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Original Article

Accessible design features and home modifications to improve physical housing accessibility: A mixed-methods survey of occupational therapists

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ABSTRACT

Background: Despite the number of older people and people with disabilities increasing in Australia, it is unclear which housing design features are needed to support physical housing accessibility for people with and without disabilities across the lifespan.
Objective: This study drew upon the experience of occupational therapists to investigate accessible housing design features and home modifications to support aging in place and discharge from hospital to home.
Methods: A cross-sectional online survey exploring housing design features and home modifications was completed by 144 Australian occupational therapists over six weeks in 2021. Descriptive quantitative and qualitative data analyses were used.
Results: For both aging in place and hospital discharge, the most important housing design features included step-free access to the dwelling, large step-free showers, and bathroom and bedroom space on the ground floor. Qualitative findings also highlighted the importance of preparing for home modifications, such as reinforcing bathroom walls to support the post-build installation of grab rails. The most frequently needed modifications were for bathroom features, while structural changes to the dwelling were the most time-intensive modifications, requiring more than six weeks to be completed.
Conclusions: External access to the home and internal access to bedroom and bathroom facilities can support aging in place and hospital discharge and mitigate the need for costly and time-intensive home modifications. While this study was conducted in Australia, the findings have relevance outside of this context, and are important for ensuring equitable accessibility for people with and without disabilities across the lifespan.

An estimated 4.4 million Australians in 2018 identified as having a disability, comprising almost 20% of the Australian population.[1] Of these, physical disorders are the most common disability type,[1] with nearly 2.9 million Australians reporting a mobility limitation.[2] Concerningly, the number of people living with mobility limitations is projected to almost double by 2060.[2] Similar projections have been reported in other countries like the United States of America, where one-quarter of households are estimated to contain at least one person with a mobility limitation by 2050.[3] The projected increase in the prevalence of disabilities is partly due to an aging population—the highest prevalence of disability in Australia is among people aged over 65[1] and this age group is expected to more than double by 2055.[4] Consequently, the demand for accessible housing that is suitable for people with and without disabilities across the lifespan will drastically increase over the next few decades.

The current mainstream housing supply is unlikely to meet this increased demand for accessible housing. Housing accessibility is generally defined as being inclusive of easy entry and exit to the home, easy navigation in and around the home and potential for

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easy adaptation over time in response to the needs of the occupants.[5,6] In the Australian context, housing accessibility is informed by the Livable Housing Australia (LHA) standards.[6] The current housing stock in Australia does not sufficiently meet these accessibility standards, with the homes of 74% of older people and people with mobility issues reportedly not meeting their accessibility needs.[7] Moreover, housing dissatisfaction and poor-quality housing are frequently reported concerns among people with disabilities.[8,9] The lack of accessible housing options is partly because volume builders in Australia do not systematically incorporate accessible design features, leaving buildings only partially accessible.[10] Concerns regarding a lack of physical housing accessibility have also been raised in other countries, including the United States of America,[11] Sweden,[12] and Japan.[13] Therefore, poor housing accessibility is an issue of global relevance, impacting the lives of people with disabilities and older people.

Home modifications to improve housing accessibility

Housing accessibility can be improved by modifying homes retrospectively. Home modifications involve changes to the physical structure and layout of the home, and are typically recommended by occupational therapists following a home assessment in which the safety and accessibility of the home environment are assessed.[14,15] Home assessments are conducted to support safe and timely discharge of people from hospital to home, as well as enable older people to safely remain in their own home as long as possible, defined as "aging in place." Previous research has established a positive impact of home modifications upon supporting hospital discharge and aging in place. Home modifications have been found to enhance the independence and occupational performance of people with disabilities and the elderly,[14,16] reducing formal and informal care needs by more than six hours per week.[17] Home modifications are also associated with a reduction in home falls[18] and may increase health-related quality of life of older people and people with disabilities by improving their independent living, mental health and relationships.[14] Unsurprisingly, modifying the homes of older people is associated with an increased ability to age in place.[19] Moreover, patients in an Australian rehabilitation unit have reported that home modifications recommended by occupational therapists improved their daily functioning post-discharge.[20]

While modifying homes post-construction is one approach to achieving accessible housing, a number of studies have identified the inefficiencies of home modifications. Given that many dwellings lack adaptability, post-construction home modifications are often expensive and fail to fully meet the accessibility needs of older people and people with disabilities, especially those with mobility limitations.[7] In addition, reliance on home modifications can impede timely hospital discharge. In a series of studies assessing delayed discharge from Australian hospitals, the need to wait for the completion of home modifications delayed discharge by a median number of 21–34 days.[21,22] This is concerning, given that delayed discharge can result in increased pressure on the hospital system[23] and may contribute to a deterioration in mobility and functional performance.[23,24] Despite these concerns, no studies in Australia have specifically explored which home modifications take the longest to complete, thereby contributing to hospital discharge delays.

