APPENDICES

APPENDIX 1. Methodology and Methods further detail

Introduction and rationale

Realist synthesis is a relatively new approach for identifying and analysing the evidence with regard to a specific topic (Pawson, 2006). The method has been developed over the last decade and differs from traditional systematic reviews in that it is theory driven (Sayer, 2000; Pawson, 2006; Rycroft-Malone, 2012). Realist synthesis attempts to identify programme theories (in this review, this means theories and ideas about how the implementation of home adaptations leads to desired outcomes) and to then interrogate the evidence base to assess whether such theories are pertinent and productive (Jagosh, 2017). Application of realist synthesis was helpful for bringing the evidence together and identifying key ideas across a broad range of studies.

Realist synthesis of the evidence took place from early–mid 2017. Updated progress and findings were presented to Centre for Ageing Better monthly and the Advisory Board met at the beginning, middle and end of the project to monitor progress and provide feedback. Individuals representing older people's groups from the English regions were also involved through two Housing Champions Group meetings, co-ordinated by Care & Repair England.

Concept hierarchy and search strategy

A comprehensive search of electronic databases for peer-reviewed, 'black' and professional, practitioner-led 'grey' literature was conducted. Subject headings utilized were: 'health and social care', 'geography', 'built environment', 'housing', 'planning' and 'economics'. Relevant practice terms were: 'handy person', 'housing officer', 'environmental health officer', 'nurse' and 'occupational therapist'. Table 2.1 contains the concept hierarchy derived from the research question, detailing the concepts 'Participant', 'Exposure/Intervention', 'Outcomes', 'Studies' and the inclusion and exclusion criteria.

An experienced librarian located relevant studies by creating the optimal search strategy for provision and use of home adaptations for older people. Appendix 3 contains the original search terms and Table 2.2 the final search strategy developed for Medline. This was adjusted as appropriate for other databases.

Table xx Concept hierarchy - inclusion and exclusion criteria

Concept	Inclusion criteria	Exclusion criteria
Participants Population	Community dwelling people aged 65=+ years in all countries, all tenures, all household compositions alone and/or with others in a household	People living in residential care settings, sheltered accommodation and nursing homes
Exposure Intervention	Providing, implementing or using major or minor home adaptations (See definitions in the introduction) Includes overlap with home improvements heating, lighting, removal of fall and trips hazards. Includes technologies and devices directly related to managing in the home.	Aids, equipment, assistive technology, telehealth and telecare, Assistive technologies and devices
Outcomes	Health-related quality of life, Wellbeing Social engagement, Health and Social Care, Carer, Cost savings to NHS and social care Incremental Cost-Effectiveness Ratios (ICERs) Quality Adjusted Life Years (QALYs), Cost Benefit Ratios	
Studies	Any that contain the desired participants, exposures, interventions or outcomes and published in English	Studies published before or after Jan 2000- March 2017 Systematic literature reviews Studies published in languages other than English

Black and grey literature searches

The following databases were searched: AMED, ASSIA, CINAHL, HMIC, MEDLINE, Social Policy and Practice (which contains AgeInfo) and Web of Science, MEDLINE, AgeInfo, Web of Science, Applied Social Sciences Index and Abstracts (ASSIA), Allied and Complementary Medicine (AMED), Health Management Information Consortium (HMIC) and Social Policy and Practice. Two specific databases genHome UK and HomeMODs Australia were also searched. Snowballing then took place using the bibliographies of key publications. Abstracts were exported to REFworks for screening.

Grey literature was identified from a variety of sources. A list of prominent grey literature already developed was added to with the support of the advisory group and key national organisations. Care & Repair England put out a call for evidence and Foundations, the national body for home improvement agencies, also put out a call and posted information on their Facebook page. Experts in the field were contacted directly, including policy staff and academics in the UK and the international list of genHOME researchers. Requests for relevant grey literature were also made in talks at conferences. Emails were received from 35 individuals who provided lists of resources with links and attachments.

Table 2.2 Final Search Strategy (Medline)

Population: "older people" OR "older adult*" OR ag?ing OR elder* OR geriatric* OR older OR senior OR "disabled persons" OR frail

Intervention/Exposure: "accessible design" OR "accessible home environment" OR "accessible home" OR "accessible housing" OR "adaptable design" OR "age in place" OR "ageing in place" OR "aging in place" OR "architectural accessib*" OR barrier-free OR "better living design" OR "disab* adaptation*" OR "disab* alteration*" OR "disab* facil*" OR "environment* modification*" OR "environmental design" OR "environmental gerontology" OR "environmental modification*" OR "environmental support*" OR "hazard removal" OR HIA OR "home adaptation*" OR "home alteration*" OR "home design" OR "home hazard modification*" OR "home improv*" OR "home modification*" OR "home renovation*" OR "home safety intervention*" OR "housing accessibility" OR "housing adaptation*" OR "housing alteration*" OR "housing improv*" OR "housing modification*" OR "housing renovation*" OR "inclusive design" OR "individualised home design" OR "individualized home design" OR "lifetime home" OR "livable housing" OR "major adaptation*" OR "minor adaptation*" OR "minor work*" OR "modular extension*" OR "person-environment fit" OR "person-environment fit" OR "residential modification*" OR "retrofit* a home" OR "universal design"

Screening abstracts, removing duplicates and full text assessment

Titles and abstracts of studies were screened in the RefWorks database and duplicate studies were removed. More difficult to access texts were obtained through the British Library and other resources available to the university. Full texts of studies from the black and grey literatures were categorised into three groups by experienced researchers working in pairs. The categories were, A include; B maybe include and C, exclude study on basis of meeting exclusion criteria or not meeting all inclusion criteria. Final decisions were made by other members of the team.

Quality appraisal black and grey literature

Studies were quality appraised using validated tools presented in Appendix 4. Each stage of the appraisal process was carried out independently by the same two researchers who also extracted descriptive data. Quality appraisal tools were:-

Effective Public Health Practice Project (EPHPP) Tool – this was used to rate the quality of rigour of each of the quantitative studies (EPHPP, 2009). Each study was rated, as 'high=1', 'moderate=2' or 'low=3' quality according to the EPHPP data dictionary guidelines.

Critical Appraisal Skills Programme (CASP) Tool for qualitative studies – this was applied to the eligible qualitative studies. Each article was rated out of 10, and then categorised as 'high' (9-10/10), 'moderate' (6-8/10) or 'low' (0-5/10) quality.

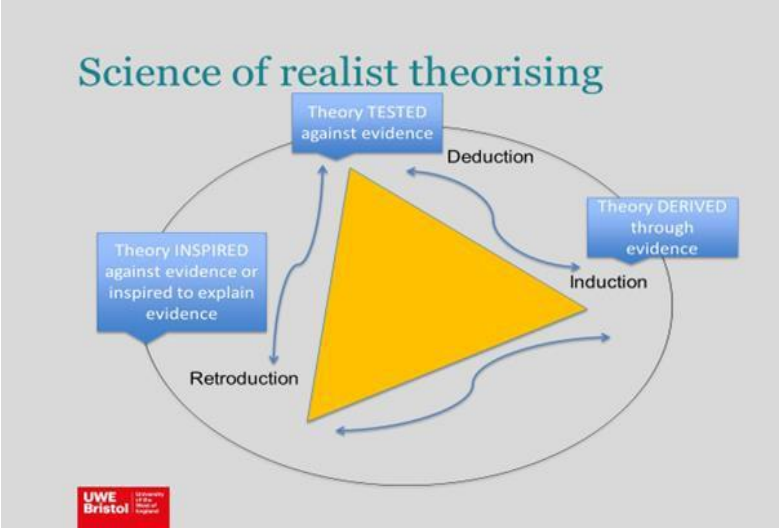
CASP Tool for Economic Evaluation studies – this was applied to the eligible economic evaluation studies identified as part of this review and each article was rated out of 8. Scores 7-8 = Strong; 5-6 = Moderate; 0-4 = Weak.

Grey literature studies were appraised for strength of the evidence with same level of rigour as academic sources using the Authority, Accuracy, Coverage, Objectivity, Date, Significance (**AACODS**) six component checklist. Scores of 5-6 = Strong; 3-4 = Moderate; 0-2 = Weak.

APPENDIX 2 REALIST SYNTHESIS – SCIENCE OF RETRODUCTION

Pawson (2006) advocates a 'realist' approach to evaluation and synthesis, combining theoretical and contextual understanding with empirical evidence for implementation of complex, social programmes, services, interventions and policy. Realist synthesis is a technique for bringing relevant, high quality evidence together to understand what, how and why interventions work for whom and in what circumstances in a real world context. Older people respond to the resources offered by home adaptations and the mechanisms that determine the response and the outcomes depend upon contextual factors. The more conducive the context, or the greater the fit or interaction between the person and environment the greater is the likelihood of positive health and wellbeing outcomes. Retroduction is theory inspired against evidence or inspired to explain evidence by combining generalizable knowledge from observational studies with theory derived through evidence from inductive processes' (Jagosh, 2017)

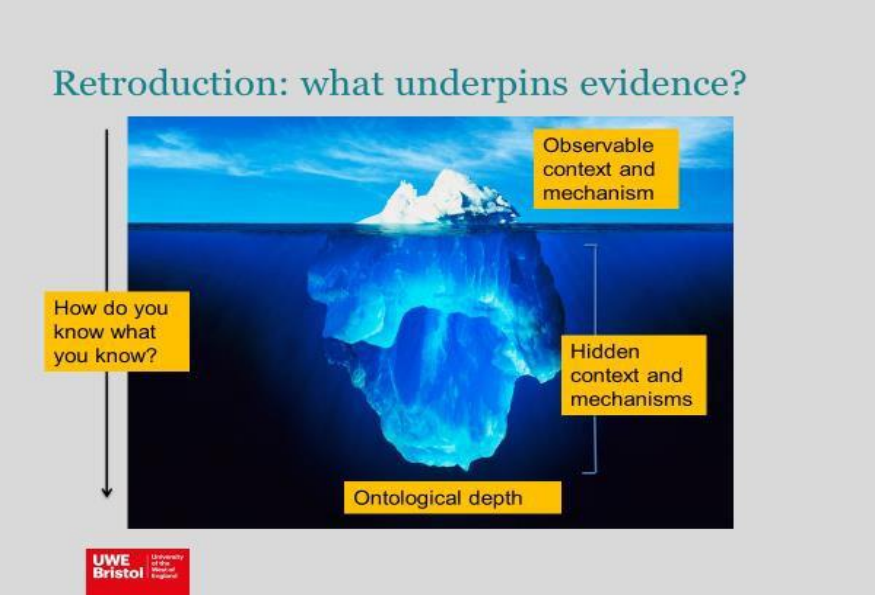
Figure A1.1 Inferences for the Real World



(Based on Jagosh, 2017)

Studies with experimental, quasi-experimental and randomised controlled designs included in this review approach take a deductive approach to the search for generalizable knowledge, testing theory by asking 'what works in home adaptations on average?' The search for meaning on the other hand is inductive, and uses qualitative, narrative and interpretive approaches to derive 'views and experiences of home and the meaning of home. Figure A1.2 below illustrates the power of the retroductive approach in generating new knowledge and understanding through realist synthesis.

Figure A1.2. Retroduction – what underpins evidence



Based on Jagosh 2017

Realist synthesis was undertaken to generate theory inspired by the observations from the evidence review that might be have real world relevance for considering the role of home adaptations in later life. The focus of realist synthesis is to develop theories about how older people respond, reason or react to the resources provided by major and minor home adaptations, depending on context to produce health and wellbeing outcomes. Elements of context might be cultural norms and values, history, economic/financial conditions, geography, public policy / health system and outcomes of previous stages of programme implementation. Physical and social environment and were a particular focus of context within the realist synthesis.

APPENDIX 3 CONCEPT HIERARCHY – INITIAL SEARCH TERMS

Table 1: Initial search terms

Population	Intervention/Exposure	Outcomes
"older people" OR "older adults" OR ageing OR aging OR elderly OR "elderly care" OR geriatric OR "geriatric assessment" OR older OR senior OR “disabled persons” OR frail	"home adaptation" OR “home improv” OR “home alteration” OR "home modification" OR "housing adaptation" OR “housing improv” OR “housing alteration” OR "housing modification" OR "structural change" OR “assistive technol*" OR "assistive device*" OR housing OR repair* OR “disab* adaptation” OR “disabil* alteration” OR “disabil* facil*” OR “environment* modification*” OR “lifetime home” OR independent living” OR “heating improv*” OR “major adaptation” OR “minor adaptation” OR “minor works” OR equipment OR “mobility aid*” OR “self-help device*” OR “communication aid*” OR “home improvement” OR HIA OR “unmet need” OR ramps OR chair* OR lift OR bath* OR shower* OR toilet* OR “bathing modification” OR “central heating” OR “heating control*” OR heating OR “environmental control equipment” OR “door entry system*” OR lifting OR hoists OR extension OR rail OR handrail OR “wheelchair acces*” OR “level acces*”	<u>RQ 1 Outcomes</u>: "Accidental falls" OR falling OR fall OR "fear of falling" OR injur* OR fractur* OR experience* OR "quality of life" OR QoL OR HRQOL OR isolat* OR access* OR wellbeing OR well-being OR "physical health" OR “prevention of accidents” OR "mental health" OR accident* OR carer* OR dementia OR outcome* OR benefit* OR evaluation or effective* OR evidence OR arthritis OR “multiple sclerosis” OR “cerebral palsy” OR “autistic disorder” OR autism OR “autistic spectrum disorder” OR tetraplegia OR “spinal cord injur*” OR “chronic illness” OR “multiple impairment” OR mobility OR “Parkinson* disease” OR “stroke” OR “depress*” OR “hip fracture” <u>RQ 2 Outcomes</u>: "quality of life" OR QOL OR HRQOL OR cost*OR saving* OR expenditure OR “care cost” OR “defer* cost*” OR “cost analysis” OR “cost allocation” OR “cost-benefit analysis” OR “cost control” OR “cost of illness” OR “cost of sharing” OR “health care costs” OR “health expenditures” OR “cost prevention” OR value OR savings OR independence OR dignity OR control OR “increased confidence” OR safety OR “more active” OR “improved family life” OR “less isolated” OR “Speed of discharge” OR “delayed discharge” OR “reduced ambulance call outs” OR “reduced accident and emergency” OR “delayed admission to care” OR “reduced care package” OR “single carer” OR “unpaid care” OR “informal care” OR “older carer” <u>RQ 3 Outcomes</u>: Barriers OR facilitators OR ineffecien* OR outcome* OR benefit* OR evaluation or effective* OR evidence OR implement*

APPENDIX 4 QUALITY APPRAISAL TOOLS

Table 2. Quality Appraisal Tools

Eligible Studies Black Literature			**Eligible Study Grey Literature**
Criteria to Score Rigour			Criteria to Score Rigour
Effective Public Health Practice Project – **EPHPP**	Critical Appraisal Skills Programme – **CASP**	Critical Appraisal Skills Programme – **CASP**	Authority, accuracy, coverage, objectivity, date, significance **AACODS**
Quantitative Studies	Qualitative Studies	Economic Evaluation	Grey Studies
Selection bias	Aims	Research questions	**Authority:** identifying who is responsible for the intellectual content of a report
Study design	Research design	Competing alternatives	**Accuracy:** well-articulated aims, outline of methods and robust data analysis
Confounders	Recruitment	Evidence of effectiveness	**Coverage:** targeted and well-described population group
Blinding	Data collection	Measurement of effect	**Objectivity:** identification of bias, potential bias or confounding factors
Data collection methods	Data analysis	Adjustment of cost and effect	**Date:** timeframe in which a research is conducted
Withdrawals and drop outs	Result	ICER	**Significance:** contribution of the research to the body of knowledge and extent to which research question has been answered.
-	Value of research	Sensitivity analysis	-

WeblinkSs to the tools, below (Copyright Issues)

Quality Appraisal Tool Quantitative Studies, Effective Public Health Practice Project (EPHPP) Tool (http://www.ephpp.ca/PDF/Quality%20Assessment%20Tool_2010_2.pdf). (EPHPP)
http://www.ephpp.ca/PDF/Quality%20Assessment%20Tool_2010_2.pdf

Critical Appraisal Skills Programme (CASP) qualitative studies:
http://docs.wixstatic.com/ugd/dded87_25658615020e427da194a325e7773d42.pdf

Critical Appraisal Skills Programme (CASP) Economic evaluation studies:
http://docs.wixstatic.com/ugd/dded87_861b48c94b654b82a84250ca684d9186.pdf

AACODS checklist: https://dspace.flinders.edu.au/jspui/bitstream/2328/3326/4/AACODS_Checklist.pdf

APPENDIX 5 REFERENCE LIST OF ELIGIBLE STUDIES

Table 3: Quantitative studies (ranked according to study quality, alphabetical order)

