word variations have been searched)	3 636

ID	Search	Hits
#31	motor near (handicap* or impair* or limit* or decline* or deficit* or disable* or disability):ti,ab,kw (word variations have been searched)	2 096
#32	hearing near (reduc* or loss or handicap* or impair* or limit* or decline* or deficit* or disable* or disability):ti,ab,kw (word variations have been searched)	2 713
#33	(vision or visual or sight) near (reduc* or loss or handicap* or impair* or limit* or decline* or deficit* or disable* or disability):ti,ab,kw (word variations have been searched)	6 234
#34	blind or deaf or frail*:ti,ab,kw (word variations have been searched)	276 419
#35	wheelchair user*:ti,ab,kw (word variations have been searched)	128
#36	amputee*:ti,ab,kw (word variations have been searched)	271
#37	#27 or #28 or #29 or #30 or #31 or #32 or #33 or #34 or #35 or #36	295 336
#38	#2 and #37	47
#39	#37 near (home or homes or house or houses or housing or residen* or built environment or living environment)	1 427
#40	MeSH descriptor: [wheelchairs] explode all trees	201
#41	#2 and #40	0
#42	#26 and #40	31
#43	MeSH descriptor: [communication aids for disabled] explode all trees	91
#44	#2 and #43	0
#45	#26 and #43	4
#46	mobility near (impair* or device* or aid*):ti,ab,kw (word variations have been searched)	395
#47	#2 and #46	0
#48	#26 and #46	84
#49	#3 or #5 or #11 or #12 or #13 or #14 or #15 or #16 or #18 or #19 or #20 or #21 or #22 or #23 or #24 or #25 or #38 or #39 or #41 or #42 or #44 or #45 or #47 or #48 Publication Year from 2015 to 2018	1 067

Appendix 4a Search strategy for EMBASE (2014)

<1974 to 2014 December 19>, via OVIDSP

Search date: 22 December 2014

Records retrieved: 5142 (5113 after de-duplication)

- 1 exp disabled person/ (25824)
- 2 exp housing/ (16467)
- 3 1 and 2 (259)
- 4 (home or homes or house or houses or housing or residen\$ or built environment or living environment).ti. (125942)
- 5 1 and 4 (791)
- 6 exp "construction work and architectural phenomena"/ (47975)
- 7 1 and 6 (766)
- 8 ((home or homes or house\$ or housing or residen\$) adj2 (adapt\$ or modif\$ or access\$ or usability)).ti,ab. (2538)
- 9 (smart home\$ or smart home technolog\$).ti,ab. (172)
- 10 assistive technology/ (813)
- 11 (assistive technolog\$ and (home or homes or house or houses or housing or residence\$ or built environment\$ or living situation)).ti,ab. (225)
- 12 environmental barrier\$.ti,ab. (483)
- 13 universal design.ti,ab. (169)
- 14 (disability or disabled or handicap\$).ti,ab. (165450)
- 15 2 and 14 (545)
- 16 ((disability or disabled or handicap\$ or frail\$) adj2 (home or homes or house or houses or housing or residen\$ or environment)).ti,ab. (741)
- 17 (home environment\$ adj2 intervention\$).ti,ab. (24)
- 18 (environment\$ intervention\$ adj2 home\$).ti,ab. (34)
- 19 person environment\$ fit.ti,ab. (138)
- 20 person-environment\$ fit.ti,ab. (138)
- 21 person environment\$-fit.ti,ab. (138)
- 22 person-environment\$-fit.ti,ab. (138)

- 23 (home or homes or house or houses or housing or residen\$ or built environment or living environment).ti,ab. (463219)
- 24 (functional\$ adj (handicap\$ or impair\$ or limit\$ or decline\$ or deficit\$ or disable\$ or disability)).ti,ab. (35813)
- 25 (cognitive\$ adj (handicap\$ or impair\$ or limit\$ or decline\$ or deficit\$ or disable\$ or disability)).ti,ab. (76671)
- 26 (mental\$ adj (handicap\$ or impair\$ or limit\$ or decline\$ or deficit\$ or disable\$ or disability)).ti,ab. (6618)
- 27 (physical\$ adj (handicap\$ or impair\$ or limit\$ or decline\$ or deficit\$ or disable\$ or disability)).ti,ab. (10712)
- 28 (motor adj (handicap\$ or impair\$ or limit\$ or decline\$ or deficit\$ or disable\$ or disability)).ti,ab. (14207)
- 29 (hearing adj (reduc\$ or loss or handicap\$ or impair\$ or limit\$ or decline\$ or deficit\$ or disable\$ or disability)).ti,ab. (45448)
- 30 ((vision or visual or sight) adj (reduc\$ or loss or handicap\$ or impair\$ or limit\$ or decline\$ or deficit\$ or disable\$ or disability)).ti,ab. (25824)
- 31 (blind or deaf or frail\$).ti,ab. (212081)
- 32 wheelchair user\$.ti,ab. (957)
- 33 amputee\$.ti,ab. (4681)
- 34 24 or 25 or 26 or 27 or 28 or 29 or 30 or 31 or 32 or 33 (417431)
- 35 2 and 34 (368)
- 36 (((functional\$ adj (handicap\$ or impair\$ or limit\$ or decline\$ or deficit\$ or disable\$ or disability)) or (cognitive\$ adj (handicap\$ or impair\$ or limit\$ or decline\$ or deficit\$ or disable\$ or disability)) or (mental\$ adj (handicap\$ or impair\$ or limit\$ or decline\$ or deficit\$ or disable\$ or disability)) or (physical\$ adj (handicap\$ or impair\$ or limit\$ or decline\$ or deficit\$ or disable\$ or disability)) or (motor adj (handicap\$ or impair\$ or limit\$ or decline\$ or deficit\$ or disable\$ or disability)) or (hearing adj (reduc\$ or loss or handicap\$ or impair\$ or limit\$ or decline\$ or deficit\$ or disable\$ or disability)) or ((vision or visual or sight) adj (reduc\$ or loss or handicap\$ or impair\$ or limit\$ or decline\$ or deficit\$ or disable\$ or disability)) or (blind or deaf) or wheelchair user\$ or amputee\$) adj (home or homes or house or houses or housing or residen\$ or built environment)).ti,ab. (184)
- 37 wheelchair/ (6536)
- 38 2 and 37 (43)
- 39 23 and 37 (593)
- 40 (mobility adj (impair\$ or device\$ or aid\$)).ti,ab. (1135)

- 41 2 and 40 (12)
- 42 23 and 40 (211)
- 43 3 or 5 or 7 or 8 or 9 or 10 or 11 or 12 or 13 or 15 or 16 or 17 or 18 or 19 or 20 or 21 or 22 or 35 or 36 or 38 or 39 or 41 or 42 (7773)
- 44 (rat or rats or mouse or mice or poultry or pig or pigs or cat or cats or sheep or cow or cows).ti. (1508330)
- 45 43 not 44 (7672)
- 46 limit 45 to embase (5142)

Appendix 4b Search strategy for EMBASE (2018)

<1974 to 2018 week 15>, via OVIDSP

Search date: 10 April 2018

Records retrieved: 1271

1	exp disabled person/	33 960
2	exp housing/	17 240
3	1 and 2	201
4	(home or homes or house or houses or housing or residen\$ or built environment or living environment).ti.	129 809
5	1 and 4	913
6	exp "construction work and architectural phenomena"/	52 491
7	1 and 6	666
8	((home or homes or house\$ or housing or residen\$) adj2 (adapt\$ or modif\$ or access\$ or usability)).ti,ab.	3 611
9	(smart home\$ or smart home technolog\$).ti,ab.	325
10	assistive technology/	1 300
11	(assistive technolog\$ and (home or homes or house or houses or housing or residence\$ or built environment\$ or living situation)).ti,ab.	333
12	environmental barrier\$.ti,ab.	767
13	universal design.ti,ab.	261
14	(disability or disabled or handicap\$).ti,ab.	199 928
15	2 and 14	542
16	((disability or disabled or handicap\$ or frail\$) adj2 (home or homes or house or houses or housing or residen\$ or environment)).ti,ab.	844
17	(home environment\$ adj2 intervention\$).ti,ab.	44
18	(environment\$ intervention\$ adj2 home\$).ti,ab.	55
19	person environment\$ fit.ti,ab.	157
20	person-environment\$ fit.ti,ab.	157
21	person environment\$-fit.ti,ab.	157
22	person-environment\$-fit.ti,ab.	157
23	(home or homes or house or houses or housing or residen\$ or built environment or living environment).ti,ab.	562 178
24	(functional\$ adj (handicap\$ or impair\$ or limit\$ or decline\$ or deficit\$ or disable\$ or disability)).ti,ab.	48 553
25	(cognitive\$ adj (handicap\$ or impair\$ or limit\$ or decline\$ or deficit\$ or disable\$ or disability)).ti,ab.	119 872

26	(mental\$ adj (handicap\$ or impair\$ or limit\$ or decline\$ or deficit\$ or disable\$ or disability)).ti,ab.	4 834
27	(physical\$ adj (handicap\$ or impair\$ or limit\$ or decline\$ or deficit\$ or disable\$ or disability)).ti,ab.	11 999
28	(motor adj (handicap\$ or impair\$ or limit\$ or decline\$ or deficit\$ or disable\$ or disability)).ti,ab.	18 884
29	(hearing adj (reduc\$ or loss or handicap\$ or impair\$ or limit\$ or decline\$ or deficit\$ or disable\$ or disability)).ti,ab.	50 265
30	((vision or visual or sight) adj (reduc\$ or loss or handicap\$ or impair\$ or limit\$ or decline\$ or deficit\$ or disable\$ or disability)).ti,ab.	34 637
31	(blind or deaf or frail\$).ti,ab.	230 532
32	wheelchair user\$.ti,ab.	1 275
33	amputee\$.ti,ab.	4 610
34	24 or 25 or 26 or 27 or 28 or 29 or 30 or 31 or 32 or 33	504 084
35	2 and 34	475
36	((((functional\$ adj (handicap\$ or impair\$ or limit\$ or decline\$ or deficit\$ or disable\$ or disability)) or (cognitive\$ adj (handicap\$ or impair\$ or limit\$ or decline\$ or deficit\$ or disable\$ or disability)) or (mental\$ adj (handicap\$ or impair\$ or limit\$ or decline\$ or deficit\$ or disable\$ or disability)) or (physical\$ adj (handicap\$ or impair\$ or limit\$ or decline\$ or deficit\$ or disable\$ or disability)) or (motor adj (handicap\$ or impair\$ or limit\$ or decline\$ or deficit\$ or disable\$ or disability)) or (hearing adj (reduc\$ or loss or handicap\$ or impair\$ or limit\$ or decline\$ or deficit\$ or disable\$ or disability)) or ((vision or visual or sight) adj (reduc\$ or loss or handicap\$ or impair\$ or limit\$ or decline\$ or deficit\$ or disable\$ or disability)) or (blind or deaf) or wheelchair user\$ or amputee\$) adj (home or homes or house or houses or housing or residen\$ or built environment)).ti,ab.	205
37	wheelchair/	7 326
38	2 and 37	37
39	23 and 37	739
40	(mobility adj (impair\$ or device\$ or aid\$)).ti,ab.	1 661
41	2 and 40	18
42	23 and 40	299
43	3 or 5 or 7 or 8 or 9 or 10 or 11 or 12 or 13 or 15 or 16 or 17 or 18 or 19 or 20 or 21 or 22 or 35 or 36 or 38 or 39 or 41 or 42	10 333
44	(rat or rats or mouse or mice or poultry or pig or pigs or cat or cats or sheep or cow or cows).ti.	1 198 145
45	43 not 44	10 179
46	limit 45 to embase	5 119
47	limit 46 to yr="2015 – current"	1 271

Appendix 5 Search strategy for OT seeker (2014)

Via <http://www.otseeker.com/>

Search date: 8 January 2015

Records identified: 94 (de-duplicated to 81 references)

Series of small searches carried out as described below

8/01/2015 10:39:03 pm	[title/abstract] like 'home OR homes OR house OR houses OR housing OR (living environment)' AND [title/abstract] like 'disability OR disabled'	10
8/01/2015 10:43:37 pm	[title/abstract] like 'home OR homes OR house OR houses OR housing OR (living environment)' AND [title/abstract] like 'adapt* OR modif* OR access* OR usability'	6
8/01/2015 10:47:10 pm	[title/abstract] like 'technology' AND [title/abstract] like 'home OR homes OR house OR houses OR housing OR (living environment)	5
8/01/2015 10:52:18 pm	[any field] like 'person environment'	11
8/01/2015 10:55:51 pm	[any field] like '"home environment"'	26
8/01/2015 11:06:22 pm	[title/abstract] like 'home OR homes OR house OR houses OR housing OR (living environment)' AND [title/abstract] like 'handicap* OR impair*'	13
8/01/2015 11:10:20 pm	[title/abstract] like 'home OR hoes OR house OR houses OR housing OR (living environment)' AND [title/abstract] like 'vision OR visual OR sight OR blind OR deaf OR hearing'	7
8/01/2015 11:12:52 pm	[title/abstract] like 'home OR homes OR house OR houses OR housing OR (living environment)' AND [title/abstract] like 'mobility OR wheelchair* OR amputee*'	15

This database was not searched again in 2018.

