ACCESSIBLE HOUSING AND HEALTH-RELATED QUALITY OF LIFE: MEASUREMENTS OF WELLBEING OUTCOMES FOLLOWING HOME MODIFICATIONS

Phillippa Carnemolla
Faculty of Built Environment
University of New South Wales, Sydney, NSW, Australia

Catherine Bridge
Faculty of Built Environment
University of New South Wales, Sydney, NSW, Australia

**Corresponding Author's email address: phillippa.carnemolla@unsw.edu.au

Abstract

The multi-dimensional relationship between housing and population health is now well recognised internationally, across both developing and developed nations. This paper examines a dimension within the housing and health relationship – accessibility – that to date has been considered difficult to measure. This paper reports on the mixed method results of larger mixed-method, exploratory study designed to measure the impact of home modifications on Health-Related Quality of Life, supported by qualitative data of recipients' experiences of home modifications. Data was gathered from 157 Australian HACC clients, who had received home modifications. Measurements were taken for both before and after home modifications and reveal that home modifications were associated with an average 40% increase in Health-Related Quality of Life levels. The qualitative results revealed that participants positively associated home modifications across six effect themes: increased safety and confidence, improved mobility at home, increased independence, supported care-giving role, increased social participation, and ability to return home from hospital. This exploratory research gives an insight into the potential for accessible architecture to impact improvements in community health and wellbeing.

Keywords: *Home modification; housing; accessibility; disability; aging population*

INTRODUCTION

At the core of this research is the fact that housing is more than bricks and mortar; it provides not only shelter, but also influences a range of social and health outcomes (Thomson et al, 2009). This study offers an understanding of how investing in housing design through a program of home modifications directly influences measurable health outcomes in the form of Health Related Quality of Life. (HRQoL) in the houses of older people and those living with a disability. This examination of home modifications and HRQoL enables a broader understanding of the links between accessible housing, aging, and disability and ultimately contributes to a picture of the dynamic relationship between the built environment and community health and wellbeing in the context of the changing health of populations due to ageing and disability.

Also critical to this research is the fact that most existing Australian housing was designed with an 'average user' (a healthy, young, adult male) in mind (Burns, 2004; Heylighen, 2008; Imrie, 2003). In the case of Australia, this has resulted in an older housing stock of predominantly inaccessible housing (Carnemolla and Bridge, 2012). This pattern of ageing populations, increased levels of disability, and older housing stock is a situation that is replicated across both developed and developing nations (Brodsky, 2003; Liebig, 2000).

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Motivations for this research

The housing and health relationship has received increasing interest in recent years with a number of systematic reviews (Gibson et al, 2011; Thomson, Petticrew, and Morrison, 2001; Thomson et al, 2009) and is now considered one of the major environmental, as well as social, determinants of population health (Marmot et al, 2008). Globally, many studies have investigated the health of populations and their housing conditions, with a body of evidence that strongly associates between poor health and poor housing (Bonnefoy, 2007; Bridge et al, 2003a; Thomson et al, 2013). The findings in this study respond directly to calls for intervention studies aimed at assessing the health effects of building modifications (Braubach, 2011) and elaborating on the pathways between housing and health (Gibson et al, 2011).

In housing and health reports, housing interventions vary broadly from focusing on living conditions, such as thermal or air quality, to housing poverty, to levels of accessibility within the home. There has been little research measuring and comparing levels of access in housing by comparing the physical built environment. Indeed the social impact of inaccessible housing is difficult to measure because the association between housing and health is complex and causal relationships can be hidden or influenced by multiple factors (Jacobs et al, 2010). This, in part, explains the lack of data or research studies exploring the relationship between access and community health and wellbeing. Despite there being an extensive international body of evidence identifying non-shelter outcomes of housing and the subsequent impacts on vulnerable populations (such as older people and those living with a disability), there is less research exploring how the architectural attributes themselves can play a role in impacting non-shelter outcomes for people.