Reference	EPHPP Quality Appraisal Score*
Keall, M.D., Pierse, N., Howden-Chapman, P., Cunningham, C., Cunningham, M., Guria, J., & Baker, M.G. (2015). Home modifications to reduce injuries from falls in the Home Injury Prevention Intervention (HIPI) study: a cluster-randomised controlled trial. *The Lancet*, *385* (9964), 231-238.	1
Szanton, S.L., Leff, B., Wolff, J.L., Roberts, L., & Gitlin, L.N. (2016). Home-based care program reduces disability and promotes aging in place. *Health Affairs*, *35* (9), 1558-1563.	1
Berg, K., Hines, M., & Allen, S. (2002). Wheelchair Users at Home: Few Home Modifications and Many Injurious Falls. *Am J Public Health*, *92* (1): 48.	2
BruunstrÖm, G., SÖrenson, S., Alsterstad, K., & SjÖstrand, J. (2004). Quality of light and quality of life – the effect of lighting adaptation among people with low vision. *Ophthalmic and Physiological Optics*, *24*, 274–280.	2
Cambell, A.J., Robertson, M.C., La Grow, S.J., Kerse, N.M., Sanderson, G.F., Jacobs, R.J., Sharp, D.M., & Hale, L.A. (2005). Randomised controlled trial of prevention of falls in people aged > or =75 with severe visual impairment: the VIP trial. *BMJ*, *8* (331).	2
Fange, A., & Iwarrson, S. (2005a). Changes in accessibility and usability in housing: an exploration of the housing adaptation process. *Occupational Therapy International*, *12* (1), 44-59.	2
Fange, A., & Iwarsson, S. (2005b). Changes in ADL dependence and aspects of usability following housing adaptation--a longitudinal perspective. *American Journal of Occupational Therapy*, *59* (3), 296-304.	2
Harvey, L.A., Mitchell, R.J., Lord, S.R., & Close, J.C. (2014). Determinants of uptake of home modifications and exercise to prevent falls in community-dwelling older people. *Australian and New Zealand Journal of Public Health*, *38* (6), 585-590.	2
La Grow, S. J., Robertson, M. C., Campbell, A. J., Clarke, G. A., & Kerse, N. M. (2006). Reducing hazard related falls in people 75 years and older with significant visual impairment: how did a successful program work? *Inj Prev*, *12* (5), 296-301.	2
Lee, M.O., & Vouchilas, G. (2016). Preparing to age in place: attitudes, approaches and actions. *Housing and Society*, *43*, 69-81.	2
Lin, M.R., Wolf, S.L., Hwang, H.F., Gong, S.Y., & Chen, C.Y. (2007). A randomized, controlled trial of fall prevention programs and quality of life in older fallers. *J Am Geriatr Soc*, *55* (4), 499-506.	2
Lui, S.Y., & Lapane, K.L. (2009). Residential modifications and decline in physical function among community-dwelling older adults. *Gerontologist*, *49* (3), 344-354.	2
Mitoku, K., & Shimanouchi, S. (2014). Home modification and prevention of frailty progression in older adults: a Japanese prospective cohort study. *Journal of Gerontological Nursing*, *40* (8), 40-47.	2
Nikolaus, T., & Bach, M. (2003). Preventing falls in community-dwelling frail older people using a home intervention team (HIT): results from the Randomized Falls-HIT Trial. *Journal of the American Geriatrics Society*, *51* (3), 300-305.	2

Pain, H. (2003). The effectiveness of showers fitted via a grant for people with physical impairments. *British Journal of Therapy and Rehabilitation*, *10* (12), 563-569.	2
Petersson, I., Lilja, M., Hammel, J., & Kottorp, A. (2008). Impact of home modification services on ability in everyday life for people ageing with disabilities. *J Rehabil Med*, *40* (4), 253-260.	2
Petersson, I., Kottorp, A., BergstrÖm, J., & Lilja, M. (2009). Longitudinal changes in everyday life after home modifications for people aging with disabilities. *Scandinavian Journal Of Occupational Therapy*, *16* (2), 78-87.	2
Rantakokko, M., Törmäkangas, T., Rantanen, T., Haak, M., & Iwarsson, S. (2013). Environmental barriers, person-environment fit and mortality among community-dwelling very old people. *BMC Public Health*, *13*:783.	2
Steinman, B.A., Pynoos, J., & Nguyen, A.Q.D. (2009). Fall risk in older adults: roles of self-rated vision, home modifications, and limb function. *Journal of Aging & Health*, *21* (5), 655-676.	2
Stevens, M., Holman, C.D., Bennett, N., & de Klerk, N. (2001). Preventing falls in older people: outcome evaluation of a randomized controlled trial. *Journal of the American Geriatrics Society*, *49* (11), 1448-1455.	2
Zingmark, M., & Bernspång, B. (2011). Meeting the needs of elderly with bathing disability. *Australian Occupational Therapy Journal*, *58* (3), 164-171.	2
Ahn, M., & Hegde, A.L. (2011). Perceived Aspects of Home Environment and Home Modifications by Older People Living in Rural Areas. *Journal of Housing for the Elderly*, *25* (1), 18-30.	3
Allen, T. (2005). Private sector housing improvement in the UK and the chronically ill: implications for collaborative working. *Housing Studies*, *20* (1), 63-80.	3
Braubach, M., & Power, A. (2011). Housing Conditions and Risk: Reporting on a European Study of Housing Quality and Risk of Accidents for Older People. *Journal of Housing For the Elderly*, *25* (3), 288-305.	3
Gitlin, L.N., Corcoran, M., Winter, L., Boyce, A., & Hauck, W.W. (2001). A randomised, controlled trial of a home environmental intervention: effect on efficacy and upset in caregivers and on daily function of persons with dementia. *Gerontologist*, *41* (1), 4-14.	3
Gitlin, L.N., Winter, L., Dennis, M.P., Corcoran, M., Schinfeld, S., & Hauck, W.W. (2006). A randomized trial of a multicomponent home intervention to reduce functional difficulties in older adults. *Journal of the American Geriatrics Society*, *54* (5), 809-816.	3
Hwang, E., Cummings, L., Sixsmith, A., & Sixsmith, J. (2011). Impacts of Home Modifications on Aging-in-Place. *Journal of Housing For the Elderly*, *25* (3), 246-257.	3
Jang, M., & Lee, Y. (2015). The Effects of an Education Program on Home Renovation for Fall Prevention of Korean Older People. *Educational Gerontology*, *41* (9), 653-669.	3
Kamei, T., Kajii, F., Yamamoto, Y., Irie, Y., Kozakai, R., Sugimoto, T., Chigira, A., & Niino, N. (2014). Effectiveness of a home hazard modification program for reducing falls in urban community-dwelling older adults: A randomized controlled trial. *Japan Journal of Nursing Science*, *12* (3), 184-197.	3
Marquardt, G., Johnston, D., Black, B.S., Morrison, A., Rosenblatt, A., Lyketsos, C.G., & Samus, Q.M. (2011). A descriptive study of home modifications for people with dementia and barriers to implementation. *Journal of Housing for the Elderly*, *25* (3), 258-273.	3

Naik, A.D., & Gill, T.M. (2005). Underutilization of environmental adaptations for bathing in community-living older persons. *J Am Geriatr Soc*, *53* (9), 1497-503.	3
Peel, N., Steinberg, M., & Williams, G. (2000). Home safety assessment in the prevention of falls among older people. *Aust N Z J Public Health*, *24* (5), 536-539.	3
Safran-Norton, C.E. (2010). Physical Home Environment as a Determinant of Aging in Place for Different Types of Elderly Households. *Journal of Housing for the Elderly*, *24* (2), 208-231.	3
Stark, S. (2004). Removing Environmental Barriers in the Homes of Older Adults With Disabilities Improves Occupational Performance. *OTJR: Occupation, Participation and Health*, *24* (1), 32-39.	3
Stark, S. (2009). Client-centered home modifications improve daily activity performance of older adults. *Can J Occup Ther*, *76*, 235–245.	3
Watson, S. & Crowther, L. (2005). *Was it worth it? Study into the effectiveness of major adaptations*. City of Nottingham, UK.	3

*Effective Public Health Practice Project (EPHPP) Tool (http://www.ephpp.ca/PDF/Quality%20Assessment%20Tool_2010_2.pdf). 1 = Strong; 2 = Moderate; 3 = Weak.

Table 4: Qualitative studies (ranked according to study quality, alphabetical order)

Reference	CASP Quality Appraisal Score*
Aplin, T., de Jonge, D., & Gustafsson, L. (2013). Understanding the dimensions of home that impact on home modification decision making. *Australian Occupational Therapy Journal*, *60* (2), 101-109.	1
Aplin, T., de Jonge, D., & Gustafsson, L. (2015). Understanding home modifications impact on clients and their family's experience of home: A qualitative study. Australian Occupational Therapy Journal, 62 (2), 123-31.	1
Mackenzie, L., Curryer, C., & Byles, J.E. (2015). Narratives of home and place: findings from the Housing and Independent Living Study. Ageing and Society, 35 (8), 1684-1712.	1
Petersson, I., Lilja, M., Borell, L. (2012). To feel safe in everyday life at home - a study of older adults after home modifications. Ageing & Society 32 (5), 791-811.	1
Hong, S., Lee, M.J., & Han, C. (2015). Home modification among families with older adults with disability in Korea. Asia Pacific Journal of Social Work and Development, 25 (4), 186-197.	2
Messecar, D.C. (2000). Factors affecting caregivers' ability to make environmental modifications. Journal of Gerontological Nursing, 26 (12), 32-42.	2
Picking, C., & Pain, H. (2003). Home adaptations: user perspectives on the role of professionals. British Journal of Occupational Therapy, 66 (1), 2-8.	2
Tanner, B., Tilse, C., & de Jonge, D. (2008). Restoring and sustaining home: the impact of home modifications on the meaning of home for older people. Journal of Housing for the Elderly, 22 (3), 195-215.	2
Jones, A., de Jonge, D., & Philips, R. (2008). The role of home maintenance and modification services in achieving health, community care and housing outcomes in later life. AHURI Final Report No. 123. Melbourne: Australian Housing and Urban Research Institute.	2
Clarke, A. (2015). Evaluation of new lighting intervention schemes being undertaken by benevolent trusts. A report for the Thomas Pocklington Trust.	3
Heywood, F. (2004a) Understanding needs. A starting point for quality, Housing Studies, 19 (5), 709-726.	3
Heywood, F. (2004b). The health outcomes of housing adaptations. Disability & Society, 19 (2), 129-143.	3
Heywood, F. (2005) Adaptation: Altering the House to Restore the Home. Housing Studies, 20 (4), 531-547.	3
McNamara, N., Bleasdale, M., & Bridge, C. (2014). DIY Home Modifications: an Australian case-study of choice and control. Assistive Technology Research Series, 35, 119-128.	3
Lindahl, L. (2004). The value and benefits of home modification services for older people. Views of the user, the caregiver, and the next of kin. Paper presented at the HER Conference, July 2nd-4th, Cambridge, UK.	3
Thomas Pocklington Trust (2013). Improving better lighting, improving lives. Thomas Pocklington Trust. Research Discussion Paper 11. UK.	3

*Qualitative Critical Appraisal Skills Programme (CASP) Tool (http://www.casp-uk.net/casp-tools-checklists). 1 = Strong; 2 = Moderate; 3 = Weak.

Table 5: Economic evaluation studies (ranked according to study quality, alphabetical order)

Reference	CASP Economic Evaluation Appraisal Score*
Pega, F., Kvizhinadze, G., Blakely, T., Atkinson, J., & Wilson, N. (2016). Home safety assessment and modification to reduce injurious falls in community-dwelling older adults: cost-utility and equity analysis. Injury Prevention, 0, 1-7. doi:10.1136/injuryprev-2016-041999.	1
Jutkowitz, E., Gitlin, L., Pizzi, L., Lee, E., & Dennis, M. (2012). Cost Effectiveness of a Home Based Intervention That Helps Functionally Vulnerable Older Adults Age in Place at Home. *Journal Of Aging Research*. doi: 10.1155/2012/680265	1
Keall, M.D., Pierse, N., Howden-Chapman, P., Cunningham, C., Cunningham, M., Guria, J., & Baker, M.G. (2016). Home modifications to reduce injuries from falls in the Home Injury Prevention Intervention (HIPI) study: a cluster-randomised controlled trial. *The Lancet*, *385* (9964), 231-238.	1
Salkeld, G., Cumming, R.G., O'Neill, E., Thomas, M., Szonyi, G., & Wesbury, C. (2000). The cost effectiveness of a home hazard reduction program to reduce falls among older persons. *Australian and New Zealand Journal of Public Health*, *24* (3), 265-271.	2
Clarke, A. (2011). *Cost effectiveness of lighting adaptations A report for the Thomas Pocklington Trust*. Cambridge Centre for Housing & Planning Research.	3

* Adapted Economic Evaluation Critical Appraisal Skills Programme (CASP) Tool (http://www.casp-uk.net/casp-tools-checklists). 1 = Strong; 2 = Moderate; 3 = Weak.

Table 6: Grey literature studies (ranked according to study quality, alphabetical order)

Reference	AACODS Appraisal Score*
Heywood, F. (2001). *Money well spent: The effectiveness and value of housing adaptations*. Bristol Policy Press, UK.	1
Cottrell, S. and Plumb, J. (2012), 'An Evaluation of the Bristol Housing Adaptation Service', Bristol: Avon Primary Care Research Collaborative	2
Oxfordshire County Council. (2012). *Effectiveness of shower adaptations (adults).* Oxfordshire, UK.	3

*AACODS Checklist (http://canberra.libguides.com/c.php?g=599348&p=4148869). 1 = Strong; 2 = Moderate; 3 = Weak.

APPENDIX 6: QUALITY APPRAISAL

Table 7: Quality Appraisal of Quantitative studies (ranked according to study quality, alphabetical order)

Item* / Study	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	Quality rating
Keall et al. (2015)	4	1	2	1	Y	1	1	1	1	2	2	2	1	2	1	3	2	1	1	1	**1**
Szanton et al. (2016)	2	5	2	5	N	N/A	N/A	N/A	N/A	2	2	N/A	N/A	N/A	1	2	2	1	1	1	**1**
Berg et al. (2002)	3	3	3	7	N	N/A	N/A	N/A	3	4	3	N/A	3	N/A	3	3	3	4	5	N/A	**2**
Bruunström et al. (2004)	3	3	2	1	Y	1	1	1	3	4	2	1	3	2	3	3	2	1	3	3	**2**
Cambell et al. (2005)	2	5	2	1	Y	1	1	1	3	3	3	2	3	2	1	3	2	1	1	1	**2**
Fange & Iwarrson (2005a)	2	1	1	5	N	N/A	N/A	N/A	1	3	3	N/A	3	N/A	1	1	1	1	2	2	**2**
Fange & Iwarsson (2005b)	3	1	3	5	N	N/A	N/A	N/A	N/A	3	N/A	N/A	N/A	N/A	1	2	2	1	2	2	**2**
Harvey et al. (2014)	1	2	1	7	Y	1	1	1	1	1	1	N/A	3	N/A	3	3	3	4	4	N/A	**2**
La Grow et al. (2006)	2	5	2	1	Y	1	1	1	3	4	3	2	3	2	1	3	2	1	1	1	**2**
Lee & Vouchilas (2016)	2	5	3	7	N	N/A	N/A	N/A	2	4	2	N/A	3	N/A	3	3	2	4	5	N/A	**2**
Lin et al. (2007)	3	2	3	1	Y	1	1	1	2	2	2	2	1	2	1	2	2	1	1	1	**2**
Lui & Lapane (2009)	2	5	2	3	N	N/A	N/A	N/A	3	2	2	N/A	N/A	N/A	1	2	2	3	4	3	**2**
Mitoku & Shimanouchi (2014)	4	5	3	5	N	N/A	N/A	N/A	N/A	2	2	N/A	N/A	N/A	1	1	1	1	2	1	**2**
Nikolaus & Bach (2003)	4	5	3	1	Y	1	1	1	2	3	2	1	3	2	1	1	1	1	1	1	**2**
Pain (2013)	4	3	2	7	N	N/A	N/A	N/A	N/A	2	N/A	N/A	3	N/A	2	2	3	4	5	N/A	**2**
Petersson et al. (2008)	3	1	2	2	N	N/A	N/A	2	1	2	3	N/A	3	N/A	1	1	1	1	1	1	**2**
Petersson et al. (2009).	3	1	2	2	N	N/A	N/A	2	1	2	3	N/A	3	N/A	1	1	1	1	1	1	**2**
Rantakokko et al. (2013)	2	4	3	5	N	N/A	N/A	N/A	N/A	2	2	N/A	N/A	N/A	1	1	1	1	2	2	**2**
Steinman et al. (2009)	3	5	3	5	N	N/A	N/A	N/A	1	1	1	N/A	3	N/A	3	3	2	4	5	N/A	**2**
Stevens et al. (2001)	2	3	3	1	Y	1	1	1	2	2	2	2	2	1	1	2	2	1	1	1	**2**
Zingmark & Bernspång (2011)	3	2	3	7	N	N/A	N/A	N/A	1	N/A	N/A	N/A	N/A	N/A	1	2	2	1	1	1	**2**
Ahn & Hegde (2011)	3	3	3	7	N	N/A	N/A	N/A	N/A	4	N/A	N/A	3	N/A	3	3	3	4	5	N/A	**3**
Allen (2005)	2	3	3	7	N	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	1	2	2	2	3	3	**3**
Braubach & Power (2011)	3	3	3	7	N	N/A	N/A	N/A	3	4	3	N/A	3	N/A	3	3	3	4	5	N/A	**3**
Gitlin et al. (2001)	4	5	3	1	Y	2	1	1	1	4	3	3	3	2	1	2	2	1	1	1	**3**
Gitlin et al. (2006)	3	2	3	1	Y	1	1	1	3	4	3	2	1	2	1	2	2	1	1	1	**3**
Hwang et al. (2011)	4	5	3	7	N	N/A	N/A	N/A	N/A	2	N/A	N/A	3	N/A	1	1	1	4	5	N/A	**3**
Jang & Lee (2015)	3	1	3	7	N	N/A	N/A	N/A	1	N/A	N/A	N/A	N/A	N/A	1	2	2	3	4	3	**3**
Kamei et al. (2014)	3	1	3	7	N	N/A	N/A	N/A	3	4	3	N/A	N/A	N/A	1	2	2	1	1	1	**3**
Marquardt et al. (2011)	4	5	3	7	N	N/A	N/A	N/A	N/A	N/A	N/A	N/A	3	N/A	3	3	3	4	5	N/A	**3**
Naik & Gill (2005)	3	5	3	7	N	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	1	2	2	4	5	2	**3**
Peel et al. (2000)	4	1	2	1	Y	N	N/A	2	2	4	3	3	3	3	3	3	3	1	1	1	**3**
Safran-Norton (2010)	4	5	3	5	N	N/A	N/A	N/A	1	3	3	N/A	3	N/A	3	3	3	3	4	3	**3**
Stark (2004)	2	3	3	5	N	N/A	N/A	N/A	3	4	2	N/A	3	N/A	3	3	3	1	3	3	**3**
Stark (2009)	3	5	3	7	N	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	1	2	2	1	3	3	**3**
Watson & Crowther (2005)	2	3	2	7	N	N/A	N/A	N/A	3	4	2	N/A	3	N/A	3	3	3	4	5	N/A	**3**

* Effective Public Health Practice Project (EPHPP) Tool. For detailed description of each item, see http://www.ephpp.ca/PDF/Quality%20Assessment%20Tool_2010_2.pdf. 1 = Strong; 2 = Moderate; 3 = Weak.