Appendix 6a Search strategy for PsycINFO (2014)

<1806 to December week 3 2014>, searched via OVIDSP

Search date: 22 December 2014

Records identified: 5996 (5993 after de-duplication)

- 1 exp disabilities/ (55181)
- 2 exp housing/ (7011)
- 3 1 and 2 (211)
- 4 (home or homes or house or houses or housing or residen\$ or built environment or living environment).ti. (37270)
- 5 1 and 4 (744)
- 6 exp architecture/ (1880)
- 7 1 and 6 (16)
- 8 ((home or homes or house\$ or housing or residen\$) adj2 (adapt\$ or modif\$ or access\$ or usability)).ti,ab. (1025)
- 9 (smart home\$ or smart home technolog\$).ti,ab. (54)
- 10 assistive technology/ (994)
- 11 (assistive technolog\$ and (home or homes or house or houses or housing or residence\$ or built environment\$ or living situation)).ti,ab. (132)
- 12 environmental barrier\$.ti,ab. (286)
- 13 universal design.ti,ab. (273)
- 14 (disability or disabled or handicap\$).ti,ab. (81123)
- 15 2 and 14 (417)
- 16 ((disability or disabled or handicap\$ or frail\$) adj2 (home or homes or house or houses or housing or residen\$ or environment)).ti,ab. (413)
- 17 (home environment\$ adj2 intervention\$).ti,ab. (13)
- 18 (environment\$ intervention\$ adj2 home\$).ti,ab. (8)
- 19 person environment fit/ (1213)
- 20 person environment\$ fit.ti,ab. (628)
- 21 person-environment\$ fit.ti,ab. (628)
- 22 person environment\$-fit.t,ab. (534)

- 23 person-environment\$.ti,ab. (628)
- 24 (home or homes or house or houses or housing or residen\$ or built environment or living environment).ti,ab. (161264)
- 25 (functional\$ adj (handicap\$ or impair\$ or limit\$ or decline\$ or deficit\$ or disable\$ or disability)).ti,ab. (9190)
- 26 (cognitive\$ adj (handicap\$ or impair\$ or limit\$ or decline\$ or deficit\$ or disable\$ or disability)).ti,ab. (36482)
- 27 (mental\$ adj (handicap\$ or impair\$ or limit\$ or decline\$ or deficit\$ or disable\$ or disability)).ti,ab. (4650)
- 28 (physical\$ adj (handicap\$ or impair\$ or limit\$ or decline\$ or deficit\$ or disable\$ or disability)).ti,ab. (5997)
- 29 (motor adj (handicap\$ or impair\$ or limit\$ or decline\$ or deficit\$ or disable\$ or disability)).ti,ab. (4190)
- 30 (hearing adj (reduc\$ or loss or handicap\$ or impair\$ or limit\$ or decline\$ or deficit\$ or disable\$ or disability)).ti,ab. (9994)
- 31 ((vision or visual or sight) adj (reduc\$ or loss or handicap\$ or impair\$ or limit\$ or decline\$ or deficit\$ or disable\$ or disability)).ti,ab. (3965)
- 32 (blind or deaf or frail\$).ti,ab. (45220)
- 33 wheelchair user\$.ti,ab. (168)
- 34 amputee\$.ti,ab. (621)
- 35 25 or 26 or 27 or 28 or 29 or 30 or 31 or 32 or 33 or 34 (113969)
- 36 2 and 35 (312)
- 37 (((functional\$ adj (handicap\$ or impair\$ or limit\$ or decline\$ or deficit\$ or disable\$ or disability)) or (cognitive\$ adj (handicap\$ or impair\$ or limit\$ or decline\$ or deficit\$ or disable\$ or disability)) or (mental\$ adj (handicap\$ or impair\$ or limit\$ or decline\$ or deficit\$ or disable\$ or disability)) or (physical\$ adj (handicap\$ or impair\$ or limit\$ or decline\$ or deficit\$ or disable\$ or disability)) or (motor adj (handicap\$ or impair\$ or limit\$ or decline\$ or deficit\$ or disable\$ or disability)) or (hearing adj (reduc\$ or loss or handicap\$ or impair\$ or limit\$ or decline\$ or deficit\$ or disable\$ or disability)) or ((vision or visual or sight) adj (reduc\$ or loss or handicap\$ or impair\$ or limit\$ or decline\$ or deficit\$ or disable\$ or disability)) or (blind or deaf) or wheelchair user\$ or amputee\$) adj (home or homes or house or houses or housing or residen\$ or built environment)).ti,ab. (119)
- 38 mobility aids/ (780)
- 39 2 and 38 (6)
- 40 24 and 38 (98)

- 41 (mobility adj (impair\$ or device\$ or aid\$)).ti,ab. (383)
- 42 2 and 41 (7)
- 43 24 and 41 (79)
- 44 3 or 5 or 7 or 8 or 9 or 10 or 11 or 12 or 13 or 15 or 16 or 17 or 18 or 19 or 20 or 21 or 22 or 23 or 36 or 37 or 39 or 40 or 42 or 43 (6043)
- 45 (rat or rats or mouse or mice or poultry or pig or pigs or cat or cats or sheep or cow or cows).ti. (103962)
- 46 44 not 45 (5996)

Appendix 6b Search strategy for PsycINFO (2018)

<1806 to April week 1 2018>, searched via OVIDSP

Search date: 10 April 2018

Records identified: 1680

	Searches	Results
1	exp disabilities/	63947
2	exp housing/	8374
3	1 and 2	228
4	(home or homes or house or houses or housing or residen\$ or built environment or living environment).ti.	45216
5	1 and 4	853
6	exp architecture/	2236
7	1 and 6	17
8	((home or homes or house\$ or housing or residen\$) adj2 (adapt\$ or modif\$ or access\$ or usability)).ti,ab.	1375
9	(smart home\$ or smart home technolog\$).ti,ab.	104
10	assistive technology/	1721
11	(assistive technolog\$ and (home or homes or house or houses or housing or residence\$ or built environment\$ or living situation)).ti,ab.	183
12	environmental barrier\$.ti,ab.	415
13	universal design.ti,ab.	423
14	(disability or disabled or handicap\$).ti,ab.	96649
15	2 and 14	461
16	((disability or disabled or handicap\$ or frail\$) adj2 (home or homes or house or houses or housing or residen\$ or environment)).ti,ab.	492
17	(home environment\$ adj2 intervention\$).ti,ab.	15
18	(environment\$ intervention\$ adj2 home\$).ti,ab.	12
19	person environment fit/	1387
20	person environment\$ fit.ti,ab.	783

	Searches	Results
21	person-environment\$ fit.ti,ab.	783
22	person environment\$-fit.ti,ab.	783
23	person-environment\$-fit.ti,ab.	783
24	(home or homes or house or houses or housing or residen\$ or built environment or living environment).ti,ab.	196294
25	(functional\$ adj (handicap\$ or impair\$ or limit\$ or decline\$ or deficit\$ or disable\$ or disability)).ti,ab.	12179
26	(cognitive\$ adj (handicap\$ or impair\$ or limit\$ or decline\$ or deficit\$ or disable\$ or disability)).ti,ab.	49757
27	(mental\$ adj (handicap\$ or impair\$ or limit\$ or decline\$ or deficit\$ or disable\$ or disability)).ti,ab.	4912
28	(physical\$ adj (handicap\$ or impair\$ or limit\$ or decline\$ or deficit\$ or disable\$ or disability)).ti,ab.	6782
29	(motor adj (handicap\$ or impair\$ or limit\$ or decline\$ or deficit\$ or disable\$ or disability)).ti,ab.	5545
30	(hearing adj (reduc\$ or loss or handicap\$ or impair\$ or limit\$ or decline\$ or deficit\$ or disable\$ or disability)).ti,ab.	11933
31	((vision or visual or sight) adj (reduc\$ or loss or handicap\$ or impair\$ or limit\$ or decline\$ or deficit\$ or disable\$ or disability)).ti,ab.	5042
32	(blind or deaf or frail\$).ti,ab.	52844
33	wheelchair user\$.ti,ab.	219
34	amputee\$.ti,ab.	727
35	25 or 26 or 27 or 28 or 29 or 30 or 31 or 32 or 33 or 34	141713
36	2 and 35	349
37	((((functional\$ adj (handicap\$ or impair\$ or limit\$ or decline\$ or deficit\$ or disable\$ or disability)) or (cognitive\$ adj (handicap\$ or impair\$ or limit\$ or decline\$ or deficit\$ or disable\$ or disability)) or (mental\$ adj (handicap\$ or impair\$ or limit\$ or decline\$ or deficit\$ or disable\$ or disability)) or (physical\$ adj (handicap\$ or impair\$ or limit\$ or decline\$ or deficit\$ or disable\$ or disability)) or (motor adj (handicap\$ or impair\$ or limit\$ or decline\$ or deficit\$ or disable\$ or disability)) or (hearing adj (reduc\$ or loss or handicap\$ or impair\$ or limit\$ or decline\$ or deficit\$ or disable\$ or disability)) or ((vision or visual or sight) adj (reduc\$ or loss or handicap\$ or impair\$ or limit\$ or decline\$ or deficit\$ or disable\$ or disability)) or (blind or deaf) or wheelchair user\$ or	127

Searches		Results
	amputee\$) adj (home or homes or house or houses or housing or residen\$ or built environment)).ti,ab.	
38	mobility aids/	964
39	2 and 38	7
40	24 and 38	122
41	(mobility adj (impair\$ or device\$ or aid\$)).ti,ab.	510
42	2 and 41	9
43	24 and 41	97
44	3 or 5 or 7 or 8 or 9 or 10 or 11 or 12 or 13 or 15 or 16 or 17 or 18 or 19 or 20 or 21 or 22 or 23 or 36 or 37 or 39 or 40 or 42 or 43	7976
45	(rat or rats or mouse or mice or poultry or pig or pigs or cat or cats or sheep or cow or cows).ti.	121187
46	44 not 45	7923
47	limit 46 to yr="2015 – current"	1680

Appendix 7 Systematic reviews of which reference lists were checked for eligible studies

Brandt A, Samuelsson K, Toytari O, Salminen AL. Activity and participation, quality of life and user satisfaction outcomes of environmental control systems and smart home technology: a systematic review. *Disability & Rehabilitation Assistive Technology* 2011;6(3):189-206.

C. J. Liu MAB, V. E. Horton SBK, Mears KE. Occupational therapy interventions to improve performance of daily activities at home for older adults with low vision: a systematic review. *American Journal of Occupational Therapy* 2013;67(3):279-87.

Chase CA, Mann K, Wasek S, Arbesman M. Systematic review of the effect of home modification and fall prevention programs on falls and the performance of community-dwelling older adults. *American Journal of Occupational Therapy* 2012;66(3):284-91.

Clemson L, Mackenzie L, Ballinger C, Close JC, Cumming RG. Environmental interventions to prevent falls in community-dwelling older people: a meta-analysis of randomized trials. *Journal of aging and health* 2008;20(8):954-71. Epub 2008/09/26.

Gillespie LD, Robertson MC, Gillespie WJ, Sherrington C, Gates S, Clemson LM, et al. Interventions for preventing falls in older people living in the community. *Cochrane Database of Systematic Reviews* 2012;9:CD007146.

H. Wahl AF, F. Oswald LG, Iwarsson S. The home environment and disability-related outcomes in ageing individuals: what is the empirical evidence? *Gerontologist* 2009; 49(3):355-67.

Medical Advisory Secretariat. Prevention of falls and fall-related injuries in community-dwelling seniors: an evidence-based analysis. *Ontario Health Technology Assessment Series* 2008;8(2):1-78

Lee H-C, Chang K-C, Tsao J-Y, Hung J-W, Huang Y-C, Lin S-I. Effects of a Multifactorial Fall Prevention Program on Fall Incidence and Physical Function in Community-Dwelling Older Adults With Risk of Falls. *Archives of Physical Medicine & Rehabilitation* 2013;94(4): 606-15.e1.

Letts L, Moreland J, Richardson J, Coman L, Edwards M, Ginis KM, et al. The physical environment as a fall risk factor in older adults: Systematic review and meta-analysis of cross-sectional and cohort studies. *Australian Occupational Therapy Journal* 2010;57(1):51-64.

Lyons RA, John A, Brophy S, Jones SJ, Johansen A, Kemp A, et al. Modification of the home environment for the reduction of injuries. *Cochrane Database of Systematic Reviews* 2006(4):CD003600.

Nyman SR, Victor CR. Older people's participation in and engagement with falls prevention interventions in community settings: an augment to the Cochrane systematic review. *Age Ageing* 2012;41(1):16-23. doi: <http://dx.doi.org/10.1093/ageing/afr103>.

Rubenstein LZ, Josephson KR. Interventions to reduce the multifactorial risks for falling. [Spanish]

Intervenciones para reducir los riesgos multifactoriales de caídas. *Revista Española de Geriatria Gerontologia* 2005;40(SUPPL. 2):45-53.