Accessible housing design

A better approach to achieving housing accessibility may be to avoid the need for home modifications by incorporating accessible design features in the construction of new dwellings. To date, research regarding accessible design features has predominantly assessed *overall* housing accessibility, with a focus on the negative impacts of inaccessible housing. These studies have shown that inaccessible housing design can restrict the functional independence and performance of older people and people with disabilities in both everyday life tasks and occupational roles.[7,25,26] Moreover, overall housing inaccessibility can have negative health consequences, including reduced mental wellbeing[7] and health-related quality of life.[27] Although informative, there is a paucity of research investigating which specific design features are needed to make housing more accessible. In Australia, only one report has investigated the importance of specific housing features, identifying seven features considered most important to support aging in place.[28] Design features outside of an aging-in-place context have not yet been investigated; however, indirect evidence from home modification studies suggests that bathroom features hold particular importance, as they frequently need to be modified for people with disabilities.[14,17] Outside of Australia, a small number of studies in Europe have identified specific design features representing accessibility barriers for older people[12,29] and people with disabilities.[30,31] However, differences in building policies and housing stock limit the generalizability of these findings to Australian dwellings, highlighting the need for more research assessing both home modifications *and* accessible housing design in Australia.

The current study sought to examine physical housing accessibility in Australia for older people and people with disabilities from the perspective of occupational therapists. As occupational therapists frequently evaluate housing accessibility and recommend home modifications, they can provide valuable insights into housing accessibility.[32] The specific objectives of this study were to (1) evaluate the importance of specific accessible design features on supporting aging in place and hospital discharge; and (2) assess the frequency of home modification recommendations and the time taken to complete home modifications for aging in place and hospital discharge. A mixed-methods survey approach was used to explore accessible housing design from both a quantitative and qualitative perspective.

Methods

Procedure

A cross-sectional online survey (via QuestionPro) of Australian occupational therapists was conducted over a six week period in 2021. A full description of the research methods can be found in a report of the preliminary research findings.[33] The following provides a brief description of the procedure and survey tool. Participants were recruited via advertisements on social media and email distribution within occupational therapy networks. To be eligible, participants had to be occupational therapists working in Australia and conducting home visit assessments for hospital discharge and/or aging in place. The study was approved by the La Trobe University Human Research Ethics Committee (HEC21018). All survey responses were anonymous and no reimbursement was offered for participation.

Survey

The survey comprised three sections assessing (1) demographic and occupational information; (2) housing design features; and (3) home modifications. Questions regarding housing design features and home modifications were separated by aging in place and hospital discharge, and participants were instructed to only answer those questions relevant to their own work experience. Therefore, the number of questions completed by each participant varied.

The "housing design features" section of the survey included a list of 22 design features (Table 1) derived from the LHA standards.[6] While the study did not focus exclusively on accessibility for people with mobility issues, the 22 design features addressed physical accessibility as is consistent with the LHA standards. Participants rated the effect that each design feature has on enabling older Australians to safely age in place (from *0 = No effect* to *3 = Major effect*). For hospital discharge, participants were asked to rate how often the lack of the design feature delayed hospital discharge (from *0 = Never* to *3 = Nearly always*). Higher ratings indicated that the feature has a greater positive impact on supporting aging in place and timely hospital discharge. In addition, housing design features were evaluated through two open-ended questions, in which participants could identify and explain three changes they would make to the physical design of all future Australian homes to support aging in place and hospital discharge. This question provided an opportunity for respondents to think beyond the list of design features and provide additional descriptive information about their design choices.

The final section of the survey included a list of common home modifications. Participants were asked to indicate the frequency of recommending each home modification, drawing upon their professional experience over a typical six months. For hospital discharge, participants were also asked to report the average number of days it takes until these modifications are completed.

Data analyses

Descriptive quantitative analyses were conducted using *R* (version 4.0.3).[34] The importance of specific accessibility design features (Aim 1) was assessed by calculating the average rating for each design feature and subsequently ranking the features in descending order from the highest to lowest rating (*e.g.*, from the feature that would have the greatest positive impact to the least positive impact on supporting aging in place and hospital discharge). The second aim was assessed by calculating and ranking the average frequency and time taken to complete home modifications.