Table 8: Quality Appraisal of Qualitative studies (ranked according to study quality, alphabetical order)

Item* / Study	1	2	3	4	5	6	7	8	9	10	Quality rating
Aplin et al. (2013)	Y	Y	Y	Y	N	Y	Y	Y	Y	Y	**1**
Aplin et al. (2015)	Y	Y	Y	Y	N	Y	Y	Y	Y	Y	**1**
Mackenzie et al. (2015)	Y	Y	Y	Y	Y	N	Y	Y	Y	Y	**1**
Petersson et al. (2012)	Y	Y	Y	Y	Y	N	Y	Y	Y	Y	**1**
Hong et al. (2015)	Y	Y	N	Y	Y	N	Y	Y	Y	Y	**2**
Messecar (2000)	Y	Y	Y	N	Y	N	Y	Y	Y	Y	**2**
Picking & Pain (2003)	Y	Y	Y	Y	Y	N	Y	N	Y	Y	**2**
Tanner et al. (2008)	Y	Y	Y	Y	N	N	Y	Y	Y	Y	**2**
Jones et al. (2008)	Y	Y	Y	N	Y	N	N	N	Y	Y	**2**
Clarke (2015)	Y	N	N	Y	N	N	N	Y	Y	Y	**3**
Heywood (2004a)	Y	Y	N	N	N	N	N	Y	Y	Y	**3**
Heywood (2004b)	Y	Y	N	N	N	N	N	Y	Y	Y	**3**
Heywood (2005)	Y	Y	N	N	N	N	N	Y	Y	Y	**3**
McNamara et al. (2014)	Y	Y	N	N	N	N	Y	N	Y	N	**3**
Lindahl (2004)	Y	Y	N	N	N	N	N	N	N	Y	**3**
Thomas Pocklington Trust (2013)	Y	N	N	N	N	N	N	N	Y	Y	**3**

*Qualitative Critical Appraisal Skills Programme (CASP) Tool. For detailed description of each item, see http://www.casp-uk.net/casp-tools-checklists. 1 = Strong; 2 = Moderate; 3 = Weak.

Table 9: Quality Appraisal of Economic Evaluation Studies (ranked according to study quality, alphabetical order)

Item* / Study	1	2	3	4	5	6	7	8	Quality rating
Pega et al. (2016)	Y	Y	Y	Y	Y	Y	Y	Y	**1**
Jutkowitz et al. (2011)	Y	Y	Y	Y	N	Y	Y	Y	**1**
Keall et al. (2016)	Y	Y	Y	Y	N	Y	Y	Y	**1**
Salkeld et al. (2000)	Y	Y	N	Y	N	N	Y	Y	**2**
Clarke (2011)	Y	N	Y	Y	N	N	N	N	**3**

*Adapted Economic Evaluation Critical Appraisal Skills Programme (CASP) Tool. For detailed description of each item, see http://www.casp-uk.net/casp-tools-checklists. 1 = Strong; 2 = Moderate; 3 = Weak.

Table 10: Quality Appraisal of Grey Literature (ranked according to study quality, alphabetical order)

Item* / Study	1	2	3	4	5	6	Quality rating
Heywood (2001)	Y	N	Y	Y	Y	Y	**1**
Cottrell and Plumb (2012)	Y	N	N	Y	Y	Y	**2**
Oxfordshire County Council (2012)	Y	N	N	Y	N	Y	**3**

* AACODS Checklist. For detailed description of each item, see http://canberra.libguides.com/c.php?g=599348&p=4148869. 1 = Strong; 2 = Moderate; 3 = Weak.

APPENDIX 7a: DATA EXTRACTION HIGH QUALITY STUDIES

Table 11. Sample characteristics and study details of high rigour quantitative and economic evaluation studies

Study Country Research design	Aim(s)	Sample size	Age	Notable characteristics	Details of provision or use of home adaptation	Time	Measure(s)	Finding(s)	Quality
Szanton et al. (2016) USA Cohort Study	To reduce impact of disability among low income older adults by addressing individual capacities and the home environment	281	All >65	Low income Eligible for Medicare & Medicaid difficulty performing ADL 83% women 80% African American 45% lone dwellers Multiple health conditions Two-thirds rated heath as fair to poor	Inter-professional team (OT, nurse, handyman) provide support to achieve personal Activities of Daily Living (ADL) targets. Person decides what they want to be able to do and the inter-professional team make it happen with home adaptations	5 months	1) Activities of Daily Living 2) Instrumental Activities of Daily Living 3) Patient health questionnaire-9 (Depression)	1) 75% reported improved ADL performance 2) Improved reported ability to perform instrumental ADL 3) Reduced depression symptoms	1
Jutkowitz, (2012) USA Cost Effectiveness Analysis	To test the cost-effectiveness of a RCT of a multi-component intervention (including home modification) on life years saved.	319	Mean=79 years	Mostly females (81%) Over 50% lived alone	1) 5 OT visits (four 90 minute visit and one 20 minute telephone contact) 2) one physical therapist visit 3) Assessment and installation of home modification such as grab bars, rails and raised toilet seats 4) Control group- no intervention contact	2 years	1) Cost of the intervention per participant in base case 2) Cost of the intervention per participant in base case +10% 3) Survival benefit of the intervention 4) ICER for model 1 and 2	1) The cost of the intervention per participant was $942 for model 1 2) The cost of the intervention per participant was $1036 for model 2. 3) At the end of the intervention, 9 participants from the intervention group and 21 from the control group died. The intervention delivered a survival rate of 94% compared to with 83% in the control group 4) The ICER for model 1 was $13,179 while that of Model 2 was $14,800.	1

Keall et al. (2015) New Zealand Cluster RCT	To assess safety benefits of home adaptations after home improvements to homes built before 1980 (a)	1,848 (842 households)	Mean = 44 years	Community service card holders (b)	1) Home assessment and works by qualified builder 2) Pamphlet on home safety distributed to home dwellers	4 years	1) Unintentional falls at home per person per year exposed 2) Rate of injuries caused by at home per year exposed to intervention	1) 26% reduction in rate of all injuries caused by falls at home per year exposed in the intervention relative to the control group (relative rate = 0·74, 95% CI 0·58–0·94) 2) Injuries specific to the home-modification intervention per year exposed reduced by 39% in the intervention group relative to the control (relative rate =0·61, 0·41–0·91)	1
Pega et al. (2015) New Zealand Cost Utility Analysis	Estimate cost-utility & health equity impacts of home safety assessment & modification (HSAM)	Models	≥65 years	Community dwelling older people	1) Personalised assessment of injury hazards in the home 2) Systematic removal of hazards		1) Cost of intervention 2) Health gains 3) Incremental Cost Effectiveness Ratio (ICER)	1) HSAM was estimated to cost US$98 million (95%CI = US$65-139 million) to implement nationally 2) HSAM resulted in health gains of 34,000 QALYs (95%CI = 5,000-65,000) 3) The ICER was US$6,000 suggesting that HSAM is cost-effective	1
Keall et al. (2016) New Zealand Cost Benefit Analysis	Study to assess the economic benefits of home modification for falls prevention (described in Keall et al. 2015)	1,848 (842 households)	Mean = 45	People living in houses constructed before 1980 (a) Community service card holders (b)	1) Home assessment and works by qualified builder 2) Pamphlet on home safety distributed to home dwellers	36 months	1) Injury cost saved 2) Cost and benefit of intervention	1) The average cost saving per home fall injury prevented was $980 (discount rate=8%). 3% discount rate, cost estimated to be $646. 2) Average cost of HSAM $564 per home. Total cost of the intervention for 1.73m houses nationally = 1 billion dollars. DALYs due to falls =29,500 DALY. This generated $4977 million. Annual social cost of falls = $4977 million DALYs. Annual social cost of home falls =$2281 million DALYs.Total cost of intervention nationally $978 million DALYs. 26% reduction (injury rate model) $7392-million DALYs 33% reduction (injury cost model)=$7392 million DALYs	1

Table 12 Sample characteristics and study details of high rigour qualitative and mixed method studies

Study Country	Aim(s)	Study Design/ Sample	Age	Notable characteristics	Provision/ use of home adaptation	Findings	Quality
Aplin et al. (2013) & (2015) Australia	To explore, through qualitative interviews, the impact of home adaptations on clients (and family experience of home)	Thematic Analysis N=42	Range 25-87	Recipients of major home adaptations. In-depth interviews conducted with recipients and their families and carers	Major alterations to the physical home environment with the purpose of making the home more appropriate for the client. Adaptations included: grab rails; major bathroom modification; step ramp; chair lift; water lift; kitchen modification; ramp; stair installation or replacement; widened doors or hallway; handrails; hand-held shower hose; drop down shower seat.	**Themes:** • **Enhanced sense of safety** o Highly valued, able to perform activities comfortably/ confidently. o A few felt less safe e.g. material used made steps slippery, no edging to path for w/ch. • **Appearance and identity** - *"The homes appearance is integrally linked with the occupant's identity, reflecting who they are"* (p 126). o The appearance of the home was enhanced in some cases – e.g. new, modern bathroom or kitchen. o Others said changes *"made their home look 'disabled' or 'like a hospital'"* (p. 126). o Or rooms had been left unfinished e.g. no towel rails etc. o Others less worried about appearance - valued the practical and functional aspects. • **Independence and freedom** o Valued outcomes, to be able to do things unaided, move around the home and especially the freedom to have a shower without help. o Some felt they had not had enough control over the process or were frustrated by the service provider's restrictions. • **Occupation** o Most commonly reported outcome was that people able to live in homes without effort - easier to move around and do everyday activities. o Restored occupations such as gardening, cooking and social activities. o *"The role of carers and the activities of carers also became easier as a result of the modifications"* (p 127), reduced physical demands, strain and risk of injury.	1

						○ Negative responses included one person less able to get around and others reporting that new installations hard to keep clean. • **Physical dimension** ○ Ambiance of the home more likely to be negatively impacted than positively e.g. hard to keep warm in a bathroom with open plan design. • **Temporal dimension** ○ Enhanced sense of permanence – no longer need to think about moving, have a future in their home. • **Social dimension** ○ Positive impact on social life as people now able to have friends round or able to get out into the community. Some found the adaptations benefited visitors. ○ Negatively impacts if appearance of the home affected. **Process**: • **Good builders** ○ Vital for a positive experience ○ Poor workmanship contributed to a negative experience "*de-valuing the participant's need for a comfortable, aesthetically pleasing home"* (p 128). ○ The OTs worked closely with the builders in the private sector but in the rental sector they used contract builders who had little contact with the OTs. • **Decision-making and consultation** ○ Strongly contributed to a positive experience ○ But some respondents had little involvement or were simply told what was going to be done, even when their input would have resulted in better solutions.	
Aplin et al. (2013) Australia	As above	As above	As above	As above	As above	This earlier paper emphasised the social dimension of home even more, saying that "the focus of services and clients often seemed to be poorly aligned, with services valuing functional activities, and clients valuing leisure and social occupations" (p 108) and "preoccupation with self-care	

						activities in home modification practice can de-value the home as a place of meaningful occupation" (p 108). "Introducing 'disabled' or new features to the home, changes how we feel about our home and ourselves." (p 108). The authors think that more research is needed with people who have not sought adaptations, or who have declined them, to fully understand the decision-making process.	
Mackenzie et al. (2015) Australia	To explore narrative of homes and place, with a specific focus on the needs and experiences of older people and their expectations of future housing needs	Thematic Analysis N=202	Range 75-79	Older people residing in diverse socio-economic suburbs of Sydney, Australia	Broad narratives of home and place. Home adaptations were not the main focus of the study.	Six themes reported: Housing choice; Attachment to place; Financial issues; Changes to the home; Transport; Anticipating the future. Findings highlighted the importance of home to older adults, and people's resistance to relocate. People were more likely to change their behaviour as opposed to their environment, to manage changes in their mental/physical abilities. Participants highlighted the need for meaningful engagement and consultation with home owners, designers, architects, support services, etc. when discussing changes. Financial constraints were frequently identified as an issue if environmental adaptation was required. Participants with a strong sense of community had more positive perceptions of their homes.	1
Petersson et al. (2012) Sweden	To explore older people's experiences of safety in everyday following receipt of home adaptations	Experiential Analysis N=8	>65 years	Participants represented both males and females, age, different housing and social situations, urban and rural areas and a range of home adaptations	Home adaptations were typically conducted approximately 1 year prior to participation in this study. Adaptations included: new bathtub, automatic door openers, stair lifts, and ramps.	Factors related to participant perceptions of safety in the home: feeling healthy, having someone to rely on, feeling at home. Participants identified conflicting strategies for enabling safety in everyday life: limitation of activity, continuation as before, reconciliation and adaptation of activities. Perceptions of home adaptations were broadly positive, but were reliant on the first three factors being in place (feeling healthy, having someone to rely on, feeling at home) and trust of home adaptation technology. Participants also reported that once safety in everyday life was achieved, home adaptations facilitated independence and autonomy.	1

				received			
Heywood 2001 UK	To investigate the impact of housing adaptation on quality of life of disabled people of all ages	Mixed methods N=162	Children and older adults. Mean age= 71 years		1) Provision of minor adaptations such as grab rails stair rails, ramps, external handrails and alterations to steps 2) Provision of major adaptations including bathing adaptations, toilet interventions, extensions, stair-lifts, provision of facilities downstairs and central heating	77% of respondents indicated minor adaptations had positive effect on their health. 22% indicated that the adaptation had no effect. Respondents 65 years and above (n=24) ranked the effectiveness of major adaptation as 9.4 on a scale of 1-10 Majority of the respondents (93%) reported no problems with installation and use of minor adaptations **Person-environment interaction** There were multiple reasons: 62% felt safer, 49% were now able to take a bath or shower and 39% were now able to use the WC. About a third of people said they needed less help and were able to run the home more easily. A quarter were able to go out and a small number also said they were able to continue interests, have a social life, or prepare meals and care for someone else. The majority (93%) said there were no problems with the process and 95% were happy with the way the adaptions looked. 80% would have spent the money the same way if they had carried out the adaptations themselves. The majority who would have done things differently were either dissatisfied with the quality of work or felt the bathing adaptions supplied were not adequate to meet their needs. Most people are thoroughly content with just a simple handrail or two when this is all they need. **Mental health** Heywood points out the high levels of mental stress and depression caused by people needing adaptions from loss of dignity, feelings of uselessness and helplessness, or a sense of being imprisoned. Added to this was the fear of falling or having an accident. Adaptations gave people back their independence and dignity and enabled people to feel useful again. For older people it meant they were able to go out, have a social life and it also enabled partners who had felt trapped to get their life back. 46% of those questioned said the adaptations had improved independence. Adaptations cannot always bring back full independence, but Heywood points out the	

						role of adaptations in “maximising people’s freedom to act for themselves in whatever ways are important to them”. P18. **Impact on carers** The research showed that many family members and carers were putting their own health at risk by lifting and carrying, as well as the worry and stress of the caring role. Adaptations therefore do not just benefit the disabled person, they benefit the partner and the whole family. It is also important to consult the carer and family before adaptations are designed and installed. “Forty eight percent of respondents specifically mentioned reduced mental stress and physical strain on family carers as an adaptation outcome.” “It makes a psychological difference to carers when a partner/family member gets their dignity back	

APPENDIX 7b: DATA EXTRACTION ELIGIBLE STUDIES

Table 13: Sample characteristics and findings from quantitative studies (ranked according to study quality, alphabetical order)

Study Country Research design	Aim(s)	Sample size	Age	Notable characteristics	Provision or use of home adaptation	Duration	Measure(s)	Outcome(s)	Quality rating
Keall et al. (2015) New Zealand Cluster RCT	To assess safety benefits of home adaptations. (a)	1,848 (842 households)	Int Mean = 45; Con Mean = 43	Community service card holders (b)	Home assessment and works by qualified builder Pamphlet on home safety distributed to home dwellers	4 years	Unintentional falls at home per person per year exposed Rate of injuries caused by at home per year exposed to intervention	26% reduction in rate of all injuries caused by falls at home per year exposed in the intervention relative to the control group (relative rate = 0·74, 95% CI 0·58–0·94) Injuries specific to the home-modification intervention per year exposed were reduced by 39% in the intervention group relative to the control group (relative rate =0·61, 0·41–0·91)	**1**
Szanton et al. (2016) US Cohort	To reduce impact of disability among low income older adults by addressing individual capacities and the home environment.	281	All >65	Low income Eligible for Medicare and Medicaid with difficulty performing ADL 83% women 80% African American 45% lone dwellers	Inter-professional team (OT, nurse, handyman) provide support to achieve ADL targets	5 months	ADL Instrumental ADL Patient health questionnaire-9 (Depression)	75% reported improved ADL performance Improved reported ability to perform instrumental ADL Reduced depression symptoms	**1**
Berg et al. (2002) US Cohort	To identify prevalence of structural home adaptation in the homes of	525	N/R	All >18 Wheelchair users	N/A	12 months	Self-report falls rate occurring in the 12 months before survey completion.	4% reported presence of all five adaptations, while 36.5% had none. Those with none represented a higher proportion of injured fallers	**2**

	wheelchair users (c) and to examine relationship between home adaptations and occurrence of injurious falls.							(42.7% vs 34.0%) Presence of any indoor home adaptation was associated with a lower prevalence of falls involving injury (adjusted odds ratio [OR]=0.56; 95% confidence interval [CI]=0.35, 0.90). Factors associated with increased odds of having a fall-related injury included the use of other mobility aids adjusted OR=2.28; 95% CI= 1.37, 3.78), a reliance on multiple helpers (adjusted OR=1.83; 95% CI=1.10, 3.06), and getting outside on a daily basis (adjusted OR=2.25; 95% CI=1.31, 3.85).	
Bruunström et al. (2004) Sweden RCT	To assess the impact of improved lighting intervention on the activities of daily living (ADL) among people with visual impairment.	46	Mean = 76	Adults eligible for adjustments to home lighting	Lighting adjustments to hall, kitchen and bathroom and living room.	6 months	Quality of life ADL	A marked effect on quality of life of the lighting in the living room was found for the intervention group. The effect on ADL of the basic lighting adaptation in kitchen, hall and bathroom for both groups was significant for tasks carried out on the working surface in the kitchen.	**2**
Campbell et al. (2005) New Zealand RCT - 2X2 factorial design	To assess the efficacy and cost-effectiveness of a home safety programme (incorporating home adaptation) and	391	Mean = 83.6 (SD=4.8)		Four conditions: 1) Home safety assessment conducted by an occupational therapist 2) 1-year exercise intervention tailored for balance and	12 months	Falls Cost effectiveness analysis (CEA)	Falls incidence 41% lower among participants of home safety programme, compared with those not in that condition. 15% more falls among those in the exercise vs those not in the exercise condition. Compared the social visit group, the exercise	**2**