S. Turner GA, R. A. Lyons ALW, M. K. Mann SJJ, John A, Lannon S. Modification of the home environment for the reduction of injuries. *Cochrane Database of Systematic Reviews* 2011(2).

Schoessow K. Shifting from compensation to participation: a model for occupational therapy in low vision. *British Journal of Occupational Therapy* 2010;73(4):160-9.

Skelton DA, Howe TE, Ballinger C, Neil F, Palmer S, Gray L. Environmental and behavioural interventions for reducing physical activity limitation in community-dwelling visually impaired older people. *Cochrane Database of Systematic Reviews* 2013;6:CD009233.

Tse T. The environment and falls prevention: Do environmental modifications make a difference? *Australian Occupational Therapy Journal* 2005;52(4):271-81.

Appendix 8 Articles excluded following check of the full text, and reason for exclusion

Assistive Technology and Telecare to maintain Independent Living At home for people with dementia: The ATILA Trial (Project record). Health Technology Assessment 2013. MREC number: 12/LO/1816 ISRCTN number: ISRCTN86537017

Study protocol of assistive technology and telecare for people with dementia

A. Rickards JW, R. Wright-Rossi JS, Reddihough D. A randomized, controlled trial of a home-based intervention program for children with autism and developmental delay. *Journal of Developmental & Behavioral Pediatrics* 2007;28(4):308-16.

Study of the effect of home intervention by specialist teachers on the development of children with autism.

Anaby D, Hand C, Bradley L, DiRezze B, Forhan M, DiGiacomo A, et al. The effect of the environment on participation of children and youth with disabilities: a scoping review. *Disability & Rehabilitation* 2013;35(19):1589-98.

Review of the assessment of the ICF environmental domains and participations out-of school among 5-21 years old with disabilities.

Anaby D, Law M, Coster W, Bedell G, Khetani M, Avery L, et al. The mediating role of the environment in explaining participation of children and youth with and without disabilities across home, school, and community. *Arch Phys Med Rehabil* 2014;95(5):908-17.

Cross-sectional study of environmental factors including resources, attitude, availability of programme and accessibility, and the participation among children with and without disabilities.

Anttila H, Samuelsson K, Salminen AL, Brandt S. Quality of evidence of assistive technology interventions for people with disability: An overview of systematic reviews. *Technology and Disability*. 2012;24(1):9-48.

Systematic review of assistive technology for people with disabilities, with a focus on assistive devices.

Batchelor FA, Hill KD, Mackintosh SF, Said CM, Whitehead CH. Effects of a multifactorial falls prevention program for people with stroke returning home after rehabilitation: a randomized controlled trial. *Archives of physical medicine and rehabilitation* 2012;93(9):1648-55.

RCT of a multifactorial fall programme for people with stroke returning from rehabilitation.

Berger S, McAteer J, Schreier K, Kaldenberg J. Occupational therapy interventions to improve leisure and social participation for older adults with low vision: a systematic review. *American Journal of Occupational Therapy* 2013;67(3):303-11.

Review of occupational therapy interventions for older adults with low vision, and its effect on leisure and social participation.

Bishop M, Roessler RT, Rumrill PD, Sheppard-Jones K, Frain M, Waletich B, et al. The Relationship between Housing Accessibility Variables and Employment Status among Adults with Multiple Sclerosis. *Journal of Rehabilitation* 2013;79(4):4-14.

Cross-sectional study of the association between home accessibility variables and employment status. There was no clear cut-off point for participants with functional impairments.

Blaschke CM, Freddolino PP, Mullen EE. Ageing and technology: A review of the research literature. *British Journal of Social Work* 2009;39(4):641-56.

Review of assistive technologies, and information and communication technologies, and their impact on older adults.

Bonnefoy X. Inadequate housing and health: An overview. *International Journal of Environment and Pollution* 2007;30(3-4):411-29.

Discussion of the housing and its health effects in general.

Bozzolini G, Cassibba S. Improving home accessibility for a person with a disability after spinal cord injury. *European Journal of Physical and Rehabilitation Medicine* 2008;44(4):455-9.

Case report of home modification for 41-year old wheelchair user with no outcomes measured.

Brandt A, Samuelsson K, Toytari O, Salminen AL. Activity and participation, quality of life and user satisfaction outcomes of environmental control systems and smart home technology: a systematic review. *Disability* 2011;6(3):189-206.

Review of environmental control systems (ECS) and smart home technology (SHT) for people with impairments.

Brooks IM. Look who's cooking: six secrets to a wheelchair accessible kitchen. *Abilities* 2004(61):30-1.

Magazine article on designing a wheelchair accessible kitchen.

C. J. Liu MAB, V. E. Horton SBK, Mears KE. Occupational therapy interventions to improve performance of daily activities at home for older adults with low vision: a systematic review. *American Journal of Occupational Therapy* 2013;67(3):279-87.

Review of occupation therapy intervention for older adults with low vision with no focus on home environmental intervention.

Chase CA, Mann K, Wasek S, Arbesman M. Systematic review of the effect of home modification and fall prevention programs on falls and the performance of community-dwelling older adults. *American Journal of Occupational Therapy* 2012;66(3):284-91.

Review of the effect of home modification and fall prevention intervention among older adults in general.

Chiatti C, Iwarsson S. Evaluation of housing adaptation interventions: integrating the economic perspective into occupational therapy practice. *Scandinavian Journal of Occupational Therapy* 2014;21(5):323-33.

Theoretical paper.

Colver A, Thyen U, Arnaud C, Beckung E, Fauconnier J, Marcelli M, et al. Association between participation in life situations of children with cerebral palsy and their physical, social, and attitudinal environment: a cross-sectional multicenter European study. *Archives of Physical Medicine and Rehabilitation* 2012;93(12):2154-64.

Cross-sectional study of general environmental factors and children with cerebral palsy.

Copolillo A, Ivanoff SD. Assistive technology and home modification for people with neurovisual deficits. *NeuroRehabilitation* 2011;28(3):211-20.

Discussion of assistive technologies and home modification that can be used for people with neurovisual deficits.

Davenport RD, Elzabadani H, Johnson JL, Helal A, Mann WC. Pilot live-in trial at the GatorTech smarthouse. *Topics in Geriatric Rehabilitation* 2007;23(1):73-84.

Report on pilot study of an older adult's experience of smart home.

Demiris G, Oliver DP, Dickey G, Skubic M, Rantz M. Findings from a participatory evaluation of a smart home application for older adults. *Technology and Health Care* 2008;16(2):111-8.

Case report of sensor technology use among older adults in retirement facilities.

Demiris G, Thompson HJ. Mobilizing Older Adults: Harnessing the Potential of Smart Home Technologies. Contribution of the IMIA Working Group on Smart Homes and Ambient Assisted Living. *IMIA Yearbook of Medical Informatics*. 2012;7(1):94-9.

Theoretical paper on smart home technologies.

Dickinson HO, Colver AF. The association between participation in life situations of children with cerebral palsy and their physical, social and attitudinal environment: A cross-sectional multi-centre European study. *Developmental Medicine and Child Neurology* 2012;54:7-8.

Study of general environmental factors and participation of children with cerebral palsy.

Dorresteijn TA, Zijlstra GA, Delbaere K, Rossum E, Vlaeyen JW, Kempen GI. Evaluating an in-home multicomponent cognitive behavioural programme to manage concerns about falls and associated activity avoidance in frail community-dwelling older people: Design of a randomised control trial [NCT01358032]. *BMC health services research* 2011;11:228.

Study of a multicomponent programme and its effect on falls and activity avoidance. Programme did not include any accessibility intervention.

Edwards N, Birkett N, Nair R, Murphy M, Roberge G, Lockett D. Access to bathtub grab bars: evidence of a policy gap. *Canadian Journal on Aging* 2006;25(3):295-304.

Study of the availability of grab bars in the bathrooms of apartment buildings for older adults, their function and impact on the fear of falls and gait balance.

Eklund K, Sjostrand J, Dahlin-Ivanoff S. A randomized controlled trial of a health-promotion programme and its effect on ADL dependence and self-reported health problems for the elderly visually impaired. *Scandinavian Journal of Occupational Therapy* 2008;15(2):68-74.

Study of health promotion programme and its ADL and health effects among older adults with visual impairment. The programme did not include accessibility intervention.

Fange A, Iwarsson S. Changes in accessibility and usability in housing: an exploration of the housing adaptation process. *Occupational Therapy International* 2005;12(1):44-59.

Study on the effect of home modification on accessibility and usability in housing. Outcomes was measured from environmental barriers and functional limitations combined.

Feldman F, Chaudhury H. Falls and the physical environment: a review and a new multifactorial falls-risk conceptual framework. *Canadian Journal of Occupational Therapy* 2008;75(2):82-95.

Review of home modification and fall reduction among older adults.

Finlayson J, Jackson A, Mantry D, Morrison J, Cooper S. The provision of aids and adaptations, risk assessments, and incident reporting and recording procedures in relation to injury prevention for adults with intellectual disabilities: Cohort study. *Journal of Intellectual Disability Research* 2014:No Pagination Specified.

Study of aids provision and safety adaptation, and injury related incidents among adults with intellectual disabilities. Accessibility features were not included.

Francis GL, Blue-Banning M, Turnbull R. Variables Within a Household That Influence Quality-of-Life Outcomes for Individuals With Intellectual and Developmental Disabilities Living in the Community: Discovering the Gaps. *Research & Practice for Persons with Severe Disabilities* 2014;39(1):3-10.

Review of variables that influence a quality of life of residents in group homes.

Gibson BE, Secker B, Rolfe D, Wagner F, Parke B, Mistry B. Disability and dignity-enabling home environments. *Social Science & Medicine* 2012;74(2):211-9.

Qualitative study of an ethical analysis of adequate home environments for adults with mobility disabilities.

Gitlin LN, Winter L, Dennis MP, Hodgson N, Hauck WW. A iobehavioral home-based intervention and the well-being of patients with dementia and their caregivers: the COPE randomized trial. *Journal of American Medical association* 2010;304(9):983-91.

Study of a bio-behavioural home-based intervention for adults with dementia. The intervention included training families in home safety, simplifying tasks and stress reduction.

Granbom M, Slaug B, Lofqvist C, et al. Community relocation in very old age: changes in housing accessibility. *American Journal of Occupational Therapy* 2016; 70: 7002270020.

Study focused on improvements in accessibility, rather than health outcomes.

Hagen I, Cahill S, Begley E, Faulkner JP. "It gives me a sense of independence" - findings from Ireland on the use and usefulness of assistive technology for people with dementia. *Technology & Disability* 2007;19(2-3):133-42.

Study of the use and usefulness of assistive technologies among people with dementia.

Hanson J, Percival J. The housing and support needs of visually impaired adults living in England today. *British Journal of Visual Impairment* 2005;23(3):102-7.

Study of housing and support needs of adults with visual impairment with no outcomes.

Horvath KJ, Trudeau SA, Rudolph JL, Trudeau PA, Duffy ME, Berlowitz D. Clinical trial of a home safety toolkit for Alzheimer's disease. *International Journal of Alzheimer Disease* 2013;2013:913606.

Study of a home safety toolkit and caregivers' competence to build a safe home environment for persons with dementia.

Hutchings BL, Olsen RV, Moulton HJ. Environmental evaluations and modifications to support aging at home with a developmental disability. *Journal of Housing for the Elderly* 2008;22(4):286-310.

Study of the effect of home modification among older adults with developmental disabilities who live in group homes or supported apartments.

I. Novak AC, Lannin N. Occupational Therapy Home Programs for Cerebral Palsy: Double-Blind, Randomized, Controlled Trial. *Pediatrics* 2009;124(4):e606-14.

Study of occupational therapy home programme among children with cerebral palsy. Accessibility intervention not described.

Iwarsson S. A long-term perspective on person-environment fit and ADL dependence among older Swedish adults. *Gerontologist* 2005;45(3):327-36.

Study of relationship between P-E fit and ADL dependence among older adults.

Iwarsson S, Wilson G. Environmental barriers, functional limitations, and housing satisfaction among older people in Sweden: A longitudinal perspective on housing accessibility. *Technology and Disability* 2006;18(2):57-66.

Descriptive study of functional limitations and environmental barriers among older adults.

Johansson K, Josephsson S, Lilja M. Creating possibilities for action in the presence of environmental barriers in the process of 'ageing in place.' *Ageing & Society*. 2009;29(1):49-70.

Qualitative study of experiences on the housing adaptation process on four adults.

Kaminsky TA. Perceived environmental barriers and supports for people with low vision due to diabetic retinopathy. *Dissertation Abstracts International: Section B: The Sciences and Engineering* 2008;69(6-B):3550.

Study of general environmental support and barriers among people with diabetic retinopathy. ICF domains were used for environmental factors.

Kaminsky TA, Mitchell PH, Thompson EA, Dudgeon BJ, Powell JM. Supports and barriers as experienced by individuals with vision loss from diabetes. *Disability & Rehabilitation* 2014; 36(6):487-96.

Qualitative study of environmental support and barriers among people with vision loss from diabetes. ICF domains were used for environmental factors.