This paper draws on the quantitative results of a larger mixed methods research study, whereby the home modification experiences of 157 participants are examined, sourced from a group of Australian Home and Community Care (HACC) clients. HRQoL data for both before and after home modifications was collected in a survey and was measured using the Assessment of Quality of Life (AQoL). This was converted to pre- and post-utility and dimension scores enabling comparison.

This exploratory research project was designed to measure how incremental improvements to the accessibility of housing has a direct impact on health and wellbeing outcomes. The study design is single arm and captures the 'before' and 'after' data in a single survey. The quantitative results suggest the existence of a positive relationship between home modifications and HRQoL.

What is a home modification?

Throughout this paper, the term 'home modification' is used to describe the structural changes made to the home environment to help people to be more independent and safe in their own home and reduce any risk of injury to their carers and care workers (Adams et al, 2014). These modifications are often prescribed by an occupational therapist and relate specifically to a person's health, comfort, and ability to live independently at home. Research into home modifications has steadily increased since 1990 (Carnemolla and Bridge, 2015) and is interdisciplinary, spanning the fields of housing and health.

Accessibility as it relates to home modifications

This paper is concerned with accessibility as it relates to architecture and the built environment. Accessibility in this context can be understood to be an approach to the design, construction, and improvements of the built environment that consider how people, regardless of their age or ability, experience the design in terms of mobility, usability, independence, and equity. The term accessibility is often used to describe the built environment alongside nuanced terms such as

inclusive, *barrier-free, visitable*, and *universal design*. Home modifications, as measured in this study, are an architectural intervention designed to improve the accessibility of people's houses.

Measuring wellbeing in the context of how we experience the built environment

In a recent systematic review on home modification evidence (Author citation, 2015), all the included studies that actively reported on links between home modifications and wellbeing had positive findings (Ahmad, Shakil-ur-Rehman, and Sibtain, 2013; Lin et al, 2007; Allen, 2005); however, they all measured home modifications as part of a multi-factorial intervention. Overall, there has been relatively little direct investigation into how home modifications influence Health-Related Quality of Life and wellbeing of recipients This study responds to the need for research to be conducted on home modifications as a single intervention, rather than as a component of a multi-factorial intervention. This enables a unique understanding of the impact of the built environment independent of other interventions.

Wellbeing is a broad concept that integrates physical, mental, and social domains. Global indexes that attempt to measure the overall wellbeing of populations tend to have numerous categories of wellbeing, illustrating how it is impacted by many life domains, e.g. the Organisation for Economic Co-operation and Development (OECD) has developed a Better Life Index with 11 categories of wellbeing, housing being one, while the Canadian Index of Wellbeing has eight. Housing encompasses a range of characteristics that are integral to wellbeing (Bratt, 2002). Wellbeing has strong associations with the meaning of home and research suggests that, along with other non-economic factors (such as health deterioration, family composition changes, and local amenities), it is an important determinant in the housing choices of ageing populations (Sabia, 2008).

This paper is specifically concerned with wellbeing as it relates to people's experience of changes made to the physical, built form of their housing following home modifications. This study is designed to isolate and measure the influence of built form on the wellbeing of older people and people living with disabilities and it uses an established measurement in the form of Health-Related Quality of Life (HRQoL)

Measuring wellbeing as HRQoL

Health-Related Quality of Life (HRQoL) can be understood to be quality of life measurement in a health care context. It is a multi-dimensional indicator that, like quality of life, incorporates domains related to physical, mental, emotional and social functioning. These are also health-related to the extent that they are influenced by disease, injury, treatment, or policy (Patrick and Erickson, 1993). Measurements of HRQoL are converted to utility scores, a cardinal number, and are often incorporated as a component in health economics (Sullivan, 2003). The measurement of HRQoL changes associated with home modifications is an important indicator of the success of such home modifications as a community health intervention, for a number of reasons.