	a home exercise programme to reduce falls and injuries in older people (>75 years) with low vision.				muscle strengthening 3) Receipt of interventions 1 and 2 4) Social visit from research staff			programme showed moderate association with reduction in falls in the exercise only group. The incidence of injurious falls was reduced by 44% among participants randomised to receive home safety programme alone compared to those in the social visit group. CEA ineffective - incremental cost per fall prevented was estimated at $NZ650. The estimate ranged from $NZ460 to $NZ1569 per fall prevented for different fall scenarios.	
Fange & Iwarsson (2005a) Sweden Before-and-after	To investigate changes over time in activities of daily living (ADL) dependence and aspects usability among a cohort of Swedish participants receiving home adaptation.	131	Median = 75 (Q1-Q3 = 66-80)	67% female. Participants considered for home adaptation grants, living in a medium-sized municipality with urban and rural areas.	Hygiene facilities (N =73) (grab bars at bathtub/shower, replacing bathtub with shower), entrance adaptation (N=38) (including balcony and patio), stairway and door adaptation (N=30).	2-3 months / 8-9 months	Assessment of personal activities of daily living (PADL) using 'ADL Staircase revised version' Assessment of usability in the home, according to PADL and instrumental activities of daily living (IADL) using 'Usability In My Home (UIMH) Instrument'	No significant changes in overall PADL dependence. Significant reduction in bathing dependency (T2-T3) (p=0.0020) No significant changes in IADL (T1-T3). Housing environment more supportive of IADL at T3 than T2 (p=0.045). No significant changes in PADL T1-T3, but significant improvement T2-T3 (p=0.008).	**2**
Fange & Iwarsson (2005b) Sweden Before-and-after	To investigate longitudinal changes in housing accessibility, the personal and environmental components of	131	Range 24-93 years.	Persons living in their current address for at least 3 months before application for housing adaptation	The majority of adaptations in hygiene facilities involved installation of grab bars at the bathtub/shower, and/or replacing the bathtub with a	2-3 months / 8-9 months	Housing Enabler Usability in My Home	Accessibility and usability improved significantly, the number of physical environmental barriers decreased, and dependence on mobility devices increased.	**2**

	accessibility, and physical environmental aspects of usability in a group of clients receiving housing adaptation grants			grant. Terminally ill clients were excluded from the study	shower. A few adaptations targeted floor surfaces in bathrooms. Certain adaptations involved construction of a new hygiene facility or kitchen area, or required considerable reconstruction of entrances and outdoor areas.				
Harvey et al. (2014) Australia Cross-sectional	To determine the prevalence of uptake of home adaptations to prevent falls among older adults, and to identify determinants of these fall prevention initiatives.	5,681	Median = 75	Data obtained from the 2009 NSW Falls Prevention Baseline Survey.	Home adaptations reported by participants included installation of handrails, new steps with ramps, removal of home hazards, improved lighting, bath/shower/toilet seat.	N/A	Primary outcome: Uptake of home adaptation. Covariates: Demographic characteristics, fall history, fall beliefs, attitudes, general health, exposure to fall injury prevention initiatives.	25% of respondents reported use of home adaptations & 3.3% reported moving home to prevent falls. Proportion relocating to a safer home increased with age. The most frequently reported home adaptation was hand rails (20.5%). 5% respondents reported removal of home hazards & replacement of steps with ramps. Other home adaptations rarely reported. Factors influencing home adaptations included: age, problems undertaking usual activities, having one or more comorbidities, fair/poor self-report health, high perceived likelihood of falling, and high fear of falling. Less than 1% participants reported speaking with an OT about home adaptations to prevent falls.	**2**

La Grow et al. (2006) New Zealand RCT - 2X2 factorial design	To assess effectiveness of home safety assessments and home adaptations in reducing falls among people with poor vision.	391	All >65		Four conditions: 1) Home safety assessment conducted by an occupational therapist 2) 1-year exercise intervention tailored for balance and muscle strengthening 3) Receipt of interventions 1 and 2 4) Social visit from research staff	12 months	Type and number of hazards and risky behaviour identified in the home and garden of those receiving Compliance with home safety recommendations reported at six months Location of all falls, and environmental hazards associated with each fall	The numbers of falls at home related to an environmental hazard and those with no hazard involved were both reduced by the home safety program (n = 100 participants) compared with the group receiving social visits (n = 96) (incidence rate ratios = 0.40 (95% confidence interval, 0.21 to 0.74) and 0.43 (0.21 to 0.90), respectively).	**2**
Lee & Vouchilas (2016) USA Cross-sectional	To assess older people's efforts at preparing for ageing in place.	225 ('baby boomers' - 128 / 'non-baby boomers - 97)	Mean = 83.6 (SD=4.8)	Comparison of decision-making on home adaptations and relocation of home among baby boomers (aged 50-64) and non-boomers (aged 65 and above).	Participants were asked to report on incidence of a range of major and minor home adaptations (although not whether they had initiated them in their home).	N/A	Self-reported survey on initiation of home adaptations, desire to age in place, reasons for initiation of home adaptation, relocation or no change, and presence of home adaptation features in their home.	30% participants had made home adaptations, 78% reported desire to stay at home. 'Staying independent' and 'remaining in the community' were the most important factors for deciding to make changes in the home (81% and 70%, respectively). Respondents not initiating any changes were the largest group (57.3%). Reasons for no change were still planning to move, economics, limited time. Comparison of response by age, were higher frequency of adaptations among older participants (25% boomers vs 38% non-boomers). Some boomers observing parents experience resulted in them making adjustments to own future planning.	**2**

Lin et al. (2007) China RCT	To assess effectiveness of three fall-prevention programs (education, home safety assessment and adaptation, and exercise training) on quality of life, functional balance and gait, activities of daily living and fear of falling.	150	Adults aged >50.	Participants were comprised of people who had required medical attention due to fall in the previous 4 weeks.	Education (ED): one social visit of 30-40 minutes every two weeks. Pamphlets containing information on fall prevention through exercise, use of walking aids and home improvements provided. Home safety assessment and modification (HSAM): list of recommended adaptations following a safety assessment. 14 adaptations developed and completed within the first week, and included lighting improvement, removal of trip hazards, modification of slippery floor surface, repair of cracks in pavement, repair of steps and stairs, modification of curled carpet edge, repair of unstable chair and table.	2 and 4 months	Primary outcomes: Physical capacity Psychological wellbeing Social relationships Environment Secondary outcomes: ADL (Older Americans Resources and Services), Fear of falling (Visual analogue scale), Depression (Geriatric Depression Scale) Functional balance and gait.	Primary outcomes: After adjusting for covariates, scores on the physical domain for the ED group increased significantly (by 3.9 (95% CI=1.6–6.2) points); no significant changes in scores of the other domains were detected. Secondary outcomes: No significant changes in the QoL domains among participants in the HSAM and ET group.	**2**

					Exercise training (ET). Delivered by a physical therapist every two weeks. Exercise was targeted at muscle strengthening and balance.				
Lui & Lapane (2009) USA Cohort	To quantify the effect of home adaptation on reducing the risk of decline in physical function.	9,447	All >65	Community dwelling older adults	Respondents were asked: "Do you have ramps or street-level entrance, railings, automatic/ easy doors, bathroom modifications, kitchen modifications, elevator or lift, alerting devices, and other special features?" Those who responded "no" "don't know" or "cannot answer" were coded as unexposed to home adaptation while those that said yes were categorised as people who had been exposed to adaptation.	2 years	Self-reported difficulties with bathing or showering, dressing, eating, getting in and out of bed, walking, and toileting.	19% had one home adaptation, and an additional 19% had multiple home adaptations. Most frequently reported were the presence of railings, bath adaptations, and street level ramps, with lifts or kitchen adaptation the least frequently noted. In adjusted models, respondents with a baseline home adaptation were less likely to experience subsequent decline in functional ability (adjusted odds ratio = 0.88, 95% confidence interval = 0.79 – 0.97).	**2**
Mitoku & Shimanouchi (2014) Japan Prospective cohort	To determine whether home adaptation was associated with subsequent progression of	574	All >70	Older adults requiring low or moderate care. Participants enrolled on a long-term care	Most frequently adopted adaptation was installation of handrails, elimination of differences in floor	1, 2, 3, and 4.7 years	Frailty Mortality	34% adapted their homes, most frequently a corridor (22%), toilet rooms (19.9%), bathrooms (17.2%) and entrances (13.4%). Mortality was significantly	**2**

	frailty and mortality in older adults			insurance programme.	heights and changing of lavatory basins.			lower among older adults with home adaptations than in those without home adaptations at 2 years (adjusted hazard ratio [HR] = 0.52; 95% confidence interval [CI] [0.32, 0.87]), 3 years (HR = 0.57, 95% CI [0.54, 0.81]), and 4.7 years (HR = 0.65, 95% CI [0.65, 0.91]).	
Nikolaus & Bach (2003) Germany RCT	To assess a multi-component intervention designed to reduce older people's falls in their homes.	279 (140 int / 139 control)	All >65	Older adults living in their own homes, recruited during stay at inpatient geriatric clinic in Germany.	Home Intervention Team (HIT) consisting of a nurse, physiotherapist, occupational therapist, social worker and a secretary. To identify home hazards a home safety checklist was used. Advice was provided to intervention group participants on how to make changes to the home and support to facilitate home adaptations was given.	12 months	Falls (self-report) Barthel Index Lawton-Brody Questionnaire Mini-Mental State Examination Geriatric Depression Scale Performance Oriented Mobility Assessment Timed Test of Money Counting Home adaptation recommendations Compliance with recommendations.	31% lower fall incidence and fall-related injury in the intervention group, compared with control (RR = 0.69, 95% CI = 0.51-0.97), but no significant differences between groups in proportion of frequent fallers (>2 falls). Among frequent fallers there was a 37% lower fall rate in the intervention group, compared with control (IRR = 0.63, 95% CI = 0.43-0.94). 222 home adaptations were recommended. 137 homes with at least one recommended change (75.7%). Recommended home adaptations included shower seats, grab bars, night light in bathroom, anti-slip mat in bath, bed elevation, elevation of toilet seats. In 105 homes at least one recommendation was adhered to at 12-month follow-up, which was associated with a significant reduction in fall rate (0.64, 95% CI = 0.37-0.99).	**2**

Pain (2013) UK Cross-sectional	To assess the effectiveness of showers fitted for people with physical impairments.	614 (366 with physical impairment; 160 carers; 88 'others').	Mean = 81.5 (SD = ±6.4)	Shower recipients, their carers and other household users were recruited. Receipt of shower in the last 3-24 months.	Shower adaptation. Level-access showers; easy-access shower trays; ramped-access shower trays; and cubicles.	N/A	Assistance required Impacts on users' lives Ease of use Size of shower area Perception of safety Other shower components Installation recommendations	Improvement in help required after shower was fitted (43%) Positive impact on users' lives (89%) 94% reported finding the shower very easy or fairly easy to get in to 93% respondents found the shower to be adequate in size 95% reported feeling safe when using the new shower Other shower components were found to be well-fitted and convenient for participants 90% respondents reported that installation had resulted in a great improvement in their lives. Recommendations included fitting screens instead of curtains, improving rubber seals at the base of the shower to ensure they are watertight.	**2**
Petersson et al. (2008) Sweden Quasi-experimental	To examine the impact of home modifications on self-rated ability in everyday life from various aspects for people ageing with disabilities.	105	Range 18-80 (54% aged 70 or above)	Adults living in community-based dwelling experiencing one of the following difficulties: getting in and out of home; mobility indoors; self-care in the bathroom.	Home adaptations provided to the intervention group included: shower, toilet, elevator, ramp, handrail, automatic door opener.	2 months and 6 months	Client Clinical Assessment Protocol (C-CAP) Part 1 - assessing the self-independence, difficulty and safety in activities of daily living.	Among intervention group participants there was a significant difference in self-report difficulty and safety scores from baseline to follow-up, suggesting that participants were experiencing less difficulty in activities of daily living and had a higher perception of safety following the adaptation. There were no significant changes in self-reported responses to the C-CAP among control group participants.	**2**
Petersson et	To investigate	103	Adults	Adults living in	Home adaptations	2 months	Client Clinical	Small-to-moderate effect for	**2**

al. (2009). Sweden# Quasi-experimental	longitudinal impacts of home modifications on the difficulty of performing everyday life tasks for people aging with disabilities, and to investigate whether other factors had any additional impacts on difficulty in everyday life tasks for people receiving home modifications.		aged 40 years and above.	community-based dwelling experiencing one of the following difficulties: getting in and out of home; mobility indoors; self-care in the bathroom.	provided to the intervention group included: shower, toilet, elevator, ramp, handrail, automatic door opener.	and 6 months	Assessment Protocol (C-CAP) Part 1 - assessing the self-independence, difficulty and safety in activities of daily living. Older Americans Research and Service Centre Instrument (OARS) for socio-demographic data.	home adaptations at both follow-up points for those in the intervention group. Regression analysis, controlling for numerous possible confounders, revealed that participants receiving adaptation experienced significantly less difficulties in everyday life at 2 and 6 months post-intervention, when compared with the control group. A longer wait for the adaptation was associated with an increase in difficulty score. A comparison of intervention and control group responses revealed no significant difference in effect of home adaptation over time.	
Rantakokko et al. (2013) Sweden Longitudinal	To examine whether objectively assessed environmental barriers outdoors, at entrances and indoors and environmental barriers that generate person-environment fit problems predict mortality among single-living	397	Adults aged 40 years and above.	Older adults living alone in 'ordinary' housing.	Environmental barriers were assessed using a tool (Housing Enabler (HE) instrument) that records the presence or absence of 188 environmental barriers in the home and immediate outdoor environment. Outdoor environmental barriers were described as high	1, 2, 8-9, 9-10 years	Mortality-data was retrieved from a National register Housing Enabler instrument scores	Half of participants required mobility devices at baseline. 67% of participants died during follow up. A high number of indoor environmental barriers was associated with a slight decrease in the risk of mortality (RR 0.97; 95% CI 0.95-0.99). In fully adjusted models, there was no association between outdoor, indoor and environmental barrier at the entrance and risk of mortality. Lack of handrails on stairways was the only environmental barrier associated with higher risk of mortality (p-value = 0.025).	**2**

	community-dwelling very old people.				curbs, unlevelled path surface, inadequate shelter from weather in passenger unloading zone. Examples of indoor environmental barriers identified included shelves too deep, wall-mounted cupboards and shelves placed extremely high, no grab bars at shower/bath and/or toilet. Some of the most notable examples of barriers identified at the entrance included doors that cannot be fastened in open position, lack of handrails, stairs the only route and high thresholds and/or steps at the entrance.				
Steinman et al. (2009) USA Panel survey	To assess the association between self-rated vision, home adaptations, limb functioning, and fall risk.	8,449	Range 80-89 years. Mean = 84.6 (SD = 3.02).		Self-report completion of panel survey in 2004 and 2006. Participants were asked to provide information on fall rate, sociodemographic characteristics, vision status,	2 years	Panel data collected in 2004 and 2006 from the Health and Retirement Study (HRS). Participants were asked to provide information on fall rate, sociodemographic characteristics,	A higher proportion of women than men reported that they had adapted their home to accommodate older adult/disability needs, although the effect size was small. Effects of self-rated vision and home adaptations in predicting falls decreased after controlling functioning in upper	**2**

					presence of home adaptation, limb function, pathology, depression, hearing status, medication, alcohol consumption.		vision status, presence of home adaptation, limb function, pathology, depression, hearing status, medication, alcohol consumption.	and lower extremities. Declines/gains in functioning across short periods of time superseded self-rated vision in predicting falls. No evidence was found for a moderating effect of vision status on limb functioning.	
Stevens et al. (2001) Australia RCT	To assess the impact of a multi-component intervention to encourage removal of fall hazard or adaptation of the home on incidence of falls.	1,879 (Int – 524, Control – 1,091)	Mean age = 74.1 (SD=6.60)	Cognitively intact older adults, able to make changes to the environment inside their home. No reporting of prior home adaptation.	Home hazard assessment using a standardised instrument vetted by OT's. Advice on the removal or modification of fall hazard following assessment. Free installation of safety devices described as grab rails (maximum of 3 per house), nonslip striping on steps and double-sided tape to stabilise floor rug.	12 months	Falls recorded using daily calendar.	The intervention was not associated with any significant reduction in falls or fall-related injuries.	**2**
Zingmark & Bernspång (2011) Sweden Quasi-experimental	To compare the effectiveness of two groups provided with home health care to help with bathing.	74 (Int – 46, Control – 28)	All >70 years.	Community dwelling older adults in the process of applying for help with bathing.	Clients in the intervention group received bathing interventions in accordance with OT assessment of their needs. Each client was visited between 2 to 9 times. 25 clients received assistive devices, 12 clients	15 weeks	Ability to perform ADL- assessed using ADL taxonomy (tailored specifically to 19 bathing actions - mobility, dressing, personal hygiene and grooming) HRQoL- measured using the EQ-5D questionnaire	There was a significant improvement in intervention group participants' ability to wash their hands and face (p = 0.017). Intervention group participants reported improvements to six activities (walking inside, walking in neighbourhood, getting clothes from wardrobe, washing hair, combing hair, manicuring). There was no significant	**2**

					received acquisition interventions, and 30 clients received adaptive intervention. The intervention ended when client had achieved independence or when OT perceives that further intervention would have no effect. Following intervention, clients still in the need of help were allocated home help. Those in the control group received ordinary home help service provided by the municipality		Amount of home-help time allocated to assist with bathing	difference in any of the five domains or for HRQoL between the groups. The proportion of clients receiving home help was significantly lower in the intervention group (30%) than the control group (70%).	
Ahn & Hedge (2011) USA Cross-sectional	To examine the relationship between perceived aspects of current home environment of older adults living in rural areas and their home adaptation behaviour	317	All >65 years.	Rural residents aged 60 years and above living in their own home. 64% had an annual income of less than $20,000.	Home modification and home-accessibility features including: installation of grab bars, wide doors and movement of bedroom to the first floor of the house.	N/A	Demographic characteristics Housing characteristics Home modifications Perceived aspects of home	18% (N = 55) had made modifications to their home for reasons of safety and convenience within the past 5 years. 13% had moved their bedrooms to the first floor; 85% had added grab bars to the bathrooms, 22% widened ordinary doorways to three feet. Participants undertaking modifications had higher mean scores on perception of capability of home, home satisfaction, and perception of home safety; although these were not shown to be	**3**

								statistically significant.	
Allen (2005) UK Before-and after	To investigate the issues, and barriers, affecting collaborative working between housing and health agencies.	34	Mean = 74.45 (SD = ±8.16)	Participant with poor financial circumstances (>60% dependent on benefits). Majority were from Southeast Asian community - mainly Pakistani community.	Housing improvement- described as improvement to central heating, bathing and shower access, roofing/guttering repairs.	N/R	SF-36 Hospital Anxiety Depression Scale (HADS)	A comparison of study participants before and after the intervention also showed that housing improvement was associated with improved mental health. Findings from the qualitative study showed that residents were pleased with improved heating. There were however serious complaints about the delays encountered before the improvements were undertaken	**3**
Braubach & Power (2011) Europe Cross-sectional	European case study exploring older people's housing conditions, risk of accidents, and rate of hospitalisation arising from injury.	8,519	N/R	Older residing in 8 cities across Europe (Italy, Lithuania, Portugal, Germany, Switzerland, France, Slovakia, and Hungary).	A range of home adaptations were identified by researchers during home inspections.	N/A	Health status House inspection to assess conditions Questionnaire on perceptions of residential conditions	72% dwellings were found to be poorly accessible and especially challenging for those with disabilities. 18.2% aged 60-79 and 32% aged 80 and above reported being unable to use their residence in a normal way. The health status among those reporting problems in the daily use of their home was poorer compared with those reporting no problems (40.6% vs 7.5% rated health as 'bad', respectively). Fall rates were also higher among those reporting problems in the daily use of their home (16.8% vs 9.6, respectively). The same was also found for depression (41.6% vs 15.7%, respectively).	**3**
Gitlin et al. (2001)	To determine the short-term	202 caregivers	All >60 years.	Participants were primary	Five, 90 minutes home visit by an OT	3 months	Outcomes for dementia patients	No significant difference between intervention and	**3**