Open-ended questions were analyzed using descriptive qualitative methods,[35] providing additional insights into housing design changes considered most important by occupational therapists. Data from the open-ended survey questions was collated into two Excel spreadsheets; one spreadsheet for hospital discharge data and another spreadsheet for aging in place. Thematic analysis followed the six phases outlined by Braun and Clarke,[35] involving an iterative process of code generation, comparing, and contrasting codes, theme identification, review, and refinement. Patterns across the data were captured with color coding, while descriptions of the properties of the codes supported theme identification. Coding of all data was completed by one author (KD) with regular discussions and theme clarification with the first author (CW), ensuring consensus with the generated themes.

Results

Data handling

Data cleaning indicated that for each type of home modification, between three to seven participants reported that it takes zero days to complete the modification (n = 48 values across all home modification types). These responses were considered unrealistic and therefore not included in the data analyses. Given that the number of questions differed across participants, rather than estimating missing data, response rates were calculated to indicate the number of occupational therapists informing each outcome variable (see Table 2). These response rates are presented in ranges because not all participants provided responses for all design

Table 1
Design features evaluated in this study

Design Feature	Description
Step-free pathway to entrance	A safe, continuous, step-free pathway from the street entrance and/or parking area to a dwelling entrance that is level
Width of pathway to entrance	A pathway that is at least 1000 mm wide
Step-free entrance to residence	At least 1 step-free entrance into the dwelling and the entrance should be connected to the safe and continuous pathway as specified in feature 1
Entrance door width	A clear opening width of entry door of at least 850 mm
Transition height for different floor surfaces	A maximum transition/threshold height of abutting surfaces of 5 mm
Internal door widths	Widths of the internal doors enable comfortable and easy movement between spaces. Clear opening width of internal doors is 850 mm
Internal corridor widths	Internal corridors and passageways provide a minimum clear width of 1000 mm
Toilet on ground floor	The ground (or entry) level has a toilet to support easy access for home occupants and visitors
Space in front of toilet	The circulation space between front edge of the toilet and arc of door is at least 1200 mm
Closet toilet walls	Walls either side of the toilet are 900 mm or 1200 mm from the toilet
Toilet in bathroom located in corner	The toilet in a combined bathroom is located in the corner
Shower on ground floor	There is a shower on the ground (or entry) floor
Removable shower screen	The shower screen can be removed
Step-free shower entry	The shower is step-free or "hobless" entry
Shower size	The shower is at least 900 mm × 900 mm
Space adjacent to shower	The size of the space adjacent to showers is at least 900 mm × 900 mm
Reinforcement of bathroom and toilet walls	The toilet and bathroom walls are reinforced to enable future installation of grab rails
Internal stairways - no winders	Stairways feature no winders in lieu of landings, adjacent to a wall capable of supporting a handrail
Provision for future stair- climber or lift	Where sites have limited floor space at entry floor, precluding having amenity on entry floor, provision should be made for future fit out. This may be through the option of stairs suitable for fit out with a stair-climber or alternatively, provision for future fit out with a lift. These would need to be demonstrated on drawings to achieve compliance
Kitchen space	Clearance in front of fixed benches and appliances (excluding handles) in kitchen are at least 1200 mm
Ground (or entry) floor bedroom space	There is a space on the ground (or entry) floor that can be used as a bedroom. (Minimum size of 10m^2, excluding wardrobes, linings, etc. There is natural light and ventilation, a bed space of at least 1520 mm × 2030 mm, plus 1000 mm minimum path of travel
Slip-resistant flooring	Floor coverings are slip-resistant to reduce the likelihood of slips, trips and falls

Note. Design features were modified from the Livable Housing Australia (LHA) Guidelines.[32] See preliminary findings.[31]

Table 2
Number of occupational therapists informing key outcome variables

Cohort	Accessible design features	Home modifications	
		Frequency[a]	Time intensity[b]
Hospital discharge	46–56	42–52	19–39
Aging in place	93–100	85–94	–

Note. Numbers are presented in ranges because some participants provided responses for some but not all design features and home modifications (i.e., the number of responses differed for each design feature and home modification).

[a] Frequency refers to the frequency at which home modifications were recommended.

[b] Time intensity refers to the average number of days taken to complete modifications. The time intensity of home modifications was only assessed in the context of hospital discharge.

features and home modifications. Missing data were excluded from analyses. Visual inspection of univariate distributions and calculation of skew and kurtosis indicated that most variables approximated normal distributions.