- It is linked to self-care models of health care (Aalto, Uutela, and Aro, 1997; Buck et al, 2012) and autonomy (Vernooij-Dassen et al, 2005);
- It acknowledges person-centered (patient-centered in the case of health care provision) models of health and care that are focussed not only on need but individual choice and preference (Reeve et al, 2013); and
- It considers health in broader context than simply the body (e.g. wellbeing, social, and environmental)

METHODS

The study is a single arm analysis of data on HRQoL gathered for both before and after home modifications. Eligibility for the study was based on participants being community dwelling recipients of Australian government supported care services (Home and Community Care

clients). This meant that all participants would be either frail older people or people living with a disability. All of the Home and Community Care (HACC) clients included in the study had received home modifications prescribed by an occupational therapist. Participants were included in the study where their home modifications had been completed within a six-month period prior to the survey being distributed.

Data

Primary data was collected in a survey distributed to recent recipients of HACC-supported home modifications via the two home modification service providers in New South Wales, Australia. The survey was designed as a cross-sectional capture of longitudinal data (before and after), meaning that self-reported data on care, HRQoL and related comments about experiences of home modification were captured in a single survey at a single point in time, between one to six months after home modifications were completed.

In addition to the survey data, data was available in the form of detailed health information and home modification information. This was derived by matching the survey responses with the relevant client files (which were de-identified on site) containing both medical diagnoses and home modification information.

Measuring HRQoL in a survey

When measuring wellbeing or quality of life in relation to a particular intervention (such as home modification), there are various kinds of surveys that can be used. The constitution of the World Health Organization (WHO) defines health as "a state of complete physical, mental, and social wellbeing not merely the absence of disease…" (WHOQOL Group, 1993). The more specific concept of Health-Related Quality of Life (HRQoL) has evolved in recent decades to encompass those aspects of overall quality of life that can be clearly shown to affect health, either physical or mental. HRQoL instruments, also known as multi-attribute utility (MAU) instruments, measure the utility of health states that is suitable for an economic evaluation such as a cost utility analysis. Selection of the most appropriate instrument requires an understanding of a particular instrument's validity and reliability for the sample population being studied (Guyatt, Feeny, and Patrick, 1993). The Assessment of Quality of Life was chosen for this research study because it was based on Australian populations and in particular had been validated for older, community-dwelling Australians.

The Assessment of Quality of life (AQoL)

The Assessment of Quality of Life (AQoL) instrument was developed by the Centre for Health Economics, Monash University, Victoria, Australia. There are four versions of the AQoL, based on length of instrument. AQoL-4D is the shortest, with 12 questions in a 1-2-minute completion time. The AQoL-4D instrument was specially formatted to capture pre- and post- HRQoL data in the single survey. Throughout the survey design process, the developers of AQoL-4D, Centre for Health Economics, Monash University, were consulted about the modifications and the final survey design was approved by representatives of the Centre for Health Economics. AQoL-4d was the instrument chosen for this research.

The Assessment of Quality of Life (AQoL-4D) was integrated into the survey design to determine Health-Related Quality of Life. AQoL-4D was administered in the form of 12 questions to gather utility data regarding recipients' experiences before and after home modifications. The response was then converted to a utility score using SPSS statistic software. Australian population norms are available for the AQoL (Hawthorne, Korn, and Richardson, 2013), which has been validated for use in Australian health studies. The AQoL is also considered valid for testing older, community-dwelling populations (Osborne et al, 2003). The resultant utility scores are a measure of Health-Related Quality of Life.

The aims of the survey were to collect a range of primary data unavailable in secondary data sources including:
Demographic details about respondents, including age, income status, tenure, living status, and health.
- AQoL-4D responses for before and after home modifications. This enables any difference in utility scores (calculated from the AQoL-4D instrument) between before and after home modification to be measured.

The survey design had to gather longitudinal data of HRQoL in a single capture. The successful completion of the survey required a level of cognitive understanding that could differentiate between before and after the home modifications. The single capture methodology is vulnerable to recall bias on the part of respondents as they are being asked to provide data on two different time points in the one survey. The survey was designed and laid out using Adobe Illustrator software. The final format was a four-page, double-sided A4 document that was colour printed for distribution. A total of 650 surveys were distributed with 157 valid responses received.