Kutintara B, Somboon P, Buasri V, Srettananurak M, Jedeeyod P, Pornpratoom K, et al. Design and evaluation of a kitchen for persons with visual impairments. *Disability* 2013;8(2):136-9.

Study of designing a kitchen for people with visual impairments.

La Grow SJ, Robertson MC, Campbell AJ, Clarke GA, Kerse NM. Reducing hazard related falls in people 75 years and older with significant visual impairment: how did a successful program work? *Injury Prevention* 2006;12(5):296-301.

Discussion in relation to implementations of the included study Campbell 2005.

Linskill J, Hill J. The role of smart home technology in enhancing supported living for people with complex needs and challenging behaviour. *Journal of Assistive Technologies* 2010;4(4):24-35.

Study of smart home use in supportive living facilities for people with challenging behaviours.

M. Tomita WM, K. Stanton AT, Sundar V. Use of currently available smart home technology by frail elders: Process and outcomes. *Topics in Geriatric Rehabilitation* 2007;23(1):24-34.

RCT of smart home use that included remote control for lamps and appliances, door and windows, motion sensor, security, etc. among frail older adults.

Markle-Reid M, Henderson S, Hecimovich C, Baxter P, Anderson M, Browne G, et al. Reducing fall risk for frail older home-care clients using a multifactorial and interdisciplinary team approach: design of a randomized controlled trial. *Journal of Patient Safety* 2007;3(3):149-57.

Protocol of multidisciplinary and interdisciplinary interventions for fall prevention of frail older adults. Home accessibility intervention was not described.

Marquardt G, Johnston D, Black BS, Morrison A, Rosenblatt A, Lyketsos CG, et al. A Descriptive Study of Home Modifications for People with Dementia and Barriers to Implementation. *Journal of Housing for the Elderly* 2011;25(3):258-73.

Cross-sectional study of home modifications for people with dementia.

McCullagh MC. Home modification: how to help patients make their homes safer and more accessible as their abilities change. *American Journal of Nursing*. 2006;106(10):54-64.

Informative paper on home modification.

Metzelthin SF, Rossum E, Witte LP, Hendriks MR, Kempen GI. The reduction of disability in community-dwelling frail older people: design of a two-arm cluster randomized controlled trial BMC public health. 2010;10:511.

Study of primary care intervention for frail older adults, with no description of the accessibility component.

Nilsson MH, Iwarsson S. Home and health in people ageing with Parkinson's disease: study protocol for a prospective longitudinal cohort survey study. BMC Neurology. 2013;13:142.

Protocol of longitudinal cohort study of the home environment for people with Parkinson's disease. Planned to follow up for three years and results not ready.

Nishita CM, Liebig PS, Pynoos J, Perelman L, Spegal K. Promoting basic accessibility in the home: analyzing patterns in the diffusion of visitability legislation. Journal of Disability Policy Studies 2007;18(1):2-13.

Discussion and analysis of visitability legislations.

Novak I. Effective home programme intervention for adults: A systematic review. Clinical Rehabilitation 2011;25(12):1066-85.

Study of home based intervention for adults, with no description of home accessibility intervention.

Nygard L, Starkhammar S, Lilja M. The provision of stove timers to individuals with cognitive impairment. Scandinavian Journal of Occupational Therapy 2008;15(1):4-12.

Study of the provision of stove timing devices for people with cognitive impairments.

Ormerod M. Review of Accessible housing: Quality, disability and design. Ergonomics 2008;51(9):1454-5.

Book review.

Ostensjo S, Carlberg EB, Vollestad NK. The use and impact of assistive devices and other environmental modifications on everyday activities and care in young children with cerebral palsy. Disability & Rehabilitation 2005;27(14):849-61.

Cross-sectional study of assistive devices and environmental adaptation for young children with cerebral palsy. Environmental interventions mainly consisted of the provision of assistive devices and aids for the delivery of therapy.

Percival J, Hanson J. 'I don't want to live for the day any more': visually impaired people's access to support, housing and independence. British Journal of Visual Impairment 2007;25(1):51-67.

Mixed-method study of accommodation types and access to housing for people with visual impairments.

Percival J, Hanson J, Osipovic D. A positive outlook? The housing needs and aspirations of working age people with visual impairments. Disability & Society 2006;21(7):661-75.

Study of housing needs on people with visual impairments.

Pettersson C, Lofqvist C, Fange AM. Clients' experiences of housing adaptations: a longitudinal mixed-methods study. *Disability & Rehabilitation* 2012;34(20):1706-15.

Study of clients' experiences of housing adaptation process.

Prellwitz M, Skar L. How children with restricted mobility perceive the accessibility and usability of their home environment. *Occupational Therapy International* 2006;13(4):193-206.

Study of home accessibility and usability on children with restricted mobility.

Pynoos J, Steinman BA, Nguyen AQ. Environmental assessment and modification as fall-prevention strategies for older adults. *Clinics in Geriatric Medicine* 2010;26(4):633-44. Discussion paper on environmental modification as fall prevention strategies.

Reid D. Accessibility and usability of the physical housing environment of seniors with stroke. *International Journal of Rehabilitation Research* 2004;27(3):203-8.

Study of home usability and accessibility on stroke survivors.

Reid D. Impact of the environment on role performance in older stroke survivors living at home. *International Journal of Therapy & Rehabilitation* 2004;11(12):567-73.

Study of home usability on older stroke survivor.

Riazi A, Boon MY, Bridge C, Dain SJ. Home modification guidelines as recommended by visually impaired people. *Journal of Assistive Technologies* 2012;6(4):270-84.

Study of home modification guidelines recommended by visually impaired people.

Riikonen M, Makela K, Perala S. Safety and monitoring technologies for the homes of people with dementia. *Gerontechnology* 2010;9(1):32-45.

Study of safety and monitoring technologies for people with dementia.

Roessler RT, Bishop M, Rumrill PD, Sheppard-Jones K, Waletich B, Umeasiegbu V, et al. Specialized housing and transportation needs of adults with multiple sclerosis. *Work* 2013;45(2):223-35.

Study of housing and transportation needs on adults with multiple sclerosis.

Rosenberg L, Ratzon NZ, Jarus T, Bart O. Perceived environmental restrictions for the participation of children with mild developmental disabilities. *Child: Care, Health & Development* 2012;38(6):836-43.

Study of environmental restrictions at home, community and educational setting, and participation of children with developmental disabilities.

Roy L, Rousseau J, Allard H, Feldman D, Majnemer A. Parental experience of home adaptation for children with motor disabilities. *Physical & Occupational Therapy in Pediatrics* 2008;28(4):353-68. Qualitative study of parents' experience of the home adaptation process.

Shyu YI, Liang J, Lu JF, Wu CC. Environmental barriers and mobility in Taiwan: is the Roy adaptation model applicable? *Nursing Science Quarterly* 2004;17(2):165-70.

Study of parents' experiences of home adaptation process.

Steultjens E, Clemson L. A preventative home safety programme for community-dwelling older people with low vision reduced falls and was more cost-effective than an exercise programme: Commentary. *Australian occupational therapy journal* 2006;53(3):243-4.

Commentary on Campbell 2005 that has been included in this review.

Stineman MG, Xie D, Pan Q, Kurichi JE, Saliba D, Streim J. Activity of daily living staging, chronic health conditions, and perceived lack of home accessibility features for elderly people living in the community. *Journal of the American Geriatrics Society* 2011;59(3):454-62.

Study of the association between ADL, and health conditions and accessibility features on older adults.

Stineman MG, Xie D, Streim JE, Pan Q, Kurichi JE, Henry-Sánchez JT, et al. Home Accessibility, Living Circumstances, Stage of Activity Limitation, and Nursing Home Use. *Archives of Physical Medicine & Rehabilitation* 2012;93(9):1609-16.

Study of physical home and social environments, and ADL on nursing home use among older adults.

Szanton SL, Thorpe RJ, Boyd C, Tanner EK, Leff B, Agree E, et al. Community aging in place, advancing better living for elders: a bio-behavioral-environmental intervention to improve function and health-related quality of life in disabled older adults. *Journal of the American Geriatrics Society* 2011;59(12):2314-20.

Pilot study of CAPABLE programme for low-income older adults with difficulties in ADL/IADL. Although the programme included handy man's visit for repair, home modification was not relevant to the accessibility component.

Torrington J. The design of technology and environments to support enjoyable activity for people with dementia. *ALTER, European Journal of Disability* 2009;3(2):123-37.

Study of technology and environments with a focus on assistive devices for people with dementia in different home types.

Van Hoof J, Kort HSM. Supportive living environments: a first concept of a dwelling designed for older adults with dementia. *Dementia* (14713012). 2009;8(2):293-316.

Conceptual paper on designing a dwelling for people with dementia.

Van Hoof J, Kort HSM, van Waarde H, Blom MM. Environmental interventions and the design of homes for older adults with dementia: an overview. *American Journal of Alzheimer's Disease & Other Dementias* 2010;25(3):202-32.

Review of focus group discussions on home environments for people with dementia.

Wahl HW, Fange A, Oswald F, Gitlin LN, Iwarsson S. The home environment and disability-related outcomes in aging individuals: what is the empirical evidence? *Gerontologist* 2009;49(3):355-67.

Study of home environments and modification, and disability-related outcomes in older adults.

Werngren-Elgström M, Carlsson G, Iwarsson S. Changes in person-environmental fit and ADL dependence among older Swedish adults. A 10-year follow-up. *Aging Clinical & Experimental Research* 2008;20(5):469-78.

Longitudinal study of the relation between ADL and P-E fit among older adults.

Werngren-Elgström M, Carlsson G, Iwarsson S. A 10-year follow-up study on subjective well-being and relationships to person-environment (P-E) fit and activity of daily living (ADL) dependence of older Swedish adults. *Archives of Gerontology & Geriatrics* 2009;49(1):e16-22.

Longitudinal study of the relation between wellbeing, and ADL and P-E fit among older adults.

York SL. Residential design and outdoor area accessibility. *NeuroRehabilitation* 2009;25(3):201-8.

Discussion on residential design and related legislations.

Young D. Light the way. Providing effective home modifications for clients with low vision. *OT Practice* 2012;17(16):7-12.

Informative paper on effective home modifications for people with low vision.

Appendix 9 Mixed Method Appraisal Tool (MMAT) – version 2011

PART I. MMAT criteria & one-page template (to be included in appraisal forms)

Types of mixed methods study components or primary studies	Methodological quality criteria (see tutorial for definitions and examples)	Responses			
		Yes	No	Can't tell	Comments
Screening questions (for all types)	<ul style="list-style-type: none"> Are there clear qualitative and quantitative research questions (or objectives*), or a clear mixed methods question (or objective*)? Do the collected data allow address the research question (objective)? E.g., consider whether the follow-up period is long enough for the outcome to occur (for longitudinal studies or study components). 				
	<i>Further appraisal may be not feasible or appropriate when the answer is 'No' or 'Can't tell' to one or both screening questions.</i>				
1. Qualitative	1.1. Are the sources of qualitative data (archives, documents, informants, observations) relevant to address the research question (objective)?				
	1.2. Is the process for analyzing qualitative data relevant to address the research question (objective)?				
	1.3. Is appropriate consideration given to how findings relate to the context, e.g., the setting, in which the data were collected?				
	1.4. Is appropriate consideration given to how findings relate to researchers' influence, e.g., through their interactions with participants?				
2. Quantitative randomized controlled (trials)	2.1. Is there a clear description of the randomization (or an appropriate sequence generation)?				
	2.2. Is there a clear description of the allocation concealment (or blinding when applicable)?				
	2.3. Are there complete outcome data (80% or above)?				
	2.4. Is there low withdrawal/drop-out (below 20%)?				
3. Quantitative non-randomized	3.1. Are participants (organizations) recruited in a way that minimizes selection bias?				
	3.2. Are measurements appropriate (clear origin, or validity known, or standard instrument; and absence of contamination between groups when appropriate) regarding the exposure/intervention and outcomes?				
	3.3. In the groups being compared (exposed vs. non-exposed; with intervention vs. without; cases vs. controls), are the participants comparable, or do researchers take into account (control for) the difference between these groups?				
	3.4. Are there complete outcome data (80% or above), and, when applicable, an acceptable response rate (60% or above), or an acceptable follow-up rate for cohort studies (depending on the duration of follow-up)?				
4. Quantitative descriptive	4.1. Is the sampling strategy relevant to address the quantitative research question (quantitative aspect of the mixed methods question)?				
	4.2. Is the sample representative of the population under study?				
	4.3. Are measurements appropriate (clear origin, or validity known, or standard instrument)?				
	4.4. Is there an acceptable response rate (60% or above)?				
5. Mixed methods	5.1. Is the mixed methods research design relevant to address the qualitative and quantitative research questions (or objectives), or the qualitative and quantitative aspects of the mixed methods question (or objective)?				
	5.2. Is the integration of qualitative and quantitative data (or results*) relevant to address the research question (objective)?				
	5.3. Is appropriate consideration given to the limitations associated with this integration, e.g., the divergence of qualitative and quantitative data (or results*) in a triangulation design?				
<i>Criteria for the qualitative component (1.1 to 1.4), and appropriate criteria for the quantitative component (2.1 to 2.4, or 3.1 to 3.4, or 4.1 to 4.4), must be also applied.</i>					

*These two items are not considered as double-barreled items since in mixed methods research, (1) there may be research questions (quantitative research) or research objectives (qualitative research), and (2) data may be integrated, and/or qualitative findings and quantitative results can be integrated.