USA RCT	effect of a home environmental intervention (aimed at educating care givers on the impact of the environment on dementia related behaviour) on self-efficacy and upset among caregivers and daily function of dementia patients.	(Int – 100, Control – 102)		caregivers living with a family member with a medical diagnosis of Alzheimer's disease or related disorder and had difficulty performing one or more ADL OR IADL.	to provide education on the impact of the environment on dementia related behaviour. Care givers were supported with skills on how to manage problems such as agitation, how to simplify the home by removing objects.		Frequency of occurrence of behavioural problems Level of dependency in ADLs Level of dependency in IADLs Outcomes for family caregivers Self-efficacy and upset in managing dementia behaviours IADL dependence ADL dependence	control group caregivers. Patients in the intervention group reported a lower IADL dependence than those in the control group (adjusted mean difference= -0.13, 95%CI = -0.24 to -0.01, P=0.03).	
Gitlin et al. (2006) USA RCT	To examine the efficacy of a multi-component intervention to reduce functional difficulties, fear of falling and home hazards and enhance self-efficacy and adaptive coping in older adults with chronic conditions.	319 (Int – 159, 160 – Control)	Range 23-92 years. Average – 61 years.	Participants were described cognitively intact and not receiving homecare but reported difficulties performing IADL or ADL.	Multi-component intervention comprising of five OT visits (four 90 minute visits and one 20-minute telephone contact). The intervention also comprised of one physical therapy visit. The area agency on ageing assessed homes of participants and installed home adaptations (grab bars, rails and raised toilet seats).	6, 12 months	Self-reported measures of functional difficulties, self-efficacy, fear of falling. Secondary outcomes were adaptive strategy use and observed home hazards	Intervention group reported less difficulty with ADL (adjusted mean difference = -0.13, P = 0.03), IADL (adjusted mean difference = -0.14, P = 0.03) and a reduction in fear of falling (adjusted mean difference = 0.61, P = 0.01), compared with those in the control group at 6 months. These effects were however not statistically significant at 12 months follow up.	**3**
Hwang et al. (2011)	To examine the relationship	376	>70	Sub-sample of the UK	Adaptations included changes to	N/A	Global self-rating of perceived health	Health, independence in ADL and other socio-demographic	**3**

UK Cross-sectional	between home adaptation and aging-in-place among older adults.			ENABLE-AGE project with very old European adults (80 years and above) living in the Wirral, Merseyside.	permanent features in indoor or immediate outdoor home environment to increase accessibility of home environments.		ADL Staircase Presence of home modifications (yes/no) Socio-demographic characteristics.	outcomes were not shown to be statistically associated with home adaptations. 36% participants had performed home adaptations. Analysis revealed that home owners and those living in one-family houses completed home adaptation more often than those in rental accommodation. Regression analysis revealed those who had home adaptations and did not live in multi-family housing had lived longer in current housing. Furthermore, when entered as a separate independent variable, home adaptation was identified as an independent predictor of aging-in-place.	
Jang & Lee (2015) Korea Quasi-experimental	To investigate the effect of an educational program on home renovation for fall prevention among older people.	51	Mean = 84.9 (SD = 2.7)	People aged 65 and above living in a 'run-down' residential area.	Three Senior Citizen Centres were used and participants were categorised into three groups Experimental group that participated in the general programme and education on home renovation (EHR) for fall prevention. EHR was delivered by providing an outline of home renovation, and a house plan	Post-intervention	Fall efficacy (measured using the fall efficacy scale) Behavioural intention towards fall prevention (BIFP)	Both intervention groups showed higher levels of fall efficacy post-intervention, compared to the control group. There was no significant difference in BFIP scores.	**3**

					proposal free from falls. Participants were also provided with practical information to support people to renovate their homes. A comparative group who participated in the general education programme only. The programme comprised of 3 teaching blocks sessions to raise awareness about falls. A control group that did not participate in any programme. The intervention was delivered over a 6-week period. Both interventions were provided once a week for 40 minutes per lesson				
Kamei et al. (2014) Japan RCT	To evaluate the impact of a multi-component intervention on awareness of fall prevention, home adaptation	130 (Int – 67, Control – 63)	>65 years. Average – 78 years.	Participants were eligible provided they were allowed to undergo exercise and were living in their own homes.	Both intervention and control group participated in a 4 week fall prevention programme involving physical and mental assessment, blood pressure check,	12 months	Primary outcomes: overall and indoor fall events. Secondary outcomes: fall prevention awareness and home adaptation.	There was no difference in overall falls (P=0.116). The intervention group achieved a 10.9% reduction in overall falls compared to the control group (Hazard ratio = 0.59, 95% CI = 0.31 to 1.15). The intervention group reported improved awareness of falls prevention	**3**

	behaviours and falls reduction.				education regarding risk factors for falls and exercise session. Intervention group was provided with further education on environmental safety (including, residential safety self-assessment, home hazard awareness programme and education on how to modify the home). Intervention participants were also shown home modification equipment including grab bars for bathrooms, automatic door lighting, small ramps between rooms, non-slip tape for stairs and non-slip rugs.			(P<0.05). 25% of intervention participants installed grab bars on bathroom walls compared to 3.7% of control participants (P<0.001). 21.4% of the intervention group installed grab bars beside the toilet compared to 37% of the control group.	
Marquardt et al. (2011) USA Cross-sectional	To better understand how homes are being adapted in the context of caring for persons with dementia.	82	>65 years.	Older adults (>70 years) living with dementia in Baltimore, Maryland.	Observation of room layout, design of entrance and interior stairs, bathroom safety features, presence of home hazards.	N/A	Home environment assessment by architect experienced in design for dementia. and 8-item questionnaire on home adaptations.	Physical environmental obstacles and safety issues identified included: 1) Entrance and interior stairs. Steps were a major physical obstacle, often lacking safety railings. 2) Bathroom safety. Nearly 50% sample had installed either a walk-in shower, handheld	**3**

								showerhead or shower seat. 57% had installed grab rails. Quality of adaptation installation varied by house. 3) Physical barriers to mobility including furniture or clutter. Use of interior railings or grab bars observed in only one household. Implementation of home adaptations: 72% caregivers (n=59) reported making at least one adaptation to care recipients' home. 39% had made these changes based on OT recommendations. Adaptations were made in response to physical limitations (including enhanced bathroom safety, stair lift installation and step railings), and memory loss (including lighting improvements, removal of home hazards). Lack of financial resources was often a barrier to adaptations designed to support those with physical limitations	
Naik & Gill (2005) USA Cross-sectional	To determine prevalence and utilisation of environmental adaptations for bathing.	566	Mean = 84.9 years (SD = N/R)	Participants eligible if they could perform (at enrolment) four key ADL tasks without personal assistance: bathing,	Participants asked how they bathe, & difficulties with bathing. In addition, direct observations of the bathing environment were made bynurse who identified key	N/A	Self-report assessment of bathing and environmental evaluation of the relevant bathroom (usual location for bathing).	Only four environmental adaptations (grab bars; shower seat, tub stool, or bath chair; tub or transfer bench; and handheld shower spray) were significantly more likely to be present in the homes of participants with bathing disability than those without.	**3**

				walking, dressing, and transferring from a chair.	characteristics of the bathing environment, including the type of primary bathing facility (tub, shower, or both), the location of the facility in relation to sleeping quarters (same floor, upstairs downstairs, or other) and the presence of a raised entry into the facility (roll-in, raised threshold, raised tub, or other). Participants asked about use of environmental adaptations. Participants grouped in to 2 categories: people with absence of, or presence of, bathing disability and type of bathing disability			More than 40% of participants who had no disability with bathing reported using at least one environmental adaptation for bathing transfers, with grab bars being used most commonly. Nearly 30% of participants reporting disability with transfer subtasks did not use any environmental adaptation for bathing transfers.	
Peel et al. (2000) Australia RCT	To assess a multi-strategy approach for preventing falls among older people, including education and awareness-	195 (Int – 96, 99 – Control)	>73 years.	Participants were volunteers from 10 branches of the National Seniors Association in Brisbane, Australia.	Intervention group received home assessment intervention, in which an occupational therapist completed a home safety check with	12 months	Adherence to home adaptations recommendations and self-reported fall incidence.	59% of intervention group had implemented at least one home adaptation recommendation, compared with 32% among the controls ($p<0.0001$). Concerns about falling were not found to differ significantly across intervention and control groups	**3**

	raising, home adaptation and medical examination.				participants. Assistance with home adaptation recommendations provided. Recommendations included: repair floors/surfaces, modify furniture, repair outdoor surfaces, improve/install lighting, install handrails/grab rails, change floor surfaces.			(p>0.05). Falls incidence among participants in intervention and control groups was not found to differ significantly.	
Safran-Norton (2010) USA Before-and-after	To investigate the relationship between physical characteristics of a home, including home adaptations, on the ability to remain in place or move to alternative accommodation.	6,585	Mean = 69 years (SD = N/R)	Data were collected over two years from participants in the Health and Retirements Survey (HRS).	Home adaptations included presence of ramps, railings, wheelchair access, bath tub safety bars and shower seats.	2 years	Housing transition according to four possible outcomes: 1) no move; 2) move into another residence; 3) move into nursing home; 4) death.	Overall there was a low rate of home adaptations reported for both single and couple households. Couple households had a lower frequency (4.5-5.4%) compared with single households (10.8-12.4%). Single and couple households had comparable adaptations (major vs minor). For couple households, home adaptations were not significant predictors of housing transitions or remaining in place. For single households, outdoor adaptations (ramps, railings, wheelchair access) were associated with remaining in place (p=0.014), while indoor adaptations much as bath tub safety bars and shower seats were associated with housing	**3**

								transition (p=0.05).	
Stark (2004) USA Before-and-after	To examine the impact of an OT intervention to remove environmental barriers from the homes of older adults with disabilities on occupational performance.	16	Mean = 73 years (SD = 5.98)	Low-income older adults living with disabilities. 75% participants of African American ethnicity. 87% retired.	A broad range of home adaptations were provided to participants, including: adaptive equipment (reaches and tub benches), architectural adaptations (ramps, stair rails, bathroom adaptations) and major home renovation (roll-in showers and accessible bathrooms).	3-6 months	Demographic information FIM instrument was used to assess severity of patient disability and functional outcomes of rehabilitation COPM used to assess change in clients' self-perceptions of their occupational performance Environmental Functional Independence Measure (Environ-FIM) to identify environmental barriers in the home.	75 barriers were identified from participants' homes, with an average of 4.7 per home (range 1-7). Safety and accessibility adaptations were the most frequent adaptations (i.e., handrails, grab bars, ramps). 45 of 75 barriers were resolved through the study. Responses to all measures improved from pre- to post-test. Analysis revealed a significant pre- to post-test difference for occupational performance (t=-8.23, p=0.0001) and satisfaction with performance (t=-9.54, p=0.0001).	**3**
Stark (2009) USA Quasi-experimental	To describe a client centred occupational therapy, home adaptation programme and examine the impact of the intervention on daily activity performance	80	Range 57-82 years. Mean = 70.69 (SD = N/R).	N/A	Current activity patterns and activities in which they experienced difficulty performing and environmental barriers by using photographs as cues to recall activities were reported by participants. Home adaptation was delivered by a trained OT and a student. The intervention	3 months and 2 years	Daily activity performance (measured using an adapted version of the Canadian Occupational Performance Measure), satisfaction, person-environment fit, functional independence-measured using the Functional Impairment Measurement.	Approximately 80% recommended adaptations were adopted. Average intervention cost was estimated to be $635 per participant (range=$50-$4000). There was a significant increase in satisfaction scores from baseline to immediate post. There was a decrease from the first post-test to the two-year follow-up. There was an increase in performance scores from baseline to the immediate post-test and no change from the first post-test to the two-	**3**

					involved providing a range of adaptive equipment such a tub and bench, architectural modification such as ramps, major home renovation such as roll-in-shower, increasing the height of toilets and training on how to use the equipment.			year follow up. There was a significant increase in Functional Impairment Measurement FIM scores from baseline to the immediate post-test. There was no change from the first post-test to the two-year follow up. There was a significant decrease in the scores of person-environment fit from baseline to the immediate post-test. There was a further decline in the scores (indicating fewer barriers) from the first post-test to the second post-test two years later.	

Note. (a) Home adaptations = handrails for outside steps and internal stairs, grab rails for bathrooms, outside lighting, edging for outside steps, and slip-resistant surfacing for outside areas such as decks and porches. (b) Community service card holders = those on low income, unemployed, students or pensioners (age 65 or older) and people in receipt of sickness benefit. (c) = bathroom modifications; widened doorways; kitchen modifications; railings; easy-open doors.

Table 16: Sample characteristics and findings from qualitative studies (ranked according to study quality, alphabetical order)

Study Country	Aim(s)	Sample	Age	Notable characteristics	Provision/ use of home adaptation	Findings	Quality rating
Aplin et al. (2013)	To explore, through qualitative interviews, how aspects of home environment influence home adaptation decision making.	42	Range 25 - 87	Recipients of major home adaptations. In-depth interviews conducted with recipients and their families and carers.	Major alterations to the physical home environment with the purpose of making the home more appropriate for the client. Adaptations included: grab rails; major bathroom modification; step ramp; chair lift; water lift; kitchen modification; ramp; stair installation or replacement; widened doors or hallway; handrails; hand-held shower hose; drop down shower seat.	The study identified six aspects of the home environment influencing decisions for home adaptation: personal, societal, physical and temporal dimensions of home, and social and occupational dimensions.	**1**
Aplin et al. (2015)	To explore, through qualitative interviews, the impact of home adaptations on clients (and their family's) experience of home.	42	Range 25-87	Recipients of major home adaptations. In-depth interviews conducted with recipients and their families and carers.	See above box.	Home adaptations were found to impact positively upon five aspects of the home environment: personal, occupational, physical, temporal and social. Outcomes attributable to the home adaptation were influenced by workmanship, consultation/involvement in decision-making, and the social dimension of the environment.	**1**

Mackenzie et al. (2015)	To explore narrative of homes and place, with a specific focus on the needs and experiences of older people and their expectations of future housing needs.	202	Range 75-79.	Older people residing in diverse socio-economic suburbs of Sydney, Australia.	Broad narratives of home and place. Home adaptations were not the main focus of the study.	Six themes reported: Housing choice; Attachment to place; Financial issues; Changes to the home; Transport; Anticipating the future. Findings highlighted the importance of home to older adults, and people's resistance to relocate. People were more likely to change their behaviour as opposed to their environment, to manage changes in their mental/physical abilities. Participants highlighted the need for meaningful engagement and consultation with home owners, designers, architects, support services, etc. when discussing changes. Financial constraints were frequently identified as an issue if environmental adaptation was required. Participants with a strong sense of community had more positive perceptions of their homes.	**1**
Petersson et al. (2012)	To explore older people's experiences of safety following receipt of home adaptations.	8	>65 years.	Participants represented both males and females, age, different housing and social situations, urban and rural areas and a range of home adaptations received.	Home adaptations were typically conducted approximately 1 year prior to participation in this study. Adaptations included: new bathtub, automatic door openers, stair lifts, and ramps.	Factors related to participant perceptions of safety in the home: feeling healthy, having someone to rely on, feeling at home. Participants identified conflicting strategies for enabling safety in everyday life: limitation of activity, continuation as before, reconciliation and adaptation of activities. Perceptions of home adaptations were broadly positive, but were reliant on the first three factors being in place (feeling healthy, having someone to rely on, feeling at home) and trust of home adaptation technology. Participants also reported that once safety in everyday life was achieved, home adaptations facilitated independence and autonomy.	**1**