Table 1. Matrix documenting the quantitative variables analysed in the study.

Variable	Description	Unit	Measured	Source
AQoL Utility Scores	AQoL utility	Utility (0-1)	Before and after home modifications	Self-reported in survey and converted using SPSS
AQoL Dimensional Scores	Independent Living Dimension	Cardinal score (0-1)	Before and after home modifications	Self-reported in survey and converted using SPSS
	Relationships Dimension	Cardinal score (0-1)	Before and after home modifications	Self-reported in survey and converted using SPSS
	Mental health Dimension	Cardinal score (0-1)	Before and after home modifications	Self-reported in survey and converted using SPSS
	Senses Dimension	Cardinal score (0-1)	Before and after home modifications	Self-reported in survey and converted using SPSS

The AQoL-4D instrument estimates utility using a three-stage procedure. Items are (i) weighted and combined using a multiplicative model to obtain dimension scores; (ii) these are weighted and combined to obtain an initial AQoL score; (iii) this is then transformed econometrically to produce the final estimate of a health state utility (Richardson, Peacock, Iezzi, Day and Hawthorne, 2007). AQoL-4D utility algorithms for the conversion were downloaded from the AQoL website.
    Five variables were calculated in the data collection: an overall utility score and 4 dimension scores (uD) that related to the four sections within the AQoL-4D 12 questions. These

five variables were collected in a pre- and post- format, for comparison between before and after home modifications. The utility dimension (Ud) scores are not comparable with the total utility score, but before and after Ud scores are comparable within each dimension. Dimensions included independent living, relationships, mental health, and senses.

Inferential statistics

Statistical analysis was undertaken using the Statistical Package for Social Sciences (SPSS) version 21. Descriptive statistical analysis was completed on the demographic information, AQoL scores, and informal and formal care hour data. Primary collected data was confirmed as having normal distribution and ANOVA testing was performed. The statistical procedures used in this research included summary statistics, standard ρ analysis. ANOVA testing is one-sided and considered to be significant where ρ value was < 0.05.

RESULTS

Sample Demographics

A total of 157 respondents were included in the analysis. This yielded a survey response rate of 24.1% (157 participants out of a sample of 650 eligible participants). A summary of the sample characteristics follows:

- The average age of respondents in the sample was 72 years, with an age distribution in line with HACC population data sets for NSW.
- In terms of being categorized as older people, or younger people living with a disability, 13% (20) were younger than 55 years old and living with a disability and 87% (137) were frail or unwell older people.
- The gender balance approximated the NSW HACC population, with just over half (54%) being women.
- Within the sample, 1.3% identified as Indigenous.
- The sample overall predominantly lived with a partner or spouse, followed by people living alone. Those who lived alone were predominantly women while the men in the sample tended to be living with a spouse or partner.
- The sample population tended to be financially supported by the aged pension.
- The sample featured overwhelmingly owner/ occupiers of their home.

Table 2. Demographic statistics of sample.

	Count	Percentage of total sample
GENDER	157	
Female	85	54.1%
Male	72	45.9%
MEAN AGE (years)	71.86	
HOUSING TENURE		
Being purchased	2	1.27%
Fully owned	149	94.90%
Live with family members	2	1.27%
Own caravan and annex and rent site	1	0.64%
Private rental	2	1.27%
Retirement village	1	0.64%

	Count	Percentage of total sample
LIVING ARRANGEMENTS		
Live alone	42	26.75%
Live with a spouse or partner	84	53.50%
Live with family or friends	30	19.11%
SOURCE OF INCOME		
Carers allowance	2	1.27%
Disability support pension	28	17.83%
Full aged pension	102	64.97%
Part aged pension	16	10.19%
Self-funded retiree	8	5.10%
Wage or salary full time	1	0.64%
INDIGENOUS STATUS		
Indigenous	2	1.27%
Non-indigenous	155	98.73%

Health of the sample

Detailed health information was derived by matching the survey responses with the relevant client files (which were de-identified on site), containing both medical diagnoses and home modification information. This enabled a snapshot of the overall health diagnoses of the sample, indicating the prevalence of co-morbidities. Co-morbidities (also referred to as multi-morbidities) are defined as the 'simultaneous occurrence of two or more chronic conditions' (Taylor et al, 2010, 1).