Participant flow

A total of 265 occupational therapists attempted the survey. Of these, 34 were excluded as they did not conduct home visit assessments for hospital discharge and/or aging in place, and six were excluded as they were not working in Australia. In addition, 116 participants did not reach the final survey page to submit their responses. Initial ethics conditions required that only fully submitted responses could be analyzed; however, an ethics amendment allowed the analysis of 35 partially submitted responses. Therefore, the final sample included 144 occupational therapists. This exceeded our aim of at least 100 participants, which was estimated to equal approximately 1% of the relevant national occupational therapy workforce in 2019.[36]

Sample characteristics

The majority of participants were working in the publicly-funded hospital system ($n = 66$; 45.83%) and community health ($n = 47$; 32.64%). When asked about the type of home visit assessments they were conducting, most participants reported conducting home visit assessments for older people requiring additional support to remain in their own home ($n = 110$; 76.39%), followed by patients in rehabilitation units ($n = 51$; 35.42%) and other hospital units ($n = 28$; 19.44%). A smaller number of participants also reported conducting home visit assessments for younger people with disabilities ($n = 13$; 9.03%) and outpatients ($n = 10$; 6.94%). These numbers sum to more than the sample size because participants could conduct multiple types of home visit assessments.

The sample predominantly consisted of highly experienced occupational therapists, with most working as a senior ($n = 63$; 45.32%) or Grade 2 clinician ($n = 54$; 38.85%). A smaller proportion of survey respondents reported being a less experienced Grade 1 clinician ($n = 19$; 13.67%) or a new graduate ($n = 3$; 2.16%). Participants' work experience ranged from 1 to 40 years, with an average of 11.94 years ($SD = 8.88$), which is comparable to the average work experience of clinical occupational therapists in Australia ($M = 10.9$ years).[36] The age of the participants reflected the spread of age ranges captured in Australian national occupational therapist data,[37] with the most frequently reported age range being 25–34 years ($n = 66$, 47.48%). Representation across urban, regional and remote regions also reflected national data, with the majority of respondents working in metropolitan/urban/city regions ($n = 92$; 66.19%). A more detailed summary of sample characteristics can be found in D'Cruz et al. (2021).[33]

Accessible design features

Rankings of the design features, as reported in the quantitative data, are displayed in Table 3, with high ranks (i.e., high mean ratings) indicating that the design feature was considered to be important to support aging in place and hospital discharge. Quantitative rankings of the design features were similar across aging in place and hospital discharge. For both cohorts, the top seven features reflected external access to the home and internal access to bedroom and bathroom facilities. These included: a step-free pathway to the entrance, a step-free entrance to the residence, a shower size of at least 900 × 900 mm, a step-free shower entry, a shower on the ground floor, a toilet on the ground floor, and bedroom space on the ground floor.

Analysis of the open-ended questions revealed suggested changes across both aging in place and discharge planning, evidenced in three key themes. The themes included: 1) External access; 2) internal access; and 3) preparing for home modifications. See Table 4 for a summary of the three key themes and associated codes and participant quotes. The first two themes provided insights into accessible design features, while the third theme pertained more specifically to home modifications. Qualitative findings across each of the three themes aligned with the quantitative results.

Theme 1: External access was identified as a key recommendation across both aging in place and hospital discharge, and was inclusive of a step-free pathway and entrance to the home. In particular, participants reasoned that a step-free external entry enabled safe access to/from the home with use of walking devices such as a walking stick, frame or wheelchair. One participant shared, "*Most common issue is getting into the home safely with reduced balance, various walking aids or a wheelchair. This [step-free entrance] would enable nearly everyone to access the home and have a safe exit too.*" The absence of a step-free entrance was identified as a key barrier to hospital discharge for people using a walking device or the frail elderly. It was also recognized that a step-free entrance and pathway reduced falls risks, ensured safe exit from the home in an emergency and enabled easier access to the community. This was described by another participant in support of a step-free entrance, "*Flush entry at both or at least one access point - for safe and independent access, reduces cost for modifications, allows clients to remain at home, reduces falls risk, [and] enables access to community.*" More specific to aging in place, it was identified that the need for walking devices increases as people age, further emphasizing the importance of a step-free entrance to the home.

Theme 2: Internal access also emerged as a key recommendation for both aging in place and hospital discharge. While key features of internal access, as described in the open-ended questions, included ground floor bedroom and bathroom amenities, the most frequently recommended feature of internal access included a large step-free shower. Respondents emphasized the importance of a large step-free shower to accommodate equipment such as mobility devices and shower chairs, while also allowing space for support workers/carers, contributing to shower safety. One participant suggested, "*Level access shower recess with adequate room for showering equipment and a carer. This enables adequate care to be provided in the home by support workers. This also supports aging in place*." It was also recognized that in the absence of an accessible bathroom, people might be discharged home from hospital with no other option than to have a sponge bath, with potential impacts on safety, hygiene and mental wellbeing.