Appendix 10 Summary of findings and evidence profile

Quality assessment							No. of participants	Effect	Quality	Importance
Number of studies	Designs	Risk of bias	Inconsistency	Indirectness	Imprecision	Other considerations				
Activities of daily living/institutional activities of daily living: dependence										
2 (Fänge 2005, Petersson 2008)	Quasi-experimental: 2 (Fänge 2005, Petersson 2008)	Moderate	Consistent	Direct	Imprecise	Studies were in 131 adults (>18 years) with functional limitations in Sweden (Fänge 2005) and 114 adults (>40 years) with problems in everyday life and requesting home modifications in Sweden (Petersson 2008)	Quasi-experimental studies: 245	Quasi-experimental studies: overall, the interventions were not found to be effective in reducing participants' dependence (Fänge 2005, Petersson 2008)	⊕⊕⊖⊖ Low	Low
Activities of daily living/institutional activities of daily living: difficulties										
4 (Gitlin 2006, Petersson 2008, Petersson 2009, Stineman 2007)	Randomised: 1 (Gitlin 2006) Quasi-experimental: 2 (Petersson 2008, Petersson 2009) Cross-sectional: 1 (Stineman 2007)	Low	Inconsistent	Direct	Imprecise	Studies were in 319 adults (>70 years) with functional limitations in the USA (Gitlin 2006), 114 and 103 adults (>40 years) with problems in everyday life and requesting home modifications in Sweden (Petersson 2008, Petersson 2009), and 25,805 adults (>18 years) with disabilities in the USA (Stineman 2007).	Randomised trial: 319 Quasi-experimental studies: 217 Cross-sectional study: 25,805	Randomised trial: reduced difficulty with ADL: p=0.03 95% CI: -0.24 to -0.01, and IADL: p=0.04, 95% CI: -0.28 to 0.00. Largest benefits were in bathing (p=0.02, 95% CI: -0.52 to -0.06) and toileting (p=0.049, 95% CI: -0.35-0.00). Quasi-experimental studies: significant decrease in self-rated difficulty (d: 0.32: t-test: -3.353, p=0.001) after 2 months (Petersson 2008) and for up to 6 months (mean difference logits: 0.450, SE: 0.156, 95% CI 0.082 to 0.819, p=0.023) (Petersson 2009). Cross-sectional study: ADL difficulty was higher (OR: 3.7, 95% CI 2.9-4.6) among participants who perceived an unmet need for accessibility features (Stineman 2007).	⊕⊕⊕⊖ Moderate	High

Quality assessment							No. of participants	Effect	Quality	Importance
Number of studies	Designs	Risk of bias	Inconsistency	Indirectness	Imprecision	Other considerations				
Activities of daily living/institutional activities of daily living: safety										
1 (Petersson 2008)	Quasi-experimental: 1 (Petersson 2008)	Moderate	Not applicable (one study)	Direct	Precise	Study was in 114 adults (>40 years) with problems in everyday life and requesting home modifications in Sweden (Petersson 2008).	Quasi-experimental study: 114	Quasi-experimental study: significant increase in self-rated safety (d: 0.40, t: -3.820, p=0.001) (Petersson 2008).	⊕⊕⊖⊖ Low	Low
Activities of daily living/institutional activities of daily living: self efficacy										
1 (Gitlin 2006)	Randomised: 1 (Gitlin 2006)	Low	Not applicable (one study)	Direct	Precise	Study was in 319 adults (>70 years) with functional limitations in the USA (Gitlin 2006).	Randomised trial: 319	Randomised trial: greater self efficacy (p=0.03, 95% CI: 0.02-0.27) (Gitlin 2006).	⊕⊕⊕⊖ Moderate	Moderate
Activities of daily living: certainty in performing specific activities										
1 (Brunnström 2004)	Randomised: 1 (Brunnström 2004)	Moderate	Not applicable (one study)	Direct	Imprecise	Study was in 46 adults with low vision in Sweden (Brunnström 2004).	Randomised trial: 46	Randomised trial: no significant change in perceived activity performance in the kitchen and bathroom after 6 months. Only the activities on the working surface in the kitchen improved significantly (7-point scale tested using Wilcoxon signed ranks test): 'pour drink' p= 0.03 and 'slice bread' p= 0.04 (Brunnström 2004).	⊕⊕⊖⊖ Low	Low

Quality assessment							No. of participants	Effect	Quality	Importance
Number of studies	Designs	Risk of bias	Inconsistency	Indirectness	Imprecision	Other considerations				
Activities of daily living: General										
3 (Edgren 2015, Slaug 2017, Tongsiri 2017)	Randomised: 1 (Edgren 2015) Quasi-experimental: 1 (Tongsiri 2017) Cross-sectional: 1 (Slaug 2017)	Moderate	Consistent	Direct	Imprecise	Studies were in 81 adults (>60 years) operated for hip fracture in Finland (Edgren), 43 people with physical disabilities in Thailand (Tongsiri 2017), and 314 adults (80-89 years) in Sweden and 322 adults (80-89 years) in Germany (Slaug 2017).	Randomised trial: 81 Quasi-experimental study: 43 Cross-sectional study: 636	Randomised trial: no significant effects were observed in ADL or IADL (Edgren 2015). Quasi-experimental study: modifications improved abilities in all function areas except for participants with severe degrees of difficulties (Tongsiri 2017). Cross-sectional study: improvements in various aspects of ADL (Slaug 2017).	⊕⊕⊕⊖ Low	Moderate
Quality of life or well-being										
4 (Ahmad 2013, Brunnström 2004, Gitlin 2014, Tongsiri 2017)	Randomised: 2 (Ahmad 2013, Brunnström 2004) Quasi-experimental: 1 (Tongsiri 2017) Cross-sectional: 1 (Gitlin 2014)	Moderate	Consistent	Direct	Imprecise	Studies were in 40 paraplegic wheelchair users in Pakistan (Ahmad 2013), 46 adults with low vision in Sweden (Brunnström 2004), 43 people with physical disabilities in Thailand (Tongsiri 2017), and 88 dyads of adults with dementia and their caregivers in the USA (Gitlin 2014).	Randomised trials: 86 Quasi-experimental study: 43 Cross-sectional study: 88 dyads	Randomised trials: home modifications (Ahmad 2013) and improvements to lighting (Brunnström 2004) both produced significant improvements in quality of life. Quasi-experimental study: modifications improved quality of life (Tongsiri 2017). Cross-sectional study: environmental factors (hazards and accessibility) were not associated with quality of life of participants with dementia but having unmet assistive device/navigation needs were associated with patient-perceived lower quality of life (Gitlin 2014).	⊕⊕⊕⊖ Low	Low

Quality assessment							No. of participants	Effect	Quality	Importance
Number of studies	Designs	Risk of bias	Inconsistency	Indirectness	Imprecision	Other considerations				
Falls or injuries										
4 (Campbell 2005, Carlsson 2017, Maggi 2018, Tchalla 2012)	Randomised: 1 (Campbell 2005) Quasi-experimental: 2 (Carlsson 2017, Maggi 2018) Cohort: 1 (Tchalla 2012)	Moderate	Consistent	Direct	Precise	Studies were in 391 adults (≥75 years) with severe visual impairment in New Zealand (Campbell 2005), 143 adults in Sweden (Carlsson 2017), 1565 frail adults (>65 years) with a history of falls in Belgium (Maggi 2018), and 194 frail adults (≥65 years) in France (Tchalla 2012).	Randomised trial: 391 Quasi-experimental studies: 1708 Cohort study: 194	Randomised trial: there were 41% self-reported fewer falls in the home safety programme only group compared with those who did not receive this programme (IRR: 0.59, 95% CI: 0.42- 0.83) (Campbell 2005). Quasi-experimental studies: falls were non-significantly reduced with the modifications in one study (Carlsson 2017) but significantly reduced with home modifications (OR: 0.46, 95% CI: 0.23-0.9, p<0.05) and with home modifications combined with case management (OR: 0.39, 96% CI: 0.21-0.69, p<0.005) in the other study (Maggi 2018). Cohort study: the use of light path and tele-assistance significantly reduced falls at home (OR: 0.33, 95% CI: 0.17-0.65) and post-fall hospitalisations (OR: 0.30, 95% CI 0.12-0.74) (Tchalla 2012).	⊕⊕⊕⊖ Moderate	Moderate
Mortality										
1 (Gitlin 2006 / 2009)	Randomised: 1 (Gitlin 2006 / 2009)	Low	Not applicable (one study)	Direct	Precise	Study was in 319 adults (>70 years) with functional limitations in the USA (Gitlin 2006 /2009).	Randomised trial: 319	Randomised trial: lower mortality rates at 14 months (1% vs 10%, p=0.003, 95% CI: 2.4-15.04) and 2 years (5.6% vs 13.2%, p=0.02), but not significantly different at 3 years (Gitlin 2006 / 2009).	⊕⊕⊕⊖ Low	Moderate

Quality assessment							No. of participants	Effect	Quality	Importance
Number of studies	Designs	Risk of bias	Inconsistency	Indirectness	Imprecision	Other considerations				
Occupational performance										
1 (Stark 2004)	Quasi-experimental: 1 (Stark 2004)	High	Not applicable (one study)	Direct	Precise	Study was in 29 low income adults (57-82 years) with functional impairments and in need for home environmental modifications in the USA (Stark 2004).	Quasi-experimental study: 29	Quasi-experimental study: significant increase in participants' self-perceived occupational performance (t: -8.23; p=0.0001) and satisfaction with performance (t:-9.54, p=0.0001) at 6 months (Stark 2014).	⊕⊕⊕⊕ Very low	Low
Psychological effects: fear of falling/accidents, feeling of depression										
3 (Carlsson 2017, Gitlin 2006, Heywood 2004)	Randomised: 1 (Gitlin 2006) Quasi-experimental: 1 (Carlsson 2016) Cross-sectional: 1 (Heywood 2004)	Moderate	Consistent	Direct	Imprecise	Studies were in 319 adults (>70 years) with functional limitations in the USA (Gitlin 2006), 143 adults in Sweden (Carlsson 2017), and 266 recipients of housing adaptations in the United Kingdom (Heywood 2004).	Randomised trial: 319 Quasi-experimental study: 143 Cross-sectional study: 266	Randomised trial: reduced fear of falling (p=0.001, 95% CI: 0.26 to 0.96) (Gitlin 2006). Quasi-experimental study: significant decrease in fear of falling at 3 months but not at 6 months (Carlsson 2017). Cross-sectional study: recipients of adaptations reported feeling safer from accidents (Heywood 2004).	⊕⊕⊕⊕ Moderate	Moderate
Participation										
1 (Norin 2017)	Cross-sectional: 1 (Norin 2017)	Moderate	Not applicable (one study)	Direct	Imprecise	Study was in 123 adults in Sweden (Norin 2017).	Cross-sectional study: 123	Cross-sectional study: accessibility problems were significantly associated with less participation and autonomy and more participation problems (Norin 2017).	⊕⊕⊕⊕ Very low	Very low

Ahmad J, Shakil-ur-Rehman S, Sibtain F. Effectiveness of home modification on quality of life on wheel chair user paraplegic population. Rawal Med J 2013; 38(3): 263-5.

Brunnstrom G, Sorensen S, Alsterstad K, Sjostrand J. Quality of light and quality of life - the effect of lighting adaptation among people with low vision. Ophthalmic Physiol Opt 2004; 24(4): 274-80.

Campbell AJ, Robertson MC, La Grow SJ, et al. Randomised controlled trial of prevention of falls in people aged > or =75 with severe visual impairment: the VIP trial. *BMJ* 2005; 331(7520): 817-20.

Carlsson G, Nilsson MH, Ekstam L, et al. Falls and Fear of Falling among Persons Who Receive Housing Adaptations—Results from a Quasi-Experimental Study in Sweden. *Healthcare* 2017; 5: 66.

Edgren J, Salpakoski A, Sihvonen SE, et al. Effects of a Home-Based Physical Rehabilitation Program on Physical Disability After Hip Fracture: A Randomized Controlled Trial. *J Amer Med Directors Assoc* 2015; 16(4): 350e1-350e7.

Fänge A, Iwarsson S. Changes in ADL dependence and aspects of usability following housing adaptation--a longitudinal perspective. *Amer J Occup Ther* 2005; 59(3): 296-304.

Gitlin LN, Hauck WW, Dennis MP, et al. Long-term effect on mortality of a home intervention that reduces functional difficulties in older adults: results from a randomized trial. *J Amer Geriatr Soc* 2009; 57(3): 476-81.

Gitlin LN, Hauck WW, Winter L, Dennis MP, Schulz R. Effect of an in-home occupational and physical therapy intervention on reducing mortality in functionally vulnerable older people: preliminary findings. *J Amer Geriatr Soc* 2006; 54(6): 950-5.