More than half (53%) of the participants were diagnosed in their medical reports as frail aged. Although on average, participants were diagnosed with two morbidities, a number of them had up to five (5) chronic or life-threatening health conditions (Figure 9).
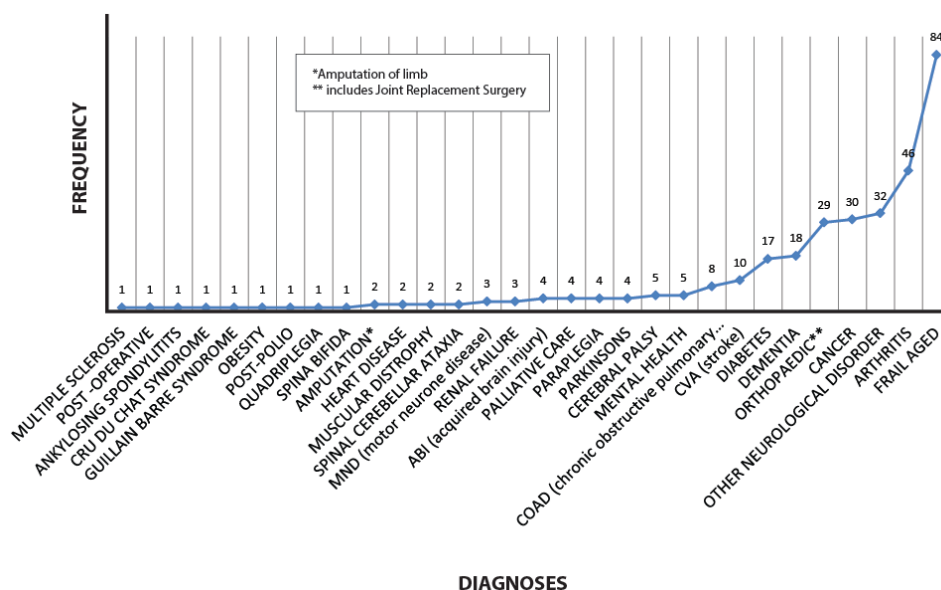

Figure 1. Analyses of diagnoses in the sample - average 2 diagnoses per participant.

Figure 1 shows the frequency of all diagnoses reported in the data. A total of 323 morbidity diagnoses were recorded for the 157 participants, with 'frail aged' being the most prevalent diagnosis in the sample (54%), followed by arthritis (29%), neurological disorders (20%), and cancer (19%).

Living situation and source of income
Twenty seven percent (27%) of the sample in this study reported living alone. The survey asked respondents to nominate their main source of income. Analysis of the responses showed that, overall, the full age pension was the predominant source of income (64%).

Housing tenure
Information on housing tenure was sought in the survey and revealed that the sample reported overwhelmingly (95%) to be owner/ occupiers of their own homes.

AQOL data results
The AQoL data results (in the form of utility scores) reveal whether a home modification changes the Health-Related Quality of Life of the recipient of a home modification. Analysis of the utility scores and utility dimensions (independent living, relationships, senses, and mental health) communicate the potential for home modification to impact autonomy and overall wellness/ wellbeing.

Inferential Statistics
Paired sample t-testing was conducted for all pre-post variables. All pairs were calculated to have statistically significant results, except for the utility dimension of senses (uD3SEN), which revealed a p score of 0.06. This result is unsurprising, given the two questions in the AQoL-4D that relate to uD3SEN ask about vision and hearing changes, health aspects that in the dataset were not targeted by home modifications specifically.