Hong et al. (2015)	To explore the psychosocial factors influencing use of home adaptation among older adults with disabilities and their carers.	13	>65 years.	Participants were eligible for Long-Term Care Insurance (LTCI). Home adaptations in older adult homes is relatively rare in South Korea, so authors contacted home care centres for knowledge of home adaptation recipients.	Home adaptations varied by household and included: safe handrails, ramps, window and flooring replacements.	Structural factors - vulnerable home environment and home ownership; Care recipient needs - health needs, lifestyle, time-varying needs; Socio-cognitive factors - attitude towards and knowledge about home modification, significant referents, self-efficacy; Enabling resources - economic status and perception of the cost of home adaptation, family interest in the caregiving environment.	**2**
Messecar (2000)	To explore the experiences of caregivers, providing care to an older adult eligible for skilled home health care.	24	Caregivers of adults aged >65 years.	Caregivers had to self-identify as the primary caregiver for an older person eligible for skilled home health care (e.g., wound care, diabetic care, therapies).	Broad definition of home adaptation: Actions to organise the home, protect elderly, structure the older person's day, implement devices and environmental cues, work around the limitations of the environment to provide care, and make the home more pleasing.	Attributes relating to the older person, the adaptation itself, quality of caregiver-older person relationship, caregivers' skills, personal resources of the caregiver, and informal support available for the caregiver. Caregivers require additional support/training to implement environmental adaptations. A collaborative approach, ensuring that the needs and preferences of the older person and the caregiver are met, is recommended.	**2**

Picking & Pain (2003)	To explore home adaptation recipients' views on their experiences of home adaptations and the role of professionals supporting completion of the adaptation works.	17	Range 43-78 years.	Participants had experience of home adaptation between values of £1,000 and £10,000.	Home adaptations included walk-in showers, lift installation, electric bidet/WC, stair lift, driveway, level-access shower.	It emerged that the majority of participants were aware of the processes and people involved with their home adaptation (for example, knowing who to contact if they were in need of help). Those who felt well-informed before the adaptation had a broadly positive perception of the process. Participants experienced stress if things did not go to plan (for example if there was a delay). Participants welcomed regular contact from OTs, however, it was noted that this support did not necessarily need to be carried by an OT.	**2**
Tanner et al. (2008)	To explore older people's experiences of receiving home adaptations and how this affects people's meaning of home.	12	>65 years.	Older adults living in public housing in a metropolitan area that had been in receipt of a home adaptation within the last 3-6 months.	Not reported.	Five themes were identified including: the meaning of home, impact of home modification on meaning of home, impact on the future, impact of modification design to accessible standards, loss of home - negative impacts on the experience and meaning of home.	**2**
Jones et al. (2008)	To explore the experiences of older people who have used Home Modifications and Maintenance (HMM) services.	30	Range 60-90 years.	16 (53%) lived alone and 11 of fourteen couples participated in the interview together.	Details of home adaptations received was relatively limited. Adaptations included - fixing door, levelling uneven surfaces. The majority of changes related to 'maintenance' of properties, as opposed to 'adaptation'.	For all participants, HMM were deemed to be an important support, often enabling people to live and remain in their own homes. HMM services were found to be of good quality (timely, reliable, approachable), but there were concerns raised about the level and costs of services available in a resource limited time.	**2**

Clarke (2015)	To assess the impact of lighting improvements (on quality of life and falls prevention) made to the homes of people with sight loss living in London and North West of England between 2013 to 2015.	34	Range 60-90 years.	Elderly people with sight loss recruited via two charities. Many of the participants suffered from other health conditions including arthritis, some were wheelchair users, some had problems with hips or knees, diabetes, heart problems etc.	Lighting improvements mostly in the kitchen, living room, hall, bedroom, bathroom, stairs outside areas and landing. Improvements included fluorescent strips or recessed lighting being installed, brighter bulbs, kitchen worktop lighting (under cupboards) and lighting in previously unlit corners such as under-stair cupboards bad alcoves.	One participant reported sight improvement, half of them said that their sight remained the same while the remaining half said their sight had deteriorated over the past 12 months. Many participants were still unable to do some of the things they wished they would be able to do such as sewing. 13 participants were happy with the intervention, 4 were indifferent while 2 were very unhappy and 1 person was quite happy. A total of 22 falls were noted 6 months before the intervention and 10 6 months after the intervention. The total number of accidents recorded 6 months before the intervention was 8 while the number of accidents 6 months after the intervention was 4.	**3**
Heywood (2004a)	To assess the impact of housing adaptation on quality of life of disabled people of all ages.	104 interviews / 162 postal surveys	N/R	Participants were those that had received state funding through the disabled facilities grant' for home adaptation.	Details on major adaptations reported in Heywood (2005): level access showers, stair lifts, ramps, safety measures (stair rails, hand rails, grab rails), house extension, kitchen alterations, central heating, through-floor lift, downstairs WC, door widening, tacking hoists, external step lift, internal redesign.	Ten themes were identified: the need to retain dignity; the need to have values recognised; the need for relief from pain, discomfort and danger; need to maximise barriers to independence; need for some element of choice; need for good communication as part of giving choice; need to be able to take part in society; need for light; need to provide growth and change for children; need of other family members.	**3**

Heywood (2004b)	To assess the health outcomes of home adaptations, through structured and semi-structured interviews with recipients of major and minor home adaptations.	104 interviews / 162 postal surveys	N/R	Participants were those that had received state funding through the disabled facilities grant' for home adaptation.	See Heywood 2004a.	Health gains self-reported by participants as a result of adaptations included: relief of pain, prevention of accidents and reduced fear of accidents, reduced feelings of low mood/depression. It was also noted that adaptations were associated with 'inter-active effects' - such as, improving relationships, and physical and mental health of everyone in the home setting.	**3**
Heywood (2005)	To assess the impact of major home adaptations, through structured and semi-structured interviews with recipients of home adaptations.	104 interviews	N/R	Participants were those that had received state funding through the disabled facilities grant' for home adaptation.	See Heywood 2004a.	Fourteen themes were identified from this study: reasons for seeking adaptations, work done and impact of work, practical outcomes of adaptations, preventive outcomes, home as a place of primal security, adaptation threatening primal security, home as a place of privacy, home as a place of control, home as place of freedom to act, home as reflection of self, a place to foster relationships, home as a place for the nurture of children, home as a node, home as rootedness.	**3**

McNamara et al (2014)	Preliminary findings from the qualitative aspect of a larger research study examining DIY home adaptations.	12	N/R	Participants were key informants from 15 organisations (government departments, disability and carer organisation, retailers with experiences of DIY adaptations).	Five commonly implemented adaptations were chosen as the focus of the study: grab rails; ramps; hand-held showers; level-access shower recess; hand railings for stairs and steps.	Authors reported on the importance of universal design features, notably equitable and flexible use. Findings identify the following motivations for DIY adaptations: aesthetics; availability; confidence; control; cost; expertise; independence; knowledge; time; trust; and, sustainability.	**3**
Lindahl (2004)	To describe how different stakeholders perceive the value and net benefit of home adaptation.	17	5 of the 17 service users interviewed were 65+. 5 of the 7 relatives interviewed were also 65+.	Service users, next of kin, care givers - described as OTs and nurses and personal assistants.	Users who received larger home adaptation of approximately 30.000SEK. The modification ranged from installation of shower cabins, ramps, automatic door openers, garages for wheelchair etc.	Home adaptations comprised of two different aspects of change: physical/material change and psychological/social change. Interviewees identified that the modification enabled them to satisfy basic needs such as going outdoors by using ramps, managing personal hygiene without external help. Findings from next of kin showed that home adaptation sometimes relieved the psychological stress associated with care for the dependent. For example, showers, ramps, wheelchair and stair lift were helpful in increasing level of independence. However. in one case the user had Alzheimer's disease, a shower adaptation was not enough to relieve the pain and tiredness of the wife.	**3**

Thomas Pocklington Trust (2013)	This two part study aimed to assess the impact of household lighting improvement for the visually impaired, through interviews with lighting intervention recipients and an assessment of lighting improvement costs related to falls (See also Clarke).	9	N/R	Older people with visual impairments.	Lighting improvements mostly in the kitchen, living room, hall, bedroom, bathroom, stairs outside areas and landing. Improvements included fluorescent strips or recessed lighting being installed, brighter bulbs, kitchen worktop lighting (under cupboards) and lighting in previously unlit corners such as under-stair cupboards bad alcoves.	All participants reported improvements in activities of daily living, including some instances of renewed ability to carry out tasks not possible before the lighting adaptation. Improvements in emotional wellbeing and self-worth were also reported. Participants also commented on changes in perception of household electrical safety as a result of specialist inspection.	**3**

Table 17: Sample characteristics and findings from economic analysis studies (ranked according to study quality, alphabetical order)

Study Country Research design	Aim(s)	Sample size	Age	Notable characteristics	Provision or use of home adaptation	Duration	Measure(s)	Outcome(s)	Quality rating
Pega et al. (2015) New Zealand CUA	To estimate the health gain, cost-utility and health equity impacts from home safety assessment and modification (HSAM) for reducing injurious falls among older people.	N/A	≥65 years	Community dwelling older people	Personalised assessment of injury hazards in the home Systematic removal of hazards		Cost of intervention Health gains ICER	The intervention was estimated to cost US$98 million (95%CI = US$65-139 million) to implement nationally The intervention resulted in health gains of 34,000 QALYs (95%CI = 5,000-65,000) The ICER was US$6,000 suggesting that HSAM is cost-effective	**1**
Jutkowitz, (2012) USA CEA	To test the efficacy of a RCT of a multi-component intervention (including home modification) on life years saved.	319	Mean=79 years	Mostly females (81%) Over 50% lived alone Participants reported difficulties performing ADL's or IADL's Some participants rated their health as fair to poor at baseline Majority reported at least one of 7 conditions at baseline- arthritis hypertension, cataracts or macular	5 OT visits (four 90 minute visit and one 20 minute telephone contact) one physical therapist visits Assessment and installation of home modification such as grab bars, rails and raised toilet seats Control group- no intervention contact	2 years	Cost of the intervention per participant in model 1 (base case) Cost of the intervention per participant in model 2 (base case +10%) Survival benefit of the intervention ICER for model 1 and 2	The cost of the intervention per participant was $942 for model 1 The cost of the intervention per participant was $1036 for model 2. At the end of the intervention, 9 participants died from the intervention group while 21 died from the control group. The intervention delivered a survival rate of 94% compared to the control group of 83% survival rate The ICER for model 1 was $13,179 while that of	**1**

				degeneration, cardiovascular problems, diabetes mellitus				Model 2 was $14,800.	
Keall et al. (2016) New Zealand CBA	Study to assess the economic benefits of home modification for falls prevention (described in Keall 2015)	1848	Children and adults	Community service card holders (a) People living in houses constructed before 1980	Home assessment and works by qualified builder Pamphlet on home safety distributed to home dwellers	36 months. Median =1148 days (IQR 1085-1263),	Injury cost saved Cost and benefit of intervention	The average cost per home fall injury prevented was $980 (discount rate=8%). For a 3% discount rate, the cost was estimated to be $646. The intervention was estimated to cost an average of $564 per house The total cost of the intervention for 1.734,500 houses nationally = 1 billion dollars. DALY's due to falls =29,500 DALY. This generated $4977 million. Annual social cost of falls = $4977 million	**1**

								DALYs Annual social cost of home falls =$2281 million DALYs Total cost of intervention nationally $978 million DALYs 26% reduction (injury rate model) $7392- million DALYs 33% reduction (injury cost model)=$7392 million DALYs	
Cottrell and Plumb (2012) UK Cohort	To evaluate the impact of Bristol housing adaptation service for major adaptations on clients and associated health services	320	Children and adults	In addition to participants who had been provided adaptation services, OT'S, and academics were involved in interviews	Adaptations of hygiene facilities such as installation of wet rooms. Installation of grab rails, stair lifts and outside handrails	12 months	Avoided health and social care contact Savings on demand for health and Social care	There was a 20% reduction in the use of health service following adaptations. Adaptations also led to improvements with self-care, 35.7% respondents had no problems with self-care post-intervention compared to 29.1% prior to adaptation. Total saving on the demand for health and social care accrued by the 1,337 adult recipients of the adaptations (based on 2010/11 and 2011/12 data) was estimated at £774,123, and the increase in the quality and quantity of life was estimated to be £2,034,914	**2**

Salkeld (2000) Sydney CEA	To estimate the cost-effectiveness of a home hazard reduction program	212	76.4 years (SD=7.1 years)	Community living older adults Cognitively impaired participants were also included	Home safety assessment conducted by an occupational therapist Completion of recommended home modifications such as Comparator group received routine care	12 months	Cost of intervention Health gains ICER	The intervention was estimated to cost US$98 million (95%CI = US$65-139 million) to implement nationally The intervention resulted in health gains of 34,000 QALYs (95%CI = 5,000-65,000) The ICER was US$6,000 suggesting that HSAM is cost-effective	**2**
Clarke (2011) UK CEA	To estimate the cost-effectiveness of fitting lighting adaptations in the homes of elderly people at risk of falling	N/R	≥75 years	Older adults with visual impairment	Fitting lighting adaptations in the homes of people at risk of falling due to visual impairment	4-5 months	Cost of the intervention per participant in model 1 (base case) Cost of the intervention per participant in model 2 (base case +10%) Survival benefit of the intervention ICER for model 1 and 2	The cost of the intervention per participant was $942 for model 1 The cost of the intervention per participant was $1036 for model 2. At the end of the intervention, 9 participants died from the intervention group while 21 died from the control group. The intervention delivered a survival rate of 94% compared to the control group of 83% survival rate The ICER for model 1 was $13,179 while that of Model 2 was $14,800.	**3**

Note. (a) Community service card holders = those on low income, unemployed, students or pensioners (age 65 or older) and people in receipt of sickness benefit.

Table 18: Sample characteristics and findings from grey literature (ranked according to study quality, alphabetical order)

Study Country	Aim(s)	Sample size	Age	Notable characteristics	Details of provision or use of home adaptation	Duration	Measure(s)	Outcome(s)	Quality rating
Heywood (2001) UK	To investigate the impact of housing adaptation on quality of life of disabled people of all ages	162	Children and older adults Mean age= 71 years		Provision of minor adaptations such as garb rails stair rails, ramps, external handrails and alterations to steps Provision of major adaptations including bathing adaptations, toilet interventions, extensions, stair-lifts, provision of facilities downstairs and central heating		Health effect of minor and major adaptations Problems/ disturbance caused by adaptations	77% of respondents indicated that minor adaptations had positive effect on their health while 22% indicated that the adaptation had no effect. Respondents who were 65 years and above (n=24) ranked the effectiveness of major adaptation as 9.4 on a scale of 1-10 Majority of the respondents (93%) reported no problems with installation and use of minor adaptations. some respondents had problems with major adaptations resulting from rom poor consultation during the process of identifying adaptations necessary, poor quality implementation and provision of adaptation that did not meet the need of client	**1**

Oxfordshire County Council (2012) New Zealand	To investigate the impact of installation of shower on people with disabilities	352 participants	Adults	Participants were described as adults with disabilities who had recently had a shower adaptation	Installation of new shower/adaptation of existing shower		frequency of shower use Perceived impact of shower adaptation Cost savings from adaptation Need for carers	96% of all respondents were satisfied with the frequency of their shower use while 39% reported using their shower daily. 239 respondents (68%) reported that the adaptation made them feel safer. However, a higher proportion of the people reporting this were living with their spouse not alone. 85% of respondents reported that would have required more carers to keep clean without the shower adaptation. The shower adaptation was estimated to result in savings of £138,320 per year for 70 people who require 2 hours of care provision weekly. 88% of 146 respondents reported needing less help with shower following installation of adaptation. This was estimated to result in a saving of £248,976 per year. 6% reported that they needed more help with shower. 52% of people living alone said they had been able to stay in their home after the adaptation and 42% said their families	**3**

								worried less about them	
Cottrell and Plumb (2012) UK	To evaluate the impact of Bristol housing adaptation service for major adaptations on clients and associated health services	320	Children and adults	In addition to participants who had been provided adaptation services, OT'S, and academics were involved in interviews	Adaptations of hygiene facilities such as installation of wet rooms. Installation of grab rails, stair lifts and outside handrails	12 months	Avoided health and social care contact Savings on demand for health and Social care	There was a 20% reduction in the use of health service following adaptations. Adaptations also led to improvements with self-care, 35.7% respondents had no problems with self-care post-intervention compared to 29.1% prior to adaptation. Total saving on the demand for health and social care accrued by the 1,337 adult recipients of the adaptations (based on 2010/11 and 2011/12 data) was estimated at £774,123, and the increase in the quality and quantity of life was estimated to be £2,034,914	**2**

APPENDIX 8a: REFERENCE LIST OF EXCLUDED BLACK LITERATURE

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BRE Client Report

Cost benefit analysis of home adaptations

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Executive Summary

This report and the modelling work underpinning it, has been undertaken as part of the Centre for Ageing Better review into the role of home adaptations in improving later life. One of the objectives of the review was to model the population health impact and value of the home adaptations in terms of costs. To achieve this, we planned to model data from both the English Housing Survey (EHS), which provides population estimates for key housing and household characteristics, and estimates of cost-savings for types of adaptations found from the literature review undertaken by University of the West of England.

There are direct and indirect benefits that may be realised from various types of home adaptations. Some of these benefits have been highlighted through the literature review and include a reduction in the risk of falls, improved quality of life and mental health. Figure 3 of this report further illustrates the range of potential benefits that may arise for each type of home adaptation.

The findings of the literature review demonstrate that some home adaptations can deliver economic benefits to the state and can have a positive impact in falls prevention. The most robust evidence, however, relates to the impact of home adaptations undertaken in other countries and there was insufficient evidence to provide a usable estimate for the benefits associated with different adaptations in the UK and for older people specifically. ***We have, therefore, good knowledge of the likely benefits of home adaptations but are currently unable to quantify these where they exist. A better understanding of these benefits would enable both better adaptation decision making, and provide a justification for greater investment in future adaptations of properties.***

Analysis of the EHS has provided national estimates for key older household groups who may benefit from home adaptations now or in the future.

- In 2014, about three in every ten households (6.9 million) included an adult who is aged 65 years or over and around 3 million of these reported that they had a long term limiting illness or disability.
- Furthermore around 475,000 households contained at least one adult aged 65 years or over with a long term limiting illness or disability who also required at least one home adaptation (not already installed) in their home. This figure is likely to underestimate the need for adaptations given that reporting of long term illness and the need for adaptations is provided by the survey respondents rather than independently assessed.

The EHS also estimates that around 474,000 (7%) of households that include an adult who is 65 years of age or over, live in poor housing; these are homes with the most serious (Category 1) hazards[1] that could be mitigated through common home adaptations. A further 1.5 million (22%) live in homes where the risk of these hazards is worse than average, although not Category 1 hazards.