Gitlin LN, Hodgson N, Piersol CV, Hess E, Hauck WW. Correlates of Quality of Life for Individuals with Dementia Living at Home: The Role of Home Environment, Caregiver, and Patient-related Characteristics. *Amer J Geriatr Psych* 2014; 22(6): 587-97.

Gitlin LN, Winter L, Dennis MP, et al. A randomized trial of a multicomponent home intervention to reduce functional difficulties in older adults. *J Am Geriatr Soc* 2006; 54(5): 809-16.

Heywood F. The health outcomes of housing adaptations. *Disability & Society* 2004; 19(2): 129-43.

Maggi P, de Almeida Mello J, Delye S, et al. Fall determinants and home modifications by occupational therapists to prevent falls. *Can J Occup Ther* 2018; 85(1): 79-87.

Norin L, Slaug B, Haak M, et al. Housing accessibility and its associations with participation among older adults living with long-standing spinal cord injury. *J Spinal Cord Med* 2017; 40(2): 230-40.

Petersson I, Kottorp A, Bergstrom J, Lilja M. Longitudinal changes in everyday life after home modifications for people aging with disabilities. *Scand J Occupat Ther* 2009; 16(2): 78-87.

Petersson I, Lilja M, Hammel J, Kottorp A. Impact of home modification services on ability in everyday life for people ageing with disabilities. *J Rehab Med* 2008; 40(4): 253-60.

Slaug B, Chiatti C, Oswald F, et al. Improved Housing Accessibility for Older People in Sweden and Germany: Short Term Costs and Long-Term Gains. *Int J Environ Res Public Health* 2017; 14: 964.

Stark S. Removing Environmental Barriers in the Homes of Older Adults with Disabilities Improves Occupational Performance. *OTJR Occupation, Participation and Health* 2004;24(1):32-9.

Stineman MG, Ross RN, Maislin G, Gray D. Population-based study of home accessibility features and the activities of daily living: clinical and policy implications. *Disability Rehab* 2007; 29(15): 1165-75

Tchalla AE, Lachal F, Cardinaud N, et al. Efficacy of simple home-based technologies combined with a monitoring assistive center in decreasing falls in a frail elderly population (results of the Esoppe study). *Arch Gerontol Geriatr* 2012; 55(3): 683-9.

Tongsiri S, Ploylearmsang C, Hawsutisima K, et al. Wachara Modifying homes for persons with physical disabilities in Thailand. *Bull World Health Organ* 2017; 95: 140–5.

Appendix 11 Characteristics of included studies

1.	Study: Ahmed 2013			Citation: Ahmad J, Shakil-ur-Rehman S, Sibtain F. Effectiveness of home modification on quality of life on wheel chair user paraplegic population. Rawal Med J 2013; 38(3): 263-5.		
Study design		Setting	Population	Data collection time period	Comments	
RCT		Pakistan (district Kohat and Hangu)	Paraplegic adult wheelchair users	January to December 2012	Insufficient information provided on exclusion criteria and method of recruitment	
Size of the sample		Exposure/intervention		Outcome measures	Results	Quality
40 (n=20 home modification, mean age: 33.7 years; n=20 control, mean age: 31.6 years)		Intervention group received home modifications: wheelchair accessible doors, ramps, rails, tub seat in bathrooms and non-slip surface.		Modified LiSAT questionnaire (6 point scale): life as a whole, vocational situation, financial situation, leisure situation, contact with friends and relatives, ability to manage self-care, family life. Measured before and 2 months after the intervention.	Quality of life significantly enhanced in the intervention group, compared to the control group: LiSAT score 33.32 (p=0.001) vs 22.85 (p=0.154). No SD or CI specified.	MMAT ** (Insufficient information provided on randomisation, sequence generation or allocation concealment.)
2.	Study: Brunnstrom 2004			Citation: Brunnstrom G, Sorensen S, Alsterstad K, Sjostrand J. Quality of light and quality of life - the effect of lighting adaptation among people with low vision. Ophthalmic Physiol Opt 2004; 24(4): 274-80.		
Study design		Setting	Population	Data collection time period	Comments	
RCT		Sweden (Goteborg)	Adults with low vision (visual acuity ≤0.3 (6/18))	Not specified.	Participants were consecutively recruited from those receiving lighting adaptation help by the Low Vision Clinic at Sahlgren University Hospital.	
Size of the sample		Exposure/intervention		Outcome measures	Results	Quality
56 recruited (9 dropped out before randomisation and one did not participate in the first stage) 46 participants (mean age: 76 years, range: 20-90 years) n=24 intervention n=22 comparison Macular degeneration dry form (n=12), macular degeneration wet form (n=16), retinitis pigmentosa (n=2), glaucoma: (n=5), and other diagnoses (n=11)		Intervention group received lighting adjustment in the kitchen, bathroom and hall according to a pre-determined measurement protocol. They received an additional lighting adjustment in the living room. Control group received lighting adjustment in the kitchen, bathroom and hall. They did not receive the additional lighting adjustment.		Perceived certainty in performing activities (7 points): pouring a drink, slicing bread, regulating the cooker, findings things finding cupboards, on the table, and plate. Perceived certainty in performing activities (yes/no): preparing food, washing up, laying the table, looking in the mirror (bathroom), seeing if clothes are dirty, matching items of clothing. Reading the newspaper. Psychological and general well-being (PGWB) scale: 7 points. Outcomes obtained via interviews before and 6 months after the intervention.	Overall, no significant change in perceived activity performance in the kitchen and bathroom in both groups. Only the activities on the working surface in the kitchen improved significantly: 'pour drink' median difference (MD) 1.5 to 3.5, p=0.03, 'slice bread' MD 3.0 to 6.0, p=0.04. Control group had no change in quality of life and well-being, whereas the intervention group showed a significant improvement for all items (range p=0.01 to 0.04). No CI specified.	MMAT *** (Block randomisation used with a block size of four. Insufficient information provided on allocation concealment or blinding.) Small sample size makes it unlikely to represent the target population. Differences between groups for demographic characteristics not specified Samples were heterogeneous in terms of diagnosis. Approximately half of the participants reported that their perceived eyesight worsened during the study period. It might have affected their activity function. Validity and reliability issues of psychometrics used (ADL and quality of life).

3.	Study: Campbell 2005			Citation: Campbell AJ, Robertson MC, La Grow SJ, et al. Randomised controlled trial of prevention of falls in people aged > or =75 with severe visual impairment: the VIP trial. BMJ 2005; 331(7520): 817-20.		
Study design		Setting	Population	Data collection time period	Comments	
RCT (2x2 factorial design)		New Zealand (Dunedin and Auckland)	Older adults (≥75 years) with severe visual impairment (visual acuity ≤6/24)	October 2012 to September 2013	Participants were recruited through records from the blind register, low vision clinics and hospitals, where staff invited people to participate. Exclusion criteria: (1) could not walk around their own residence; (2) receiving physiotherapy; (3) could not understand the trial requirement	
Size of the sample		Exposure/intervention		Outcome measures	Results	Quality
391 Home safety programme only (n=100, mean age 83.1 years) Exercise programme (n=97, mean age 83.4 years) Home modification and exercise (n=98, mean age 83.8 years) Social visits n=96, (mean age 84.0 years)		Home safety programme: occupational therapist (OT) visited home and carried out home safety assessment, and made recommendations to implement. OT facilitated payment for home modification. 90% of participants (152/169) reported complying partially or completely with one or more of the recommendations: removing or changing loose floor mats, painting the edge of steps, reducing glare, installing grab bars and stair rails, removing clutter, and improving lighting. Exercise programme included modified Ontago exercise for a year with vitamin D supplementation. Social visits included two home visits lasting 60 minutes each.		Number of self-reported falls and injuries resulting from falls. Economic evaluation. Outcomes measured at 1-year follow-up.	41% fewer falls in the home safety programme only group compared with those who did not receive this programme (incident rate ratio 0.59, 95% CI 0.42 to 0.83); exercise programme (incident rate ratio 1.15, CI 0.82 to 1.61). No significant difference in reduction of falls at home compared to outside home environment. Neither intervention decreased fall related injuries. Home safety programme cost \$NZ 650 (£234, 344 euro, \$US 432 at 2004 prices) per fall prevented.	MMAT **** (Computer generated random numbers used for allocation. Assessors for falls and investigators for classifying fall events blinded to allocation.) Duration of visual impairment varied significantly. Participants' abilities were not taken into account for participating in an exercise programme.
4.	Study: Carlsson 2017			Citation: Carlsson G, Nilsson MH, Ekstam L, et al. Falls and Fear of Falling among Persons Who Receive Housing Adaptations—Results from a Quasi-Experimental Study in Sweden. Healthcare 2017; 5: 66.		
Study design		Setting	Population	Data collection time period	Comments	
Quasi-experimental		Sweden	Non-institutionalized persons (>20 years) who had applied for a housing adaptation grant	Started in 2013	Purpose of the study was to investigate effects of applying a standardized research-based strategy to housing adaptation compared to ordinary practice and to investigate effects of housing adaptations on fall-related outcomes.	

Size of the sample		Exposure/intervention	Outcome measures	Results	Quality
196 at baseline, 163 at 3 months, and 143 at 6 months		Occupational therapists applied an intervention with a standardized strategy for housing adaptation management (compared to the control site at which the occupational therapists worked according to their ordinary practice routines for housing adaptation management)	Falls and fear of falling	6 months after housing adaptation, proportion of fallers increased to 71.8% for control but proportion of fallers increased to 55.4% for intervention ($p=0.041$); mean number of falls decreased from 2.2 (SD: 5.5) to 1.7 (SD: 8.8), with clearer drop for intervention (mean changed from 2.4 (SD: 5.5) to 1.4 SD: 3.4). Fear of falling was significantly lower at 3 months but not at 6 months.	Moderate risk of bias (lack of information on whether duration or completeness of follow-up was adequate.)
5.	Study: Edgren 2015		Citation: Edgren J, Salpakoski A, Sihvonen SE, et al. Effects of a Home-Based Physical Rehabilitation Program on Physical Disability After Hip Fracture: A Randomized Controlled Trial. J Amer Med Directors Assoc 2015; 16(4): 350e1-350e7.		
Study design		Setting	Population	Data collection time period	Comments
RCT		Finland (Jyväskylä and neighbouring municipalities)	Community-dwelling adults (>60 years) operated for hip fracture	Not reported	Purpose of the study was to investigate effects of a multicomponent home-based rehabilitation programme (ProMo) on physical disability after hip fracture.
Size of the sample		Exposure/intervention	Outcome measures	Results	Quality
81		Intervention (1 year) including evaluation and modification of environmental hazards, guidance for safe walking, pain management, home exercise, physical activity counselling, and standard care	Activities of daily living (ADL)	Mean ADL score for intervention was 4.7 (SD: 3.2) versus 3.9 (SD: 3.0) for control ($p=0.316$). Mean IADL score for intervention was 9.4 (SD: 7.7) versus 7.8 (SD: 6.5) for control ($p=0.421$). No intervention-related adverse events.	Low risk of bias
6.	Study: Fange 2005		Citation: Fange A, Iwarsson S. Changes in ADL dependence and aspects of usability following housing adaptation--a longitudinal perspective. Amer J Occup Ther 2005; 59(3): 296-304.		
Study design		Setting	Population	Data collection time period	Comments
Longitudinal, before and after		Sweden (medium-sized municipality with urban and rural areas)	Adults >18 with functional limitations who were being considered for housing adaptation grants.	Not reported.	Clients were consecutively enrolled over 18 months, who applied for housing adaptation grants. Exclusion criteria: (1) terminally ill; (2) clients who spent most of the in a bed or chair; (3) communication problems.