AQoL utility scores are reported in Figure 2 and display averages for:
- Average AQoL utility scores for the data set before and after home modifications
- AQoL utility scores for the Australian population of equivalent average age (70-79) as reported by Hawthorne et al (2013)
- Australian population norm (includes all ages) as reported by Hawthorne et al (2013)

The graphing of before and after average utility scores for the data set indicates that home modifications resulted in an average increase of 0.12 utility points, increasing from 0.3 to 0.42 for the study participants. However, the data set still has a lower average utility score than the general Australian population (0.81) and the Australian population aged between 70-79 years (0.76).
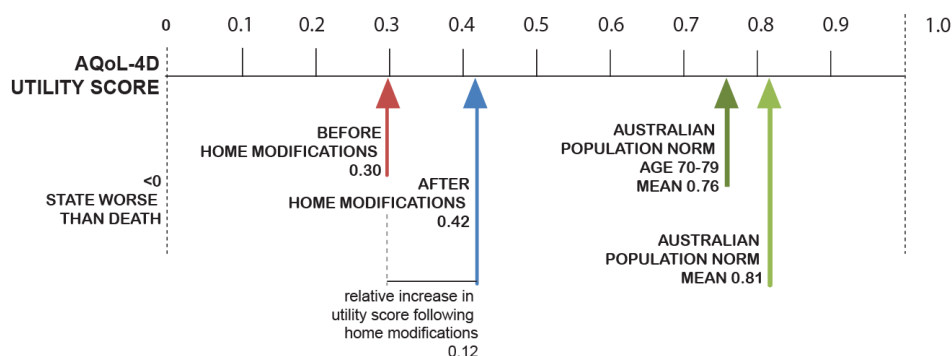

Figure 2. Analysis of the utility dimensions (uD).

The AQoL-4D instrument used for this research included 12 questions about the following four quality-of-life dimensions: Independent Living, Mental Health, Relationships, and the Senses. Data from the survey was collated and analysed using AQoL algorithms in SPSS software. Mean utility could also be analyzed according to the individual utility dimensions of AQoL-4D. Table 18 indicates how utility was distributed for each of the dimensions.

Table 3. AQoL Utility Dimension (uD) data.

AQoL Dimension	Mean Dimension Score Before Home Modifications	Mean Dimension Score After Home Modifications	Change in Dimension Score	% Change from Original Score
uD Independent Living	0.62	0.72	+0.10	+ 16%
uD Relationships	0.75	0.81	+0.06	+ 8%
uD Mental Health	0.82	0.87	+0.05	+ 6%
uD Senses	0.84	0.87	+0.03	+ 3.5%

Of note, and as anticipated, the biggest change in mean utility was in the Independent Living dimension (+0.10). Levels of self-reported independent living, mental health, relationships, and senses are all important influencers of utility scores in this context. As shown in Table 17, the Senses dimension was the least significant of dimension variables and the difference in before and after results is the smallest of all the dimensions. This was in line with expectation, due to the Senses questions being about changes to hearing and vision, not attributes targeted by home modifications.