As it has proven difficult to quantify the extent of the benefit from any adaptation for older households, we have produced a cost benefit model for adaptations and hazard mitigation using economic benefits over a

[1] as assessed by the Housing Health and Safety Rating System (HHSRS)

range of possible values. The model examines return on investment (ROI) and payback periods. Once known through further primary research, costing the benefits of adaptations could be added to the model. The model allows costs and benefits associated with each element of the model to be included or excluded from the analysis. The main findings from this model are provided below.

Mitigating worse than average hazards associated with falls on stairs has the best ROI. Work to mitigate these hazards among households with an adult aged 65 years or over would cost in the region of £290 million. It is estimated that if all of this work were conducted 'up front' there would be benefits to society of around £470 million pounds; a ROI of 61.7% and a payback period of 0.62 years. Given that the literature review findings suggest that home modifications can have a notable impact on falls prevention, the evidence for investment into mitigating falls is particularly strong.

The cost benefit model can also show the potential effects of home adaptations and hazard mitigation on a smaller sample of households with adults aged 65 years or more, such as those in need of home adaptations. The ROI and payback in years would not vary if the proportion with the hazard present in these smaller populations is equal to the proportion among all households with an adult aged 65 years or over. This research is unable to provide further data on this, however, due to small sample sizes for hazards in these smaller subgroups.

While the ROI for some hazard mitigation is good, this drops off quickly when you include the potential cost of a HHSRS assessment required to identify those households living in a home with serious hazards. The cost associated with mitigating the hazard is, however, dependent upon the sample size, since all homes in the sample would have to undergo a HHSRS assessment and a proportion of these would require the mitigation measures. ***At an adaptation benefit of £2,000 per household and a HHSRS assessment cost of £150, mitigating stair fall hazards provides an overall payback in less than 3 years, even with a Net Present Value 3% discount rate. Once the benefit to society from adaptations exceeds £2,000 in the first year then the size of the sample is less important, and if anything concentrating on those homes that are known to need an adaptation will be the most cost effective.***

While benefits of hazard mitigation can be considered both at the benefit to the NHS (and adult social care) level and at the benefits to society level, most of the calculations presented in this report are based on benefits to society. An option to consider QALY benefits has been considered in the model, but there is more uncertainty in such a calculation.

The data regarding mitigation of hazards was less reliable for some of the hazards considered for this project, such as the risks associated with food safety, domestic and physical hygiene as the size of the sample was too small. In the report only 5 of the hazards with the best data are considered. All presented cost benefit calculations that examine the impact of including the cost of a HHSRS assessment are based on mitigating only the hazard with the best return on investment, namely falls on stairs***.***

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Introduction

Background

The Centre for Ageing Better (CAB) has commissioned a review to both clarify the role of home adaptations in improving later life and to model the potential cost and saving implications of present policies and future options. One of the objectives of the review was to model the population health impact and value of the home adaptations in terms of costs. To achieve this, we planned to model data from both the English Housing Survey (EHS), which provides population estimates for key housing and household characteristics, and the findings from the literature review undertaken by University of the West of England (UWE)[2], to provide estimates cost-savings for types of adaptations.

The findings of the literature review demonstrate that some home adaptations can deliver economic benefits as well as having a positive impact on people's quality of life, their independence, well-being and mental health. However, the most robust evidence identified regarding economic benefits relates to the impact of home adaptations undertaken in other countries and, for some research, the findings were not exclusive to older households. The UWE literature review confirms that there are evidence gaps in our understanding of the economic benefits of types of home adaptations for older people in the UK. In view of this, it was not possible to simply apply the evidence of the non UK based research and apply these to an England cost-benefit model.

As it is difficult to quantify the extent of the benefit from any adaptation, and how this benefit may vary from one type of adaptation to another, this report outlines a proposed methodology for evaluating the cost-benefit of home adaptations once more robust data becomes available. The model, therefore, considers the benefits from adaptations over a range of possible values.

For this project, we adapted the methodology used for the BRE reports 'The Cost Benefit to the NHS arising from Preventative Housing Interventions' (Garrett et al, 2016) and 'The full cost of poor housing' (Roys et al, 2016) to provide a cost-benefit analysis of home interventions/adaptations that can mitigate the risk of a harmful event occurring in the home where the risk is assessed as significantly worse than average under the Housing Health and Safety Rating System (HHSRS). Where a risk of harm is significantly worse than average, the home is considered to be 'poor housing'.

The first two sections of this report provide an overview of the need for adaptations among older households and our approach to cost-benefit modelling of adaptations. It then looks at the modelled cost-benefits of mitigating hazards through home adaptations among households with an adult aged 65 years or more, highlighting return on investment (ROI) findings and payback periods. For the hazard associated with falls on the stairs, where remedial action delivers the best ROI, the cost benefit analysis is then adapted to include the cost of a risk assessment.

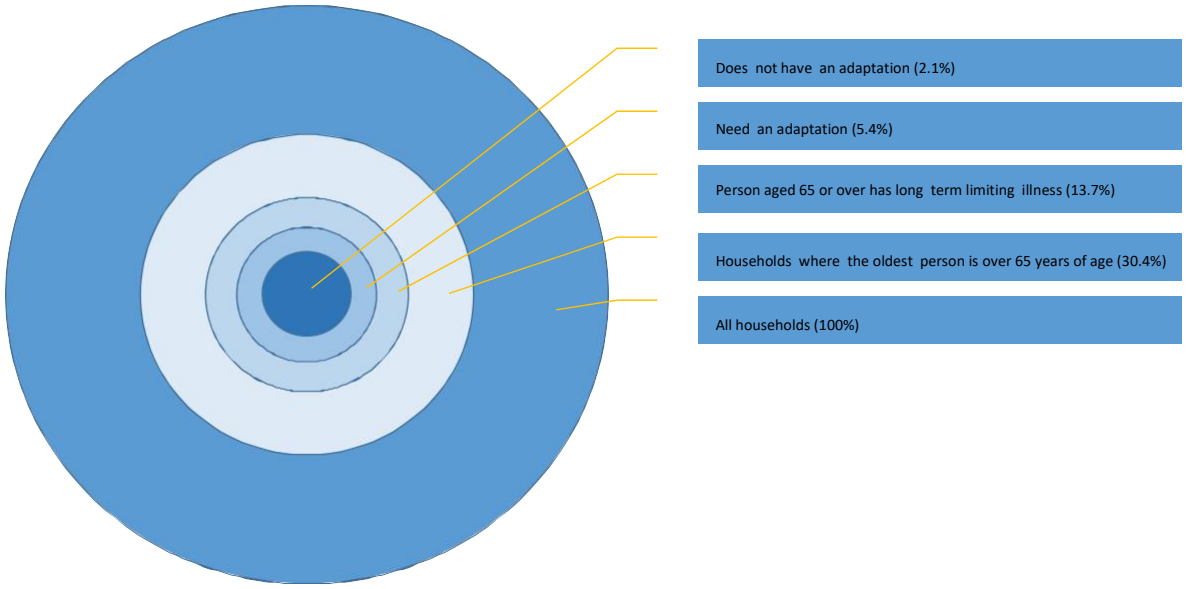
[2] The Role of Home Adaptations in Improving Late Life: Realist Synthesis of Evidence for Policy and Practice, 2017

Households needing home adaptations

Data for this were obtained using the EHS. The EHS is a continuous national survey commissioned by the Department for Communities and Local Government (DCLG). Through two components, a household interview and a physical inspection of a subsample of properties, it collects information about people, their housing circumstances and the condition of their homes. As part of the interview survey, respondents are asked whether any member of their household has a long term illness or disability which limits their daily activities. Those households with a long term limiting illness or disability are subsequently asked whether there is a need for any home adaptation (or adaptations), and whether this has been installed[3]. Any need for a home adaptation is therefore subjective; it is the respondent's own assessment of need and it may differ from any need identified through a formal assessment of a trained occupational therapist.

From the 2014 EHS data[4], we can estimate that about three in every ten households (6.9 million) includes an adult who is aged 65 years or over, Figure 1. In about 45% of these households (3 million) a person aged 65 years or over reported having a long term limiting illness. Nearly 40% of the households reporting long term limiting illness also needed an adaptation, which is about 18% of all households with an adult aged 65 or over. In 60% of the households requiring an adaptation, the adaptation was already present, leaving 40% (7% of all households with an adult aged 65 or over) still requiring an adaptation. This equates to 475,000 households across England.

Figure 1: Proportion of households which include adults aged 65 years or over with adaptation needs, 2014



[3] As the questions on home adaptations are only asked of those households where someone has a long term limiting illness or disability, the need for adaptations is likely to be underestimated by the EHS. This is because some respondents who need adaptations may not label themselves as having such an illness or disability.

[4] The analysis used data from the EHS 2013 and 2014 surveys, providing a 2014 base for the findings.

Source: English Housing Survey, 2014

Cost benefit of adaptations

Cost

Home adaptations that enable homes to become safer and promote independent living have the potential to transform the quality of life for those who need them. They also help deliver some government health and social care key policy objectives, for example, prevention of unnecessary hospital stays, reducing strain on carers, and promoting the social inclusion of people who may otherwise have to remain at home or live in just a few rooms of their home. Demand for home adaptations is increasing nationally due to our ageing society and medical advances. Around 40,000 (Adams, 2015) people every year (mainly older people), benefit from home adaptations provided through a Disabled Facilities Grant (DFG) administered by local authorities. These grants, however, represent a small proportion (about 8%) of the estimated 475,000 households who would benefit from an adaptation.

Table 1 highlights a list of 30 different adaptations typically found in home adaptations, ranging from adding a toilet seat or grab rails through to the redesigning of a kitchen or bathroom. In some extreme cases the adaptation required will be an extension to the home. Each of these adaptations has a typical cost associated with them. By considering the frequency of each of these adaptations, and the typical cost, it is possible to estimate the average cost of an adaptation, which is £2,695.

Benefit

The June 2013 Spending Round announced the creation of a £3.8 billion Better Care Fund (BCF), pooled budget for local integrated health and social care services, based on agreed strategies between the NHS and local authorities. This new fund included all central funding (£220 million) for DFGs in 2015/16. In 2016/17, the Better Care Fund was increased to a mandated minimum of £3.9 billion with the national allocation of funding for DFGs set to almost double to £394 million (Department of Health and Department of Communities and Local Government, 2016). Considering the £220 million budget available, and the 40,000 people benefiting from the grant each year, the average available funds is £5,500, equating to an average of 2.04 adaptations per household.

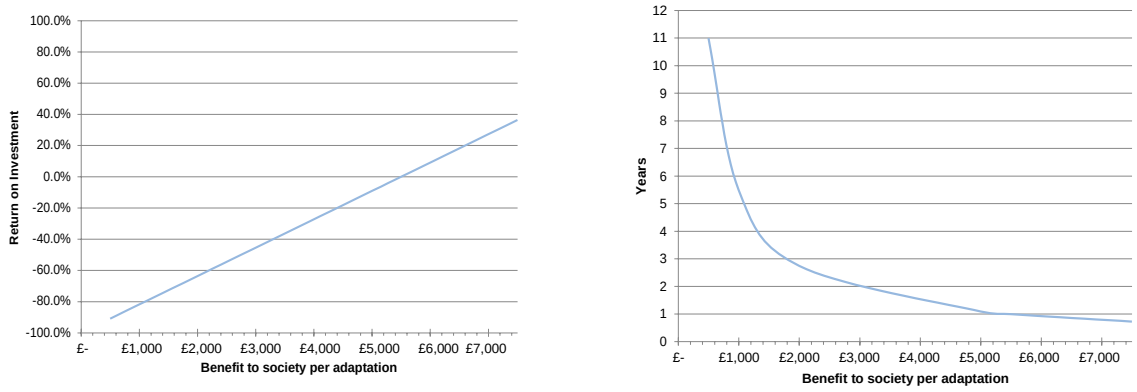
In order to get a good ROI, the amount of benefit generated by providing the adaptation should be reasonable. Figure 2 illustrates the ROI profile and the basic payback period for the average fund of an adaptation (£5,500). Where the ROI is 0%, or where the payback period is one year exactly, the investment cost is equal to the benefit. Positive ROI is where the benefit exceeds the cost, and relates to the cost being paid back within one year. Similarly a negative ROI results in a longer payback period.

Table 1: Range of adaptations and average costs

Adaptation	% of total	Typical Cost
Extension of home	1.47%	£27,500
Redesign kitchen	2.01%	£8,500
Redesign bathroom	3.27%	£7,550
Graduated floor shower	3.78%	£5,750
Stair lift	4.87%	£5,400
External ramp	4.68%	£4,500
New bath / shower room	2.72%	£4,500
Shower replacing bath	5.86%	£4,250
Wheelchair accessible parking	2.91%	£4,250
Adjustable bed or related aid	4.41%	£3,250
Hoist	1.15%	£3,150
Wide doorways	2.21%	£2,625
Additional / relocate toilet	2.75%	£2,500
Low level bath	1.96%	£2,000
Relocate bath / shower	1.18%	£1,900
Additional heating	1.52%	£1,775
Shower over bath	3.32%	£1,700
Wide paths	2.56%	£1,275
Entry phone	2.01%	£1,250
Other external adaptation	1.64%	£1,000
Other modification of kitchen	1.25%	£1,000
Individual alarm system	2.53%	£850
External rail to steps	5.63%	£775
Internal ramp	0.76%	£505
Bath / shower seat	9.64%	£483
Visual / hearing impairment related	1.11%	£475
Wide gateway	1.48%	£275
Electrical modifications	1.02%	£275
Grab rail or other rail	13.03%	£140
Toilet seat	7.24%	£40
Total	100%	
Weighted average cost		£2,694.35

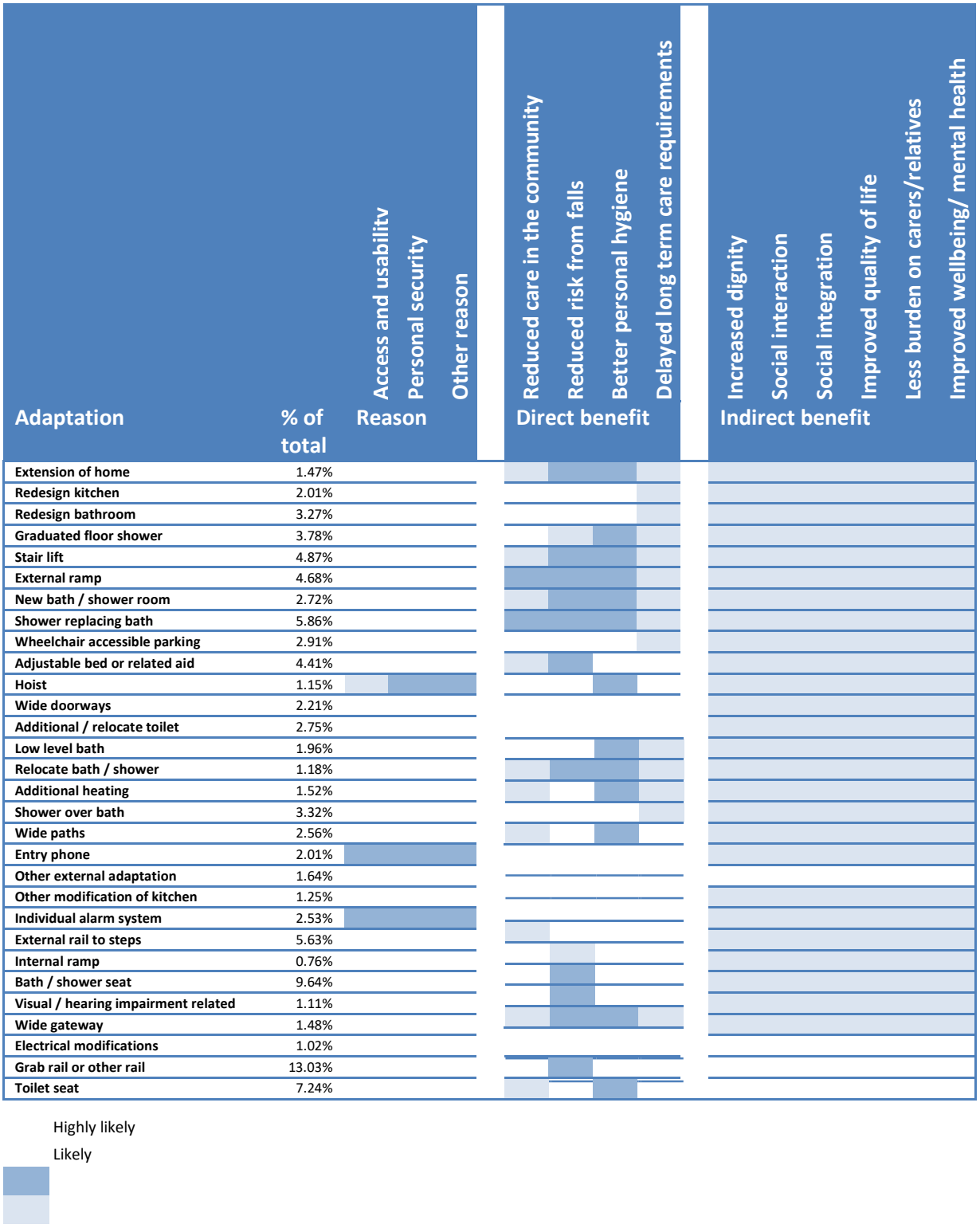
Source: 'The Cost Benefit to the NHS arising from Preventative Housing Interventions' (Garrett et al, 2016), Table 11

Figure 2: Return on investment and basic payback



It is difficult to quantify the extent of the annual benefit from an adaptation, and how this benefit may vary from one type of adaptation to another. Figure 3 highlights some possible direct benefits to the NHS and adult social care budgets relating to changes in care needs as a result of an adaptation. In addition to these direct benefits, indirect benefits to society are likely to occur from the adaptation. However, there appears to be a lack of information regarding the quantification on these benefits within the literature. A better understanding of these benefits would enable both better adaptation decision making, and provide a justification for greater investment in future adaptations of properties.

Figure 3: Direct and indirect benefits of adaptations



Cost of poor housing benefits

While the exact magnitude of the benefits of adaptations is unknown, we do have some indication of the potential benefit of reducing the risk from falls and other risks likely to cause injury. As in the BRE report 'The Cost Benefit to the NHS arising from Preventative Housing Interventions' (Garrett et al, 2016), EHS data relating to hazards assessed under the Housing rating System (HHSRS)[5] for a smaller sample of the population can be considered. In this case the sample is households that include an adult who is 65 years of age or over. For each of the hazards relating to home adaptations, information for this group of households can be obtained; however, the sample size of the raw data used in the analysis for some hazards is small leading to potential sampling errors in the results.