Table 3
Mean ratings, standard deviations, and ranks for individual design features (range 0–3)

Design Feature	Hospital discharge			Aging in place		
	Rank	M (SD)	95% CI	**Rank**	M (SD)	95% CI
Step-free entrance to residence	**1**	1.89 (0.96)	[1.63, 2.15]	**4**	2.41 (0.70)	[2.27, 2.55]
Step-free shower entry	**2**	1.76 (0.92)	[1.50, 2.02]	**1**	2.59 (0.67)	[2.46, 2.72]
Step-free pathway to entrance	**3**	1.61 (0.91)	[1.36, 1.85]	**5**	2.36 (0.72)	[2.22, 2.50]
Shower size	**4**	1.55 (0.92)	[1.29, 1.81]	**7**	2.28 (0.68)	[2.14, 2.42]
Shower on ground floor	**5**	1.48 (0.94)	[1.22, 1.74]	**3**	2.49 (0.79)	[2.34, 2.65]
Toilet on ground floor	**6**	1.40 (0.99)	[1.12, 1.67]	**2**	2.57 (0.76)	[2.41, 2.72]
Ground (or entry floor) bedroom space	**7**	1.35 (0.84)	[1.11, 1.60]	**6**	2.31 (0.75)	[2.16, 2.46]
Transition height for different surfaces	**8**	1.33 (0.92)	[1.08, 1.58]	**13**	1.87 (0.84)	[1.70, 2.04]
Space in front of toilet	**9**	1.25 (0.79)	[1.03, 1.47]	**11**	1.96 (0.74)	[1.81, 2.11]
Removable shower screen	**10**	1.24 (1.02)	[0.95, 1.53]	**12**	1.92 (0.80)	[1.76, 2.08]
Space adjacent to shower	**11**	1.21 (0.93)	[0.94, 1.49]	**15**	1.78 (0.80)	[1.62, 1.94]
Internal door widths	**12-14**	1.19 (0.78)	[0.97, 1.40]	**17**	1.68 (0.74)	[1.54, 1.83]
Reinforcement of bathroom and toilet walls	**12-14**	1.19 (0.96)	[0.91, 1.47]	**9**	2.09 (0.87)	[1.92, 2.27]
Slip-resistant flooring	**12-14**	1.19 (0.85)	[0.94, 1.44]	**8**	2.15 (0.78)	[1.99, 2.30]
Toilet in bathroom located in corner	**15**	1.16 (0.91)	[0.90, 1.42]	**18**	1.58 (0.74)	[1.43, 1.73]
Closet toilet walls	**16**	1.12 (0.99)	[0.84, 1.41]	**16**	1.73 (0.93)	[1.54, 1.92]
Entrance door width	**17**	1.02 (0.76)	[0.81, 1.22]	**19**	1.57 (0.72)	[1.42, 1.71]
Width of pathway to entrance	**18**	0.91 (0.70)	[0.72, 1.10]	**22**	1.40 (0.67)	[1.27, 1.54]
Internal corridor widths	**19**	0.90 (0.71)	[0.70, 1.10]	**20**	1.50 (0.82)	[1.33, 1.67]
Internal stairways - no winders	**20**	0.87 (0.81)	[0.63, 1.11]	**10**	2.03 (0.87)	[1.85, 2.21]
Provision for future stair-climber or lift	**21**	0.73 (0.70)	[0.53, 0.94]	**14**	1.86 (0.84)	[1.69, 2.03]
Kitchen space	**22**	0.67 (0.63)	[0.48, 0.85]	**21**	1.48 (0.74)	[1.33, 1.63]

Note. Higher ranks and higher means indicate that the design feature has a greater positive impact on supporting hospital discharge or aging in place. The design features are sorted by the ranks for hospital discharge. CI = confidence interval.

While ranked lower in the quantitative data, level access throughout the house and wider internal passageways/doorways were reported as important design features in the open-ended questions, especially for wheelchair users. This was captured by the following quote about the impacts of an internal home environment without level access. "*Poor access for wheelchair users or requires multiple internal ramps, requires changes to living arrangements e.g. having to move bedrooms which affects sense of self and social relationships, requires provision of multiple aids which 'hospitalizes' the look of home or can be expensive.*"

Home modifications to support hospital discharge and aging in place

Frequency of home modification recommendations

Average frequencies of recommending home modifications are displayed in Fig. 1. Overall, the frequencies were comparable across aging in place and hospital discharge. For both cohorts, the most frequent home modification recommendations were the installation of a grab rail in the shower and toilet, which were recommended to more than half of the occupational therapists' clients. Interestingly, both of these modifications appeared to be recommended slightly more frequently for aging in place (*M* for shower = 67%; *M* for toilet = 61%) than hospital discharge (*M* for shower = 57%; *M* for toilet = 54%). Consistently, qualitative data in the context of supporting aging in place showed an increased emphasis upon safe installation of grab rails in the bathroom with reinforced walls and more uniform placement of wall studs.