What modifications were made

In order to understand what home modifications were made in the sample, home modification data was analyzed in terms of where the modifications took place in the home, specifically the bathroom, the kitchen or laundry, or as an access modification to help move in/ out/ through the house. Given their broad variability (from a bath hand rail to an electric lift), they were considered too variable to be typified according to type. Figure 23 compares the home modifications in each location. Bathroom modifications were the most common in the sample (78.3%) followed by modifications to help in moving through the home (61.8%) and, well behind in third place, kitchen or laundry modification (4.4%).
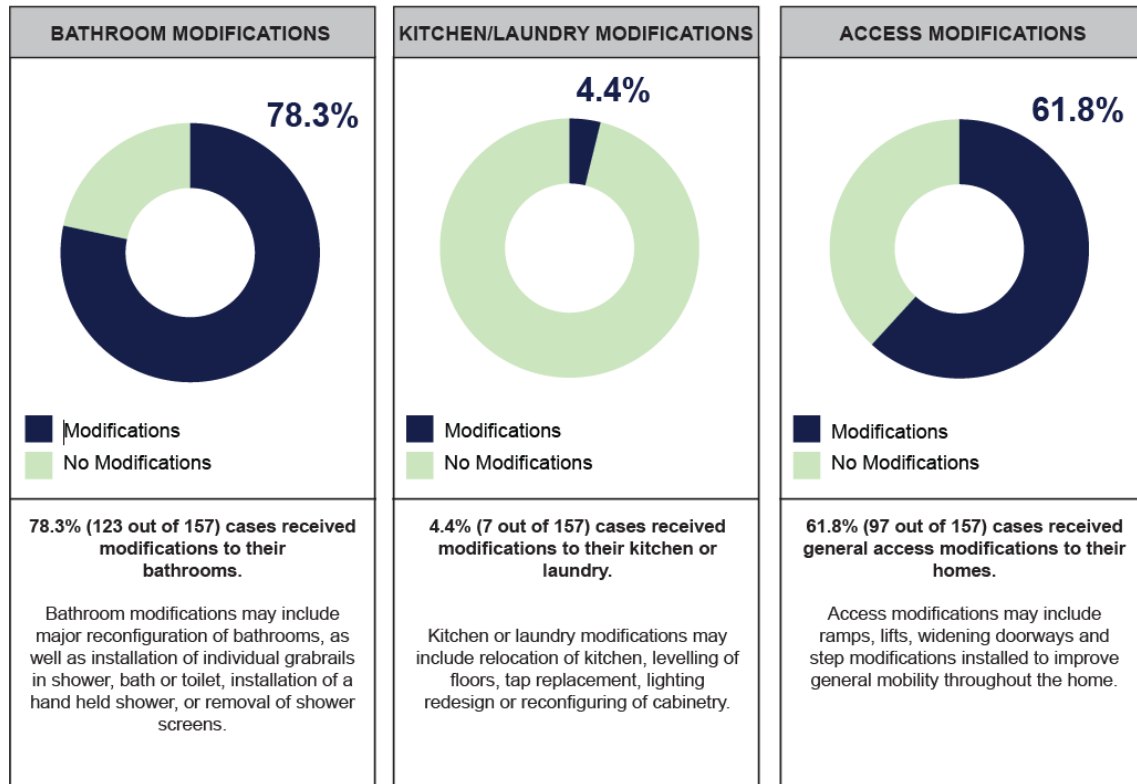
Figure 3. Where home modifications were made in the home.

DISCUSSION

The research findings suggest the existence of a relationship between home modifications and HRQoL, more specifically, they suggest that home modifications lead to an overall increase in participants' utility scores. Overall, with an average increase in utility score of 40 % after home modifications were installed, this relationship is significant. This positive result in self-reported wellbeing measures following home modification is reflected in two previous qualitative studies, Andrich et al (1998) and Pettersson et al (2012).

Overall, there has been relatively little direct investigation into how home modifications independently influence wellbeing measures such as HRQoL. Therefore, a major contribution of this present research is the study of a single-factor home modification intervention with directly-compared 'before' and 'after' HRQoL values.

When reviewing the sample demographics it becomes clear that people receiving home modifications through government funded services are overwhelmingly owners of their own home while receiving a government pension. The significance of a predominance of home owners is that it signals an exclusion of private renters, possibly due to difficulties in authorizing home modifications through landlords. This brings to light the need for research in this area in the context of building and construction policy: how home modifications might be able to be better provided to older people in a way that does not exclude private renters who are older or living with a disability.

The utility dimensions

This is the first study to apply the Australian-developed and validated Assessment of Quality of Life directly to changes in utility following home modifications, and therefore, the first time that the utility dimensions have been explored from the perspective of home modifications.