Overall the EHS estimates that around 474,000 (7%) of households that include an adult who is 65 years of age or over, live in poor housing, that is, homes with the most serious (Category 1) hazards that could be mitigated through common home adaptations. A further 1.5 million (22%) live in homes where the risk of these hazards are worse than average, although not Category 1 hazards.

Cost of repairs

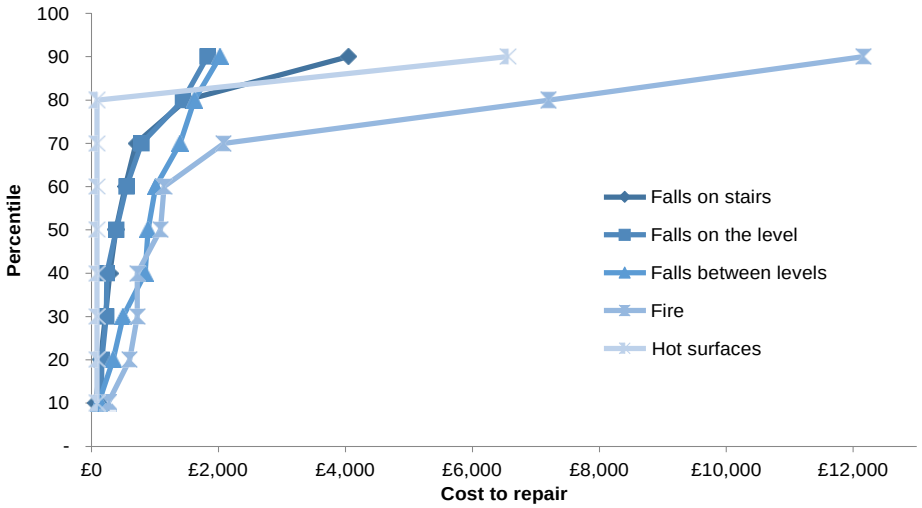
For five of the hazards, falls on/from stairs, falls on the level, falls between levels, fire and hot surfaces[6], the cost to repair or mitigate hazards[7] can be determined using data collected by EHS. The range of potential costs can be quite varied, and this is illustrated in Figure 4. Cost values are skewed to the higher values, so the best measure of central tendency for these data would be the median (50th percentile) rather than the arithmetic mean, see Table 2.

[5] The HHSRS is the government's evidence based risk assessment procedure for residential properties. It identifies hazards in dwellings and evaluates their potential effects on the health and safety of occupants and their visitors, particularly vulnerable people. The system provides a means of rating the seriousness of any hazard so that it is possible to differentiate between minor hazards and those where there is an imminent threat of major harm or even death. The most serious hazards are known as Category 1 hazards and where a home has at least one of these hazards, it fails to reach the statutory minimum standard for housing in England.

[6] The data regarding mitigation of hazards was less reliable for some of the hazards considered for this project, such as the risks associated with food safety, domestic and physical hygiene as the size of the sample was too small. Even though the data for 10 hazards is included in the model caution should be applied to interpreting the results from many of the hazards. In the report only 5 of the hazards with the best data are considered.

[7] Hazards are considered to be mitigated when the risk of harm from it is no worse than the national average for the type and age of home,

Figure 4: Range of cost to repair for each hazard, 2014



Source: English Housing Survey, 2014

Table 2: Average cost to repair/mitigate hazard, 2014

Hazard	Median	Mean
Falls on stairs	£ 386.64	£ 1,009.27
Falls on the level	£ 389.88	£ 733.78
Falls between levels	£ 891.38	£ 1,070.10
Fire	£ 1,085.51	£ 4,456.24
Hot surfaces	£ 85.54	£ 1,037.50

Source: English Housing Survey, 2014

Benefit of repairs

Using the methodology outlined in the 'Full cost of poor housing' report (Roys et al, 2016) it is possible to determine the benefit associated with improving the poorest housing lived in by adults aged 65 years or over so that the risk of injury in their home is no worse than the national average. Table 3 provides the median estimates for the likelihood of different harm outcomes and the probability of having an incident for average housing and worse than average housing for five hazards. The number of households with a Category 1 hazard present (the most serious hazards), or with a worse than average hazard are also recorded.

Table 3: Probability and likelihood of hazardous outcomes for households with an adult aged 65 years or over.

	Number of households (n)	Probability of having a incident (1/x)	Likelihood of extreme outcome (%)	Likelihood of severe outcome (%)	Likelihood of serious outcome (%)	Likelihood of other outcome (%)
Category 1						
Falls on stairs	272,001	32	2.2	10.0	21.5	66.3
Falls on the level	150,377	32	0.2	10.0	31.6	58.2
Falls between levels	67,426	18	0.2	4.6	21.5	73.7
Fire	29,449	100	21.5	10.0	46.4	22.1
Hot surfaces	18,162	6	0.1	1.0	21.5	77.4
Not Category 1 but higher than average						
Falls on stairs	479,747	100	2.2	10.0	21.5	66.3
Falls on the level	298,238	32	0.2	10.0	31.6	58.2
Falls between levels	525,577	180	0.2	2.2	10.0	87.6
Fire	268,018	1000	10.0	4.6	31.6	53.8
Hot surfaces	94,701	32	0.1	1.0	21.5	77.4
Average						
Falls on stairs		245	1.9	6.7	21.7	69.7
Falls on the level		135	0.2	13.8	27.3	58.7
Falls between levels		1693	0.2	1.8	9.9	88.1
Fire		4760	7.0	2.6	29.1	61.3
Hot surfaces		39	0.1	1.4	21.9	76.5

Three different benefit weightings can be applied to this data, see Table 4. These values can be used to calculate the potential benefit associated with repairing/mitigating the five hazards for all dwellings occupied by someone aged 65 years or over where there is a potential hazard, see Table 5.

Table 4: Benefit weightings

Class of Harm	Benefit to the NHS	Benefit to Society	Benefit in QALYs
Extreme outcome	£ 90,000	£ 1,703,822	16*
Severe outcome	£ 30,000	£ 45,600	0.1
Serious outcome	£ 1,800	£ 8,300	0.03
Other outcome	£ 120	£ 200	0.001

* If extreme outcome is equivalent to a fatality, mitigating this harm outcome is assumed to be equivalent to restoring 16 years of life (to average life expectancy of 81 [81-65=16])

Source: The full cost of poor housing (Roys et al, 2016)

Table 5: Potential benefit if all worse than average housing, containing households with an adult aged 65 year or over, were repaired

Hazard	Benefit to the NHS	Benefit to Society	Benefit in QALYs
Falls on stairs	£ 59,556,203	£ 469,914,477	3,932.83
Falls on the level	£ 37,311,633	£ 109,946,411	548.51
Falls between levels	£ 10,558,098	£ 41,842,252	262.01
Fire	£ 9,307,616	£ 149,641,517	1,382.16
Hot surfaces	£ 2,189,498	£ 9,888,998	53.34

These benefits can be compared with the costs of repair work to determine the ROI for mitigating these hazards within households containing adults aged 65 years or over. For example, Table 6 illustrates the cost benefit calculation using the benefit to society values from Table 5, in order of quickest payback. The last column (3% NPV) shows the calculation in terms of Net Present Value (NPV) with a 3% discount year on year. Since the payback periods are quite short for most hazards the discounted benefit values are not that dissimilar to the straight payback calculation. As the payback period increases, for example with the falls between levels hazard, the discount calculation can have a significant effect. A similar table could be generated for benefit to the NHS. The cost would remain the same resulting in much longer payback periods for benefit to the NHS.

Table 6: Cost benefit to society of five hazards

	Cost	Benefit	ROI	Payback years	3% NPV years
Falls on stairs	£ 290,653,000	£ 469,914,000	61.7%	0.62	0.64
Hot surfaces	£ 9,655,000	£ 9,889,000	2.4%	0.98	1.01
Falls on the level	£ 174,907,000	£ 109,946,000	-37.1%	1.59	1.63
Fire	£ 322,905,000	£ 149,642,000	-53.7%	2.16	2.21
Falls between levels	£ 528,590,000	£ 41,842,000	-92.1%	12.63	15.66

The difficulty with looking at the straight cost benefit of mitigating hazards is knowing which households have the hazard. It is therefore sensible to provide an estimated cost for an HHSRS assessment within the analysis.

Table 7 considers what the effect of increasing the cost of an assessment would have on the cost benefit calculation for falls on stairs[8]. With a HHSRS assessment cost assumed to be £150 per dwelling, we have estimated that the ROI is likely to be -61.4% equivalent to a payback period of less than three years. Any cost benefit calculation with a ROI of more than -80% (five year payback) is worth considering.

[8] This hazard has been selected for this analysis because (i) it is the most common hazard among households with a person aged 65 years or over (ii) it delivers the best ROI for hazard mitigation (iii) there is more robust evidence about the impact of minor adaptations on falls prevention in the literature review.

Table 7: Cost benefit of falls on stairs including an HHSRS assessment to all homes with an adult aged 65 years or over

Cost of HHSRS assessment		Total HHSRS assessment cost	Cost of mitigating falls on stairs	Benefit to society of mitigating falls on stairs	ROI	Payback years	3% NPV years
£	**-**	£ -	£ 290,653,000	£ 469,914,000	61.7%	0.62	0.64
£	**50**	£ 342,624,000			-25.8%	1.35	1.37
£	**100**	£ 685,248,000			-51.8%	2.08	2.12
£	**150**	£ 1,027,872,000			-61.4%	2.81	2.92
£	**200**	£ 1,370,497,000			-71.7%	3.54	3.70
£	**250**	£ 1,713,121,000			-76.5%	4.26	4.51

It is worth remembering that the assessment would have to be conducted on all households with an adult aged 65 or over. Assuming the proportion of households with the hazard remain constant, it would be possible to scale down the calculation to the smaller groups of older households highlighted in Figure 1[9]. The ROI and payback in years would not vary if the proportion with the hazard present in these smaller groups is equal to the proportion in the whole population.

Even a small cost associated with the HHSRS assessment has a significant impact on the ROI and payback. However, the cost is a one off that allows the assessment of all the potential hazards. In addition, if the assessment can be performed by an individual who is already making an adaptation assessment of a property, for example an Occupational Therapist (OT), then the cost of the assessment can be kept to a minimum. It is also worth remembering that the HHSRS assessment is an assessment of the dwelling and not the needs of the individual.

[9] The EHS is unable to provide sufficiently robust data on the prevalence of hazards within the smaller groups due to small sample sizes.

Adding adaptations cost benefit to a hazard mitigation

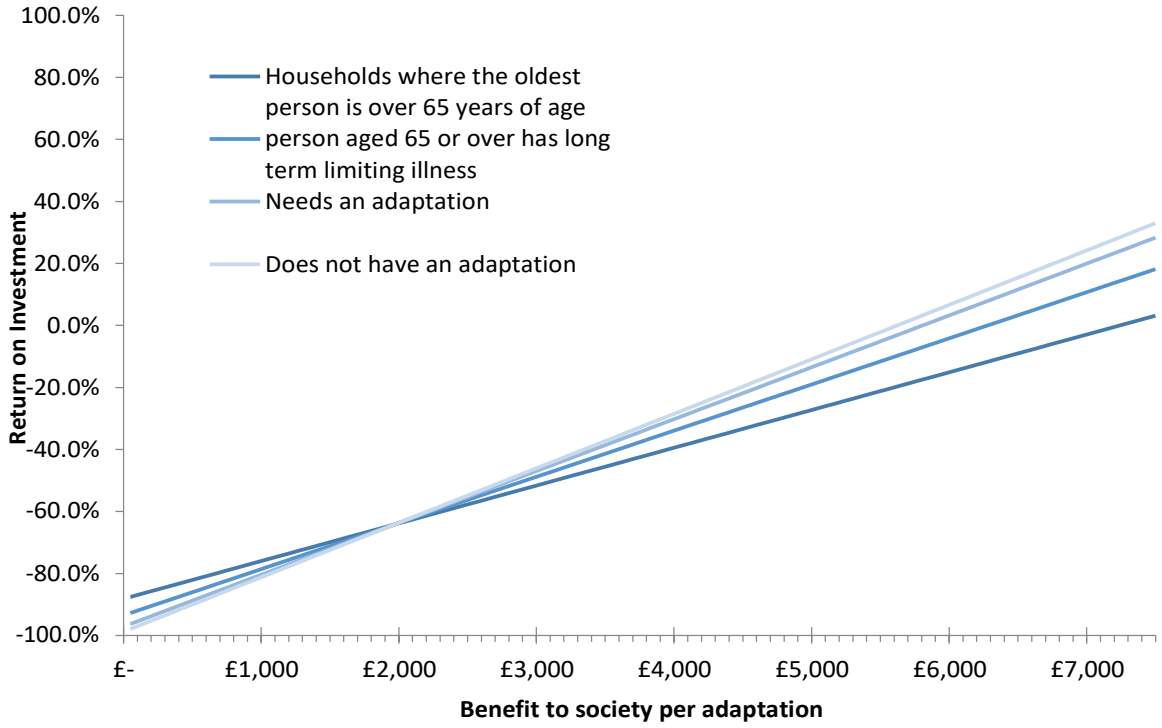
Going back to the population in Figure 1, we can compare the costs and benefits associated with both the adaptations and the mitigation of hazards for each of the four samples: households where the oldest person is at least 65 years of age, of those households who have a long term illness or disability, of those only those who need an adaptation, and finally only those who need an adaptation and don't have one yet. In each sample size, the total number of adaptations needed remains constant at 7.1% of the households where the oldest person is 65 years or over, or 475,000 households. The cost and benefit associated with adaptations therefore remains constant at each sample size. It is noted however, that we are not likely to see 475,000 adaptations in one year. The cost benefit calculation would remain equal with a smaller sample of homes that need adaptations, for example those homes that are eligible for the DFG.

The cost associated with mitigating the hazard however is dependent upon the sample size, since all homes in the sample would have to undergo a HHSRS assessment and a proportion of these would require the mitigation measures. As the sample gets smaller, therefore, the benefit associated with adaptations becomes more cost effective in the calculation. Where the benefits from adaptations are low, see Table 8, then more benefit per household is achieved with a larger sample. However, in all cases the cost benefit is poor, with payback periods over 8 years or more. Once the benefit to society from adaptations exceeds £2,000 in the first year then the size of the sample is less important, and if anything concentrating on those homes that are known to need an adaptation will be the most cost effective. This is also illustrated in Figure 5

Table 8: Return on Investment for mitigating stair hazards, with a £150 HHSRS assessment cost over a range of Adaptation benefit values

Benefit associated with Adaptation in the first year	Households where the oldest person is over 65 years of age	Person aged 65 or over has long term limiting illness	Needs an adaptation	Does not have an adaptation
£ 50	-87.6%	-92.8%	-96.3%	-97.9%
£ 100	-87.0%	-92.0%	-95.5%	-97.0%
£ 500	-82.1%	-86.1%	-88.8%	-90.0%
£ 1,000	-76.1%	-78.7%	-80.4%	-81.2%
£ 2,000	-63.9%	-63.8%	-63.7%	-63.7%
£ 5,000	-27.3%	-19.1%	-13.5%	-11.0%
£ 5,500	-21.3%	-11.7%	-5.2%	-2.2%
£ 7,500	3.1%	18.1%	28.3%	33.0%

Figure 5: Return on Investment for mitigating stair hazards, with a £150 HHSRS assessment cost over a range of Adaptation benefit values



Conclusion and recommendations

The findings of the literature review demonstrate that some home adaptations can deliver economic benefits to the state as well as having a positive impact on their lives of people who receive them. There is, however, insufficient data to provide robust estimates of potential cost savings that may arise from the installation of different types of home adaptations in the UK. The evidence we have therefore, enables us to theorise the benefits of home adaptations but we are currently unable to quantify these where they exist. A better understanding of these benefits would enable both better adaptation decision making, and provide a justification for greater investment in future adaptations for people who need them.

We have produced a cost benefit model for adaptations and hazard mitigation in households where the oldest adult is aged 65 years or over. Due to lack of robust evidence regarding the economic benefits of specific adaptations, the model considers the benefits from adaptations over a range of possible values. Figure 3 of this report highlights the potential direct and indirect benefits linked to different home adaptations, and the findings of further primary research into costing these benefits could be added to the model when known.

The cost benefit model can show the potential effects of home adaptations and hazard mitigation on a subsample of households with adults aged 65 years or more, such as those in need of home adaptations. The Return on Investment (ROI) and payback in years would not vary if the proportion with the hazard present in these smaller samples is equal to the proportion in the whole population.

Mitigating worse than average hazards associated with falls on stairs has the best ROI. Work to mitigate such hazards among households with an adult aged 65 years or over would cost in the region of £290 million. It is estimated that if all of this work were conducted ‘up front’ there would be benefits to society of around £470 million pounds; a ROI of 61.7% and a payback period of 0.62 years.

While the ROI for some hazard mitigation is good, this drops off quickly when you include the potential cost of a HHSRS assessment required to identify those households living in a home with serious hazards. The cost associated with mitigating the hazard is, however, dependent upon the sample size, since all homes in the sample would have to undergo a HHSRS assessment in order to identify households living in homes with serious risks of harm. At an adaptation benefit of £2,000 per household and a HHSRS assessment cost of £150, mitigating stair fall hazards provides an overall payback in less than 3 years, even with a Net Present Value 3% discount rate.

The model suggests that once the benefit to society from adaptations exceeds £2,000 in the first year then the size of the sample is less important, and if anything concentrating on those homes that are known to need an adaptation will be the most cost effective.

The model is able to estimate benefits to the NHS (and adult social care) and to society. An option to consider QALY benefits has been considered in the model, but there is more uncertainty in such a calculation. The data regarding mitigation of hazards was less reliable for some of the hazards considered for this project, such as the risks associated with food safety, domestic and physical hygiene as the size of the sample was too small. Consequently only 5 of the hazards with the best data were considered for this report. All presented cost benefit calculations that examine the impact of including the cost of a HHSRS assessment are based on mitigating only the hazard with the best ROI, namely falls on stairs.

These conclusions demonstrate the need for further primary research into the economic and wider societal benefits of different types of home adaptations so that the cost-benefit model can be developed further.

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