Other common recommendations included the installation of a shower curtain, step-free shower, and handrail at the entrance to the home, as well as the removal of a shower screen. These modifications were, on average, recommended to more than one-quarter of clients in both cohorts. A notable exception was the installation of a ramp for 1–2 steps, which was more frequently recommended

Table 4
Thematic analysis of qualitative survey responses

Themes	Codes	Participant quotes (hospital discharge & aging in place)
1: External access (getting in/out of home)	Step-free pathway and entrance to home	*Many patients are unable to use steps post hospital admission and therefore stay in hospital longer to either progress to a level where they can do steps or until a ramp is built so that they can access their home*
2: Internal access (moving around home)	Step-free shower entry and circulation space	*This [step-free shower entry] would reduce falls risk and increase patient independence with accessing showers. Patients are commonly fearful of entering the shower over a hob/into a recess and this would improve safety*
	Wider internal corridors and doors	*Often we can get people home but they have to remain in one room due to door width issues*
	Higher toilets with circulation space	*Recommend standard toilet height to be higher - 95% of my clients cannot sit/stand transfer from the 'standard' low toilet seat and require either bilateral grab rails, a toilet seat raiser or over toilet frame to be added. Many clients on pensions cannot afford modifications or equipment*
	Level access throughout home	*[Recommend] no internal steps and level floor surfaces within the home to limit falls risk*
	Upstairs/downstairs bathroom and bedroom options	*[Upstairs/downstairs bathroom and bedroom options] would reduce the need for patients to purchase/hire additional equipment and retain dignity for those who live with others (not having to sponge wash in a laundry, kitchen etc.)*
		Older people can stay in their own home longer if they have a bedroom and bathroom downstairs and can avoid having to go upstairs
3: Preparing for modifications	Reinforced walls/ceilings for rail installation	*[Recommend] bathroom and toilet walls be reinforced to allow installation of grab rails at any point. Having to install grab rails into studs results in restrictions to accessing the best location for the user*
	Policies and systems	*There needs to be a shift in focus towards building smart, not quantity*

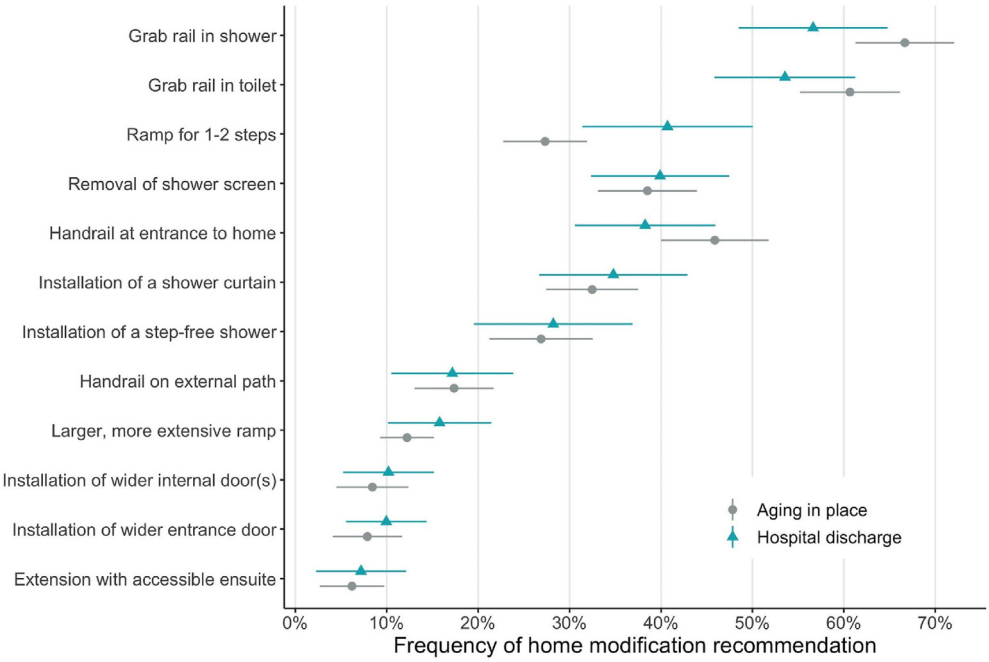

Fig. 1. Means and 95% confidence intervals of the frequencies of home modification recommendations for hospital discharge and aging in place. Home modifications are ordered from the most frequent to least frequent home modification recommendation for hospital discharge.

for hospital discharge (M = 41%) compared to aging in place (M = 27%).