Size of the sample	Exposure/intervention	Outcome measures	Results	Quality
131 (88 female, mean age 71 years) at baseline, 104 at 2-3 months follow-up; 98 at 8-9 months follow-up	Housing adaptation grants administered. Most of the adaptations targeted hygiene facilities (installation of grab bars at the bathtub or shower, replacing the bathtub with a shower), entrances including balcony and patio, and stairways and doors. A few adaptations targeted floor surfaces in bathrooms.	ADL staircase, Revised version that comprises 5 personal ADL and 4 IADL, 3 graded scale (independent, partly dependent, independent). Usability in My Home Instrument: environmental impact on performance of ADL/IADL, 23 items in total with 16 of 7-point scale and 7 of open-ended questions. Outcomes measured before, 2-3 months and 8-9 months after the intervention.	No significant change in overall ADL dependence at any time point relative to baseline, but dependence in bathing decreased between T2 and T3 ($p=0.002$). No significant change in activity aspects between T1 and T3, but great improvement between T1 and T2 ($p=0.045$). Significant improvement in personal and social aspects between T2 and T3 ($p=0.008$), but no changes earlier.	MMAT ** Small sample size may explain the lack of significant changes over time. No comparison group. Other interventions may have been implemented on the participants: mobility devices were prescribed from other interventions during the home modification process.
7.	Study: Gitlin 2006 ¹		Citation: Gitlin LN, Winter L, Dennis MP, et al. A randomized trial of a multicomponent home intervention to reduce functional difficulties in older adults. J Am Geriatr Soc 2006; 54(5): 809-16.	
Study design	Setting	Population	Data collection time period	Comments
RCT	the USA	Older adults (≥ 70 years) who reported difficulty with one or more activities of daily living and were ambulatory.	2000 to 2003	Participants were recruited from an area agency on aging and advertisements through media and posters. Exclusion criteria: (1) MMSE ≤ 23 , (2) non-English speaking, (3) receiving home care.
Size of the sample	Exposure/intervention	Outcome measures	Results	Quality
319 (mean age: 79 years) at baseline, 300 at 6 months, 285 at 12 months Intervention (n=160, mean age 79.5 years) Control (n=159, mean age 78.5 years)	Intervention group received home occupational (four 90 minute visits and one 20 minute telephone contact) and physical therapy sessions (one 90 minutes) during the first 6 months. OT/PT sessions included home modifications (e.g. grab bars, rails, raised toilet seats) and training; instruction in problem solving strategies, energy conservation, safe performance, fall recovery technique, and balance and muscle strength training. Home modifications were paid for through grant funds.	ADL, mobility/transferring, and IADL: 5 point scale, perceived difficulty. Tinetti et al.'s Falls Efficacy Scale, and three items from Powell et al.'s Activities-specific Balance Confidence Scale: 10-point scale, perceived fear of falling Self-efficacy: confidence in managing ADL, IADL and mobility, 5 point scale. Secondary outcomes: observed home hazards, use of adaptive strategies Outcomes measured before and 6 and 12 months after the intervention.	At 6 months, the intervention group reported less difficulty than controls with ADL ($p=0.03$, 95% CI: -0.24 to -0.01) and IADL ($p=0.04$, 95% CI: -0.28 to 0.00). Largest benefits were in bathing ($p=0.02$, 95% CI: -0.52 to -0.06) and toileting ($p=.049$, 95% CI=-0.35-0.00). No significant change in mobility/transfer difficulty. Intervention group had greater self efficacy ($p=0.03$, 95% CI: 0.02 to 0.27), less fear of falling ($p=0.001$, 95% CI: 0.26 to 0.96), and greater use of adaptive strategies ($p=0.009$, 95% CI: 0.03 to 0.22). 12-month effects were similar to those at 6 months.	MMAT **** (Samples were stratified and randomised in each of 4 strata using random permuted blocks. Randomisation lists and 4 sets of randomisation were prepared using double opaque envelopes.) Participants were voluntary, and might have been more motivated. As it was a multicomponent intervention, it is unclear if one intervention was more effective than others. Control group may have benefited from attention from health professionals.

8.	Study: Gitlin 2006 ²			Citation: Gitlin LN, Hauck WW, Winter L, Dennis MP, Schulz R. Effect of an in-home occupational and physical therapy intervention on reducing mortality in functionally vulnerable older people: preliminary findings. J Amer Geriat Soc 2006;54(6):950-5.		
Study design		Setting	Population	Recruitment time period	Comments	
RCT (14 months follow-up of Gitlin 2006 ¹)		the USA	Older adults (≥70 years) with functional difficulties and were cognitively intact	2000 to 2003	Participants were recruited from an area agency on aging and advertisements through media and posters. Exclusion criteria: (1) MMSE ≤23, (2) non-English speaking, (3) receiving home care.	
Size of the sample		Exposure/intervention		Outcome measures	Results	Quality
319 (mean age: 79 years, SD: 5.9) Female 62%, living alone 62% Intervention (n=160, mean age 79.5 years) Control (n=159, mean age 78.5 years)		Intervention group received home occupational (four 90 minute visits and one 20 minute telephone contact) and physical therapy sessions (one 90 minutes) during the first 6 months. OT/PT sessions included home modifications (e.g. grab bars, rails, raised toilet seats) and training; instruction in problem solving strategies, energy conservation, safe performance, fall recovery technique, and balance and muscle strength training. Control: no treatment Home modifications were paid for through grant funds.		Health and physical function: health conditions, days hospitalised 6 months before study entry, self-rated health, formal services, medications, emergency visits, days in rehabilitation, difficulty in ADL, IADL and mobility/transfer. Mortality over 14 months. Control-oriented strategy use.	Intervention group had a significantly lower mortality rate than controls: 1% vs 10% (p=0.003, 95% CI: 2.4 to 15.04). None of the intervention group with previous days hospitalised (n=31) died, whereas 21% of control group counterparts did (n=35; p=0.001). Mortality was lower for intervention participants with low strategy use at baseline (p=0.007).	MMAT **** Cause of death generally not known. Health professionals might have detected medical problems and recommended treatment for intervention group. Subjective self-reports of functional difficulties were used. Few deaths occurred in the study period (n=14). Exploratory analysis, this study was not planned at the outset.
9.	Study: Gitlin 2009			Citation: Gitlin LN, Hauck WW, Dennis MP, et al. Long-term effect on mortality of a home intervention that reduces functional difficulties in older adults: results from a randomized trial. J Amer Geriat Soc 2009; 57(3): 476-81.		
Study design		Setting	Population	Recruitment time period	Comments	
RCT (4 years follow-up of Gitlin 2006 ¹)		the USA	Older adults (≥70 years) with difficulties performing daily activities, were ambulatory, cognitively intact	2000 to 2003	Participants were recruited from an area agency on aging and advertisements through media and posters. Exclusion criteria: (1) MMSE ≤23, (2) non-English speaking, (3) receiving home care.	

Size of the sample		Exposure/intervention	Outcome measures	Results	Quality
319 (mean age 79 years) Intervention (n=160, mean age 79.5 years) Control (n=159, mean age 78.5 years)		<p>ABLE intervention:</p> <p>Active phase: five OT contacts (four 90 minutes visits and one 20 minutes telephone contact) and one 90 minutes PT visit during the first 6 month.</p> <p>OT/PT sessions included home modifications (e.g. grab bars, rails, raised toilet seats) and training; instruction in problem solving strategies, energy conservation, safe performance, fall recovery technique, and balance and muscle strength training.</p> <p>Maintenance phase (from 6-12 months): three brief OT telephone calls.</p> <p>Control: no treatment</p> <p>Home modifications were paid for through grant funds.</p>	Mortality rate from the national death index over 4 years.	<p>At 2 years, intervention group had significantly lower mortality rate than controls: 5.6% (n=9/160) vs 13.2% (n=21/159; p=0.02).</p> <p>Mortality rates remained lower in the intervention group up to 3.5 years, but there was no significant difference by 3 years between intervention and control group.</p> <p>The mortality benefit to 2 years was similar in low and moderate mortality risk groups, although this attained statistical significance only in the moderate group (log rank test, $\chi^2=5.3$, p=0.02).</p>	<p>MMAT ****</p> <p>As it was the multicomponent intervention, it is unclear whether home accessibility intervention contributed to survivorship.</p> <p>The database did not allow multivariate risk adjustment or control of clinical variables, e.g. comorbidities, health service utilisation, hospitalisation.</p> <p>Exploratory analysis, this study was not planned at the outset.</p>
10.	Study: Gitlin 2014		Citation: Gitlin LN, Hodgson N, Piersol CV, Hess E, Hauck WW. Correlates of Quality of Life for Individuals with Dementia Living at Home: The Role of Home Environment, Caregiver, and Patient-related Characteristics. Amer J Geriat Psych 2014; 22(6): 587-97.		
Study design	Setting	Population	Data collection time period	Comments	
Cross-sectional	the USA (East Coast region)	Adults with dementia (caregivers ≥ 21 years; living with/in close proximity to patients; English speaking; provided care for 5 months or more)	June 2009 to October 2010	<p>Participants were recruited through media advertisements and mailings by aging and faith-based organisations, targeting caregivers.</p> <p>Exclusion criteria for patients: (1) MMSE<10, (2) bed-bound or unresponsive, (3) could not speak English.</p>	

Size of the sample		Exposure/intervention	Outcome measures	Results	Quality
<p>88 dyads (97%) completed two home assessments and are included in the analysis</p> <p>Patients (n=88, mean age 82 years, range 56 to 97 years)</p> <p>Caregivers (n=88, mean age 65.8 years, range 38 to 89 years)</p>		Participants received a 45-minute telephone interview, 90-minute first home visit with MMSE administration, and a second visit within 2 weeks of completion of interviews.	<p>Quality of Life in Alzheimer Disease: 4 point scale.</p> <p>Home Environmental Assessment Protocol: home hazards (access to dangerous objects), adaptations (grab bars, visual cues), measured via observation or interviews, two indices represent the total number of hazards and adaptation.</p> <p>Unmet home environmental needs by asking two yes/no questions to caregivers,</p> <p>Patient-related factors: health conditions, behavioural frequency, fall risk, pain & sleep quality.</p> <p>Caregiver-based factors: mood, positive caregiving, and communication.</p>	<p>Home environmental factors were not associated with perceived quality of life: adaptation (Regression Coefficient B=-0.284, 95% CI: -0.647 to 0.079, t=-1.558, p=0.123), hazards (B=0.002, 95% CI: -0.292 to 0.296, t=0.016, p=0.987).</p> <p>Environmental factors were not associated with caregiver-perceived quality of life of patients.</p> <p>Having more unmet assistive device/navigation needs (B=-2.314, 95% CI: -4.370 to -0.258, t=-2.240, p=0.028) and health conditions (B=-0.707, 95% CI: -1.161 to -0.253, t=-3.101, p=0.003) were associated with patient-perceived lower quality of life in separate regressions.</p>	<p>MMAT **</p> <p>Small sample size and cross-sectional design.</p> <p>Not all modifiable and relevant factors were included.</p>
11.	Study: Heywood 2004		Citation: Heywood F. The health outcomes of housing adaptations. Disability & Society 2004; 19(2): 129-43.		
Study design		Setting	Population	Data collection time period	Comments
Mixed method: interviews and questionnaires		The United Kingdom: England and Wales	Recipients of housing adaptation	1999 to 2000	Participants were recruited through social services or housing authority records.

Size of the sample		Exposure/intervention	Outcome measures	Results	Quality
104 interviews (84 face-to-face and 20 telephone) Questionnaires (n=162, mean age 71 years, women 115)		104 interviews with recipients of major home adaptations and 162 postal questionnaires by recipients of minor adaptations in six out of seven areas. Minor adaptations: quickly and easily fitted fixed alteration costing less than £500, e.g. hand-rails, grab-rails. Major adaptations: stair-lifts, bathroom conversions (usually providing a level-access shower, extensions to provide ground-floor bedroom, bathroom or both, stair- and through-floor lifts, the installation of a downstairs toilet, door widening, ramps, kitchen alterations. Home modifications included heating.	SPSS database used for establishment of core frequencies and links. Then, an adapted version of the NCSR framework methodology was used, involving repeat reading of interview transcripts to identify themes. Searches from the themes on words or groups of words were carried out to check frequency.	Key themes identified: Health impacts on disabled people before housing adaptation or after inadequate adaptation: pain, accident, exacerbated illness, feeling of depression Health impacts on caregivers and other family members: injuries, falls Health gains from good quality adaptations for disabled people: relief of pain, preventing accidents and reducing fear of accidents, ending depression Health benefits to other household members Inter-active effects	MMAT overall**: Qualitative **, Quantitative **, Mixed Method ** (Random sampling and stratified - tenures, local districts, racial/ethnic and age groups. <60% response rate for questionnaires. Five confidential interviews in each authority were also carried out by telephone by a disabled researcher or the research coordinator.) Questions were sent to participants in advance for interviews. In most cases, transcripts of interviews were sent back to participants to check.
12.	Study: Maggi 2018		Citation: Maggi P, de Almeida Mello J, Delye S, et al. Fall determinants and home modifications by occupational therapists to prevent falls. Can J Occup Ther 2018; 85(1): 79-87.		
Study design		Setting	Population	Data collection time period	Comments
Quasi-experimental		Belgium	Frail adults (>65 years) living at home, with history of falling	2010 to 2014	
Size of the sample		Exposure/intervention	Outcome measures	Results	Quality
1565		Interventions offering home modifications and advice by occupational therapists with and without case management.	Falls	Logistic regression for persons who fell in the 3 months before the interventions with home modifications: OR: 0.46 (95% CI: 0.23-0.91, p<0.05); with home modifications and case management (n=249): OR: 0.39 [95% CI: 0.21-0.69, p<0.005).	High risk of bias due to lack of details on key aspects of study design.