The findings relating to the utility dimensions as part of the overall utility score support the idea of an overlapping suite of effects working in combination, all as a result of home modifications. Increases were found to be statistically significant in three of the four utility dimensions: Independent Living, Mental Health, and Relationships. The fact that the fourth utility dimension, Senses, is least influenced by home modifications is unsurprising, given that, although home modifications can improve the environment for hearing or vision, by improving light levels for example, they cannot directly improve a person's vision or hearing levels.

An implication of these findings in utility dimensions is that it reinforces the multi-layered influence a home modification can exert in a hierarchy: firstly, providing independence, secondly, impacting mental health, and thirdly, impacting relationships in the home.

Relating the study to Australian population norms of HRQoL and health of the sample

This study found that average self-reported measurements of HRQoL (measured as a utility score) increased by 40%, from 0.3 before home modifications to 0.42 after home modifications. This means that the sample population (whose average age was 72 years) sits well below the Australian population norm of 0.76 for the compatible average age bracket (70-79) (Hawthorne et al, 2013). The study sample is even further below the overall Australian population norm for all age groups, which is 0.81. The lower average utility scores in this study can be explained, at least in part, by the complex and serious health problems consistently found throughout the sample.

Being a sample drawn from the HACC-eligible population would suggest that the participants were more likely to be frailer and have more co-morbidities than the equivalent-aged non-HACC eligible population. It would be fair to consider that the sample represents a snapshot within the Australian population who are likely to rely considerably on public health budgets and community health services. The significant positive influence of home modifications on overall HRQoL as well as the dimensional increases in Independent living, mental health, and relationship is an important signaller for the value of our home environments to contribute to public health and community services costs, such as caregiving for more vulnerable populations. Indeed, further research within this wider study explores the influence of home modifications on caregiving directly and is pending publication.

HRQoL and home modification location

The mapping of where home modifications were carried out in the home indicates that the bathroom was the most common location at 78.3%, followed by general access modifications. This tells us that the design of bathrooms has a significant role to play in maintaining levels of independence and wellbeing in the houses of older people and those living with a disability. This is unsurprising on two levels; first the nature of personal self-care tasks such as toileting and washing are undertaken in the bathroom. Requiring care with these tasks can significantly impact the nature of relationships in the home. Therefore, maintaining or restoring independence in the bathroom not only restores the autonomy and ability of the person, but the care relationships in the home. This is reflected in the increase in utility dimensions of Independent Living and Relationships.

CONCLUSION

Implications of the research

Evidence from this research shows that home modifications have the potential to improve HRQoL scores by 40%. Taking into consideration the exploratory nature of the research and the possibility of recall bias in the self-reported results, the resulting data was found to be statistically significant and the results remain compelling.

The results for the utility dimension data highlight the role home modifications can play in influencing a number of different, yet overlapping wellbeing factors (independent living, mental

health, and relationships) that, when combined, result in significant improvements in Health-Related Quality of Life. There is supporting evidence for each of the overlapping factors, including independence (Gignac, Cott, and Badley, 2000; Pettersson et al, 2012).

The contribution that the results of this study make to an understanding of housing and health pathways are fourfold:

- It gathers primary housing and health data directly and concurrently, where previous evidence has tended to be populated by less direct housing and health associations, due to multi-factorial research, indirect health data, or estimated care data.
- It measures health from the perspective of the built housing domain, which is important for future cross-disciplinary policy making.
- Given the lifespan of buildings, it focuses on rehabilitation or improving buildings to bring about health improvements, as evidenced by the increase in HRQoL results following home modification.
- It provides a basis from which to understand the broader health consequences of regulatory and performance-based building codes relating to accessibility.

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AUTHORS

Phillippa Carnemolla
PhD, Research Associate
UNSW, Faculty of Built Environment
University of New South Wales, Sydney, NSW, Australia
Phillippa.carnemolla@unsw.edu.au

Catherine Bridge
Associate Professor
UNSW, Faculty of Built Environment
University of New South Wales, Sydney, NSW, Australia