Time intensity of home modifications

Refer to Table 5 for the average time required to complete home modifications. The most time-intensive modifications included structural changes to the dwelling, such as an extension with an accessible ensuite and the installation of a wider entrance door, internal door(s), step-free shower, and larger more extensive ramps. These modifications were reported to take on average more than six weeks to be completed. This finding is supported by qualitative analysis of the open-ended responses in which occupational therapists raised concerns about substantial delays to hospital discharge when waiting for ramp installation to compensate for the lack of a step-free entrance to the home. This concern is captured in the following quote, "*Many patients are unable to use steps post hospital admission and therefore stay in hospital longer to either progress to a level where they can do steps or until a ramp is built so that they can access their home.*" Similar concerns were raised in relation to discharge delays waiting for the installation of a step-free shower.

Even the least time-intensive modifications required, on average, between one to two weeks to be completed (see Table 5). These modifications included the installation of a handrail at the entrance to the home and grab rails in the toilet and shower. This finding is best considered in the context of the high frequency in which the installation of grab rails by the shower, toilet, and entrance to the home is recommended by occupational therapists, as reported earlier. Furthermore, the qualitative data captured in **Theme 3: Preparing for home modifications** reflected concerns raised by participants about barriers to timely modification of homes post-build. This theme was evident across both hospital discharge and aging in place. Respondents suggested more efficient grab rail installation with pre-installed reinforced walls and metal plumbing pipes, and pre-installed reinforced ceilings to aid hoist installation. For example, "*More reinforcement of housing structure e.g. studs, trusses and jibs for load-bearing with ceiling hoists and grab rails.*" Policy and system changes were also suggested to support a more efficient and equitable provision of funding.

Table 5
Average time (in days) to complete home modifications, ranked from the most time intensive to the least time intensive home modification

Home Modification	Mean (*SD*)	95% CI
Extension with accessible ensuite	64.47 (44.78)	[42.89, 86.06]
Installation of wider internal door(s)	55.50 (45.98)	[35.12, 75.88]
Installation of wider entrance door	53.10 (45.03)	[32.60, 73.59]
Installation of a step-free shower	52.65 (31.72)	[39.84, 65.47]
Larger, more extensive ramp	44.70 (28.68)	[34.36, 55.04]
Ramp for 1–2 steps	20.60 (16.02)	[15.18, 26.02]
Installation of a shower curtain	16.55 (15.03)	[11.22, 21.87]
Handrail on external path	15.83 (11.59)	[11.51, 20.16]
Removal of shower screen	15.77 (14.44)	[11.09, 20.45]
Handrail at entrance to home	13.27 (11.76)	[9.23, 17.31]
Grab rail in toilet	12.87 (11.48)	[9.15, 16.59]
Grab rail in shower	12.46 (11.13)	[8.85, 16.07]

Note: CI = Confidence interval.

Discussion

To our knowledge, this is the first study to explore specific design features to support physical housing accessibility in Australia from the perspective of occupational therapists. Occupational therapists conduct home assessments and have specialist knowledge of the impact of the physical home environment upon the participation of people in their everyday lives. Qualitative and quantitative results emphasized the importance of external access to the home and internal access to bedroom and bathroom facilities, with remarkable consistency across hospital discharge and aging in place. Findings also indicated the inefficiencies of relying on home modifications instead of including accessible design features during the design stage of mainstream housing stock.

As captured in both quantitative and qualitative data, level access to the home was identified to be of key importance in the

context of aging in place and hospital discharge. More specifically, respondents suggested the inclusion of at least one step-free entrance to the home with a level pathway to the entrance. This was further reinforced by the finding that, in the absence of a step-free entrance to the home, ramps for 1–2 steps are frequently recommended by occupational therapists at the time of hospital discharge. Previous studies on accessible design elements conducted in Europe[12,29–31] and Australia[28] have also highlighted the importance of level access to the home. Collectively, this reinforces that level home entrances represent a globally needed housing accessibility feature.

A key strength of this study was the addition of qualitative responses that provided insights into occupational therapists' reasoning underpinning their accessible design recommendations. In terms of level home access, respondents frequently cited the importance of being able to safely and independently exit the home in the event of an emergency, as well as enabling everyday access to the community. This finding supports previous evidence that has highlighted the negative impacts of social isolation as a consequence of inaccessible housing.[7,14] Furthermore, respondents in the current study emphasized the universal applicability of a level entrance to the home for wheelchair users, people using walking devices, the frail elderly, and people with reduced balance or visual impairment.