13.	Study: Norin 2017			Citation: Norin L, Slaug B, Haak M, et al. Housing accessibility and its associations with participation among older adults living with long-standing spinal cord injury. J Spinal Cord Med 2017; 40(2): 230-40.		
Study design		Setting	Population	Data collection time period	Comments	
Cross-sectional		Sweden (Lund)	Adults (≥ 50 years) with a traumatic or non-traumatic spinal cord injury for ≥10 years, in Swedish Aging with Spinal Cord Injury Study	Not reported	Purpose of the study was to describe the housing situation and aspects of participation among older adults living with longstanding spinal cord injury (SCI) with attention to SCI severity, and to examine whether and how objective housing accessibility is associated with aspects of participation.	
Size of the sample		Exposure/intervention		Outcome measures	Results	Quality
123		Accessibility of housing		Participation in society	Autonomy indoors: indoor accessibility was significantly associated (OR: 1.00, 95% CI: 1.00-1.01, p=0.009). Participation: indoor accessibility was significantly associated with family role (p=0.003) and participation problems (P=0.003). Entrance accessibility was significantly associated with autonomy indoors (p=0.008) and family role (p=0.013) but not with participation problems.	High risk of bias due to lack of details on key aspects of study design.
14.	Study: Petersson 2008			Citation: Petersson I, Lilja M, Hammel J, Kottorp A. Impact of home modification services on ability in everyday life for people ageing with disabilities. J Rehab Med 2008; 40(4): 253-60.		
Study design		Setting	Population	Data collection time period	Comments	
Quasi-experimental pre-post test (part of a larger ongoing longitudinal research project)		Sweden	Adults (≥40 years) with disabilities (problems in everyday life and requesting home modifications related to at least one of (1) getting in and out of the home, (2) mobility indoors, and (3) self-care in the bathroom.	2002 to 2005	Home Modification (AHM) identified potential participants. Exclusion criteria: (1) MMSE <19, (2) CES-D depression ≥24, (3) could not communicate in Swedish.	

Size of the sample		Exposure/intervention	Outcome measures	Results	Quality
114 at baseline, (n=73 intervention, n=41 comparison group) 105 at follow up (mean age 75.3 years; n=73 intervention, mean age 75.7 years; n=41 comparison, mean age 74.6 years)		<p>People scheduled for home modifications within 4 weeks were allocated in the intervention group, and received their home modifications. Common home modifications included shower, ramps and automatic door openers.</p> <p>People waiting for their application to be investigated by the AHM were allocated to the comparison group and did not receive home modifications during the study.</p> <p>Costs of modifications were covered by the local authorities.</p>	Client-Clinician Assessment Protocol (C-CAP) Part I: self-rated independence (4-point scale), difficulty (5-point scale) and safety (3-point scale) in ADL, IADL, mobility & leisure, measured before and 2 months after the intervention	<p>Intervention group had a significant increase of safety ($t = -3.820$, $p = 0.001$, effect size $d = 0.40$) and decrease of difficulty ($t = -3.353$, $p = 0.001$, $d = 0.32$) in ADL.</p> <p>No significant change in self-rated functional independence in the intervention group ($t = -0.630$, $p = 0.531$).</p> <p>Decreased difficulties and increased safety in bathroom use, and getting in and out of house. Self-rated safety in taking medication was significantly decreased in the intervention group.</p> <p>No significant change in abilities in the comparison group.</p>	<p>MMAT ***</p> <p>Small sample size and urban living samples that applied for home modifications might not be generalisable.</p> <p>Psychometric limitations in the C-CAP Part I.</p> <p>Difficulty of measuring self-rated improvements in everyday life were directly from home modifications, or related to other factors, e.g. technical devices.</p>
15.	Study: Petersson 2009		Citation: Petersson I, Kottorp A, Bergstrom J, Lilja M. Longitudinal changes in everyday life after home modifications for people aging with disabilities. Scand J Occupat Ther 2009; 16(2): 78-87.		
Study design	Setting	Population	Data collection time period	Comments	
Quasi-experimental pre-post test	Sweden	Adults (≥ 40 years) with disabilities (problems in everyday life and requesting home modifications related to at least one of (1) getting in and out of the home, (2) mobility indoors, and (3) self-care in the bathroom.	2002 to 2005	<p>Home modification (AHM) identified potential participants.</p> <p>Exclusion criteria: (1) MMSE < 19, (2) CES-D depression ≥ 24, (3) could not communicate in Swedish.</p>	

Size of the sample		Exposure/intervention	Outcome measures	Results	Quality
103 at baseline (mean age 75.1 years; n=74 intervention, mean age 75.19 years; n=29 comparison (mean age 74.5 years), 94 at 2 months (n=69 intervention, n=25 comparison), 84 at 6 months (n=64 intervention, n=20 comparison)		Intervention group received home modifications as scheduled. Common home modifications included shower, ramps and automatic door openers. Comparison group did not receive home modifications during the study.	Self-rated Difficulty scale of the Client-Clinician Assessment Protocol (C-CAP) Part I: only difficulty part used, 5-point scale, measured before and 2 and 6 months after home modifications	Intervention group had less difficulty up to 6 months than the comparison group: intervention vs comparison mean difference Logits= 0.450 SE=0.156 p=0.023 95% CI: 0.082 to 0.819 Small to moderate effect size for home modifications for the intervention group at 2 months (mean=0.35 SE=0.15 d=0.34) and 6 months (mean=0.37, SE=0.16, d=0.0.32) No effect in the comparison group. One confounding factor, waiting time for home modifications had an additional impact on experienced difficulties in ADL	MMAT *** Small sample size, large dropout in the comparison group, and urban living samples who applied for home modifications might not be generalizable. Psychometric limitations in the C-CAP Part I. Difficulty of measuring whether self-rated improvements in everyday life were directly due to home modifications, or related to other factors, e.g. technical devices.
16.	Study: Stark 2004		Citation: Stark S. Removing Environmental Barriers in the Homes of Older Adults with Disabilities Improves Occupational Performance. OTJR Occupation, Participation and Health 2004;24(1):32-9.		
Study design	Setting	Population	Data collection time period	Comments	
Non-randomised pre-post	the USA	Low income older adults with functional impairments and indicated a need for environmental modifications	1999 to 2000	Participants were identified by a not-for-profit agency that provides free or low cost architectural (accessibility) modifications in partnership with occupational therapists. Exclusion criterion: Cognitive subscale of the FIM ≤25	

Size of the sample	Exposure / Intervention	Outcome measures	Results	Quality
29 at baseline (mean age 70.7 years, range 57-82 years), 16 retained (n=12 African Americans n=12 women)	<p>Participants received occupational therapy home modification programme, an average of 2.5 home modifications per person, ranging from 1-7. Most common modifications were the installation of handrails, grab bars and ramps. Less common modifications included bedrails, widening doors, relocating laundry facilities from the basement to the living floor, and additional lights.</p> <p>Interventions were limited to compensatory strategies only. No other remedial intervention.</p> <p>If participants were able to pay for home modifications, they did so. If not, the agency provided it at no cost.</p>	<p>Canadian Occupational Performance Measure (COPM) via semi-structured interviews and structured scoring method (10-point scale). Participants were asked about importance, performance and satisfaction in self-care (personal care, functional mobility and community management), productivity in work, household and play/school, and leisure (quiet recreation, active recreation and socialisation)</p> <p>Baseline data collection:</p> <ul style="list-style-type: none"> Severity of disability by the FIM, COPM, Environmental Functional Independence Measure (Enviro-FIM) assessed by interviews and observations. Outcomes were measured before, 3 and 6 months after home modifications. 	Participants' self-perceived occupational performance (t=-8.23, p=0.0001) and satisfaction with performance (t=-9.54 p=0.0001) increased significantly at 6 months.	<p>MMAT **</p> <p>Small sample size and limited follow-up.</p> <p>No control group.</p> <p>Participants were mainly African American: not representative of the general population of older adults with disabilities.</p> <p>Lengthy time from enrolment to completion of modifications may have allowed changes in physical status.</p>
17.	Study: Slaug 2017		Citation: Slaug B, Chiatti C, Oswald F, et al. Improved housing accessibility for older people in Sweden and Germany: short term costs and long-term gains. Int J Environ Res Pub Health 2017; 14: 964	
Study design	Setting	Population	Data collection time period	Comments
Cross-sectional	Germany and Sweden	Adults (80-89 years), in the ENABLE-AGE survey	2002 to 2003	Purpose of the study was to estimate the potential impact on instrumental activities of daily living (I-ADL), usage of home services, and related costs.
Size of the sample	Exposure/intervention	Outcome measures	Results	Quality
397 in Sweden and 450 in Germany at baseline; 314 and 322 at 1 year	Barriers to accessibility (26 barriers in Sweden and 21 in Germany)	Activities of daily living (ADL)	"Our simulations show that improved accessibility of the ordinary housing stock has the potential to maintain or improve the health of our ageing population."	Moderate risk of bias due to lack of information on some aspects of study design.

18.	Study: Stineman 2007			Citation: Stineman MG, Ross RN, Maislin G, Gray D. Population-based study of home accessibility features and the activities of daily living: clinical and policy implications. Disability Rehab 2007; 29(15): 1165-75		
Study design		Setting	Population	Data collection time period	Comments	
Cross-sectional (survey)		the USA	Adults (>18 years) with disabilities, non-institutionalised, answered all survey questions themselves, and described at least one physical limitation (Phase II of the National Health Interview Survey (NHIS) supplements on Disability (NHIS-D))	Phase I: 1994 to 1997 Phase II: 206 to 722 days later, limited to persons with disabilities	Data from phase I and II of NHIS-D: Phase I was representative of the US non-institutionalised civilian population >18 years. Phase II was limited to persons with disabilities. Phase II data were used to address person-environmental interactions.	
Size of the sample		Exposure/intervention		Outcome measures	Results	Quality
25,805 in Phase II		80% (n=20,644) randomly assigned to a model building sample, and 20% (n=5,161) to a validation data. 7,922 (85%) in the model building data met all the criteria, and had all variables necessary for primary analysis. This made up the samples on which the effects of environmental barriers were modelled: 1952 respondents in the validation data set who met the same criteria.		Outcome measure: Self-reported difficulty or inability in ADL. Primary predictors: Self-perceived environmental barriers: wide doorways, ramps into the home, railings inside the home, automatic doors, elevators, bathroom, kitchen or other modification. Physical limitations: lower body use, hand use and reaching. Assistive technology: limited to mobility aids. Socioeconomic variable.	There were 12,743 people with physical impairments, 10.3% of whom perceived an unmet need for at least one home accessibility feature. After adjusting for severity of physical limitation and socioeconomic differences, the odds of an ADL difficulty were 3.7 times larger (95% CI 2.9-4.6) among participants who perceived an unmet need for accessibility features.	MMAT *** Restricted to physical limitations only and the perceived effects of architectural barriers. Subgroup analyses of the NHIS-D may be vulnerable to errors resulting from non-response bias that occurred during the original survey.
19.	Study: Tchalla 2012			Citation: Tchalla AE, Lachal F, Cardinaud N, et al. Efficacy of simple home-based technologies combined with a monitoring assistive center in decreasing falls in a frail elderly population (results of the Esoppe study). Arch Gerontol Geriatr 2012; 55(3): 683-9.		
Study design		Setting	Population	Data collection time period	Comments	
Longitudinal Perspective cohort (pilot study)		France (Correze district in Limousin area) July 2009-June 2010	Frail older adults (≥65 years), registered on a list of frail elderly people and living at home	July 2009 to June 2010	Participants were recruited through a population survey in Correze district (pre-selected by the council). Exclusion criteria: (1) severe dementia (MMSE ≥25), (2) participation in a falls prevention rehabilitation programme.	

Size of the sample		Exposure/intervention	Outcome measures	Results	Quality
194 (mean age 83.4 years, women 77.4%) Exposed group (n=96, mean age 84.9 years, women 76.6%) Unexposed group (n=98, mean age 82.0 year, women 78.1%)		Intervention group received light path installed near the bed, which is 1.5m long and turns on automatically on when the person sets foot on the ground. The light path proved visibility by showing the right path and improving conscious awareness of environment. They also received tele-assistance service 24/7: a remote intercom, an electronic bracelet. Control group did not receive any intervention.	Falls (over 12 months)	Light path coupled with tele-assistance was significantly associated with reduction in falls at home (OR: 0.33, 95% CI: 0.17 to 0.65 p=0.0012). Large reduction in post-fall hospitalisation rate in intervention group (OR: 0.30, 95% CI: 0.12 to 0.74, p=0.0091).	MMAT ** (Sample size was calculated and participants were grouped by a dynamic random allocation using minimisation) Potential recall bias, especially in older adults where the cognitive impairment is important, which might underestimate the rate of falls. Identification of the falls is influenced by knowledge of exposure group.
20.	Study: Tongsiri 2017		Citation: Tongsiri S, Ploylearmsang C, Hawsutisima K, et al. Wachara Modifying homes for persons with physical disabilities in Thailand. Bull World Health Organ 2017; 95: 140–5.		
Study design	Setting	Population	Data collection time period	Comments	
Quasi-experimental	Thailand	Persons with physical disabilities	2013	Purpose of the study was to describe results and lessons learned from implementing the home modification programme.	
Size of the sample	Exposure/intervention		Outcome measures	Results	Quality
43	Home modification programme with a multidisciplinary team of medical and nonmedical practitioners and volunteers, to modify homes for persons with disabilities to address identified functioning difficulties.		Functional dependence and health-related quality of life	After home modifications, all 43 participants reported reduced difficulties in all areas, except for participants with severe degrees of difficulties (e.g. those unable to walk and unable to get up from the floor). Quality of life improved: average EQ-5D-5L score increased by 0.203 (from 0.346 at baseline to 0.549 after modifications).	High risk of bias due to lack of details on key aspects of study design.