Quantitative and qualitative findings also highlighted the importance of internal housing accessibility, with a focus on bathroom features. Specifically, large step-free showers and bathrooms on the ground floor were suggested to support aging in place and hospital discharge. This is consistent with the only previous study that has investigated specific accessible design features in Australia, which has also highlighted the importance of step-free showers for older adults across a range of care needs, including physical, social and cognitive.[28] Incorporating these accessible bathroom features during the design of new dwellings may minimize the need for potentially inefficient bathroom modifications at a later date. Indeed, a retrospective installation of step-free showers was found to be one of the most time-intensive home modifications. Moreover, the most frequent home modification recommendations identified in this study were for bathroom features, aligning with previous home modification research in Australia.[14,17] More specifically, in the current study, the installation of grab rails in the bathroom was reported to be the most commonly needed home modification. This is particularly concerning given that bathroom walls are often not reinforced, making a retrospective installation of grab rails more difficult.[7] A lack of grabrails in bathrooms has also been identified as a key accessibility barrier in Europe, highlighting the global relevance of this feature.[12,30] The need for bathroom grabrails could potentially be avoided if dwellings were built with large step-free showers, further highlighting the importance of including this feature in the design of new builds.

Findings regarding the time needed to complete home modifications also highlighted the inefficiencies of modifying mainstream housing stock in lieu of designing dwellings to accessibility standards. In the current study, all home modification types were reported to take at least 10 days to be completed, with several taking more than a month. This can have negative knock-on effects, including delays to hospital discharge[21,22] and deterioration in functional performance.[23,24]

While considering the implications of this study, it is encouraging to note that recent changes to Australia's National Construction Code (NCC) in April 2021 mean that several of the design features identified in this study will be included as minimum accessibility standards in new dwellings. Among other features, new dwellings will need to incorporate a level access to the residence, a toilet on the ground floor, a step-free shower and reinforced bathroom walls starting from 2022.[38] Although changes to the NCC are a significant step forward, three jurisdictions (New South Wales, Western Australia, and South Australia) have indicated their intention to opt out of the minimum accessibility standards. The findings of this study may encourage these jurisdictions to consider adopting accessibility standards. The proposed accessible design changes to housing stock are expected to improve housing accessibility for people across the lifespan, inclusive of people with and without disability. The change in policy also offers new possibilities for future research to evaluate the impact of mandated accessibility design features on hospital discharge and aging in place. The impact and learnings from these policy changes, particularly around level home entrances and accessible bathrooms, may also be applicable to other countries, where accessible design features are often not yet mandatory.[13]

Limitations

It is important to consider that the current study was exploratory due to the lack of previous accessible design research in Australia. Statistically speaking, findings of this study do not indicate whether specific design features are *significantly* more important than others, nor do they directly indicate their effect size on supporting hospital discharge and aging in place. The large standard deviations of most variables also indicate a considerable degree of uncertainty in our estimates. This large variability may be attributable to asking respondents to broadly draw upon their professional experience rather than referring to specific care needs or hospital settings. Nevertheless, findings of this study build an important foundation for future research to investigate the importance of design features with a-priori hypotheses.

While the current study investigated accessibility from the perspective of physical housing design, it is acknowledged that accessibility needs may differ across people with different disability types and care needs.[39] More specifically, the LHA guidelines that informed the design features in this study focus predominantly on physical housing accessibility aspects that are difficult to retrofit, such as door widths and the physical layout of bathrooms. Though beneficial to support certain care needs, features that can be more easily adapted retrospectively (i.e., changes to lightning or smart home technology) were not evaluated. Furthermore, it should be noted that the current research focused on the experience of occupational therapists conducting home visits for hospital discharge and/or aging in place. As such, the accessibility design features identified in this study should not be interpreted as being sufficient for *all* older people and people with disabilities. Instead, they are minimum standards that will likely benefit a large proportion of the population. Future research incorporating a broader inclusion of home visit contexts and housing features will provide additional insights into the accessibility needs of different populations.

Conclusion and implications

By seeking the expertise of occupational therapists, the findings of this study provide valuable insights into the most important design features to support housing accessibility. Furthermore, inefficiencies of modifying homes in the absence of accessible design have been revealed, emphasizing the importance of ensuring internal and external accessibility when designing new dwellings. While this study has immediate relevance to recent policy changes in the Australian housing context, the findings have the potential for broader application to the global aim of improved housing accessibility for all people across the lifetime, with and without disability.

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Presentation

D'Cruz, K., Winkler, D., Douglas, J., Goodwin, I., Wellecke, C., Mulherin, P. & Davis, E. (2021, Jul 28-30) *Making housing more accessible: Perspectives of people with physical impairment, occupational therapists and architects* [Oral presentation]. 2021 Virtual World Congress on Brain Injury.

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Conflicts of interest

The authors have no conflict of interest to disclose. The research project was funded by the Summer Foundation.

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