

The potential impact of design changes for independent living in old age

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D. Seidel, K. Richardson, C. Jagger, C. Brayne, P.J. Clarkson. The potential impact of design changes for independent living in old age. Gerontechnology 2010; 9(1):56-61; doi:10.4017/gt.2010.09.01.006.00 We attempted to quantify the potential impact of design changes on the ability of older people to live independently, as defined by the performance of instrumental activities of daily living. Data from the Disability Follow-Up Survey were obtained for analysis, which recruited a sample of 3,710 participants aged 65 years or over from Great Britain. Participants completed a comprehensive interview on functional status in 1996/97. Adjusted attributable fractions were estimated from logistic regression models. Between 43% and 64% of the difficulties with instrumental activities of daily living were attributable to motor limitations. Activities performed outside the home (shopping) had less potential for improvement than activities performed within the home (cooking, housework, and laundering). The attributable fractions were greatest for housework in men and for cooking in women. Our estimates shed light on the potential impact of design changes on the ability of older people to perform activities necessary for independent living, and they are in line with what we expected to find based on the literature. Research on design and independent living in old age should be encouraged and expanded.

Keywords: ageing in place, task environment, activity demand, motor ability

Of particular concern with regards to population ageing are the economic and social costs of disability. Innovative approaches are needed to help older people live independently for as long as possible. The environment in which activities necessary for independent living are performed (for instance, cooking and shopping) and the products used in this context play an important role in the disablement process¹. It is

widely recognized by occupational therapy and rehabilitation research that redesigning the task environment to reduce the demands associated with daily activities can improve quality of life, while at the same time reducing long-term care costs. This is because older people allocate much of their time to the performance of daily activities², and the ability to perform them is closely related to the use of care services³.

Population-based studies suggest that declines in disability over time at least partially reflect improvements in the environment that make it easier to perform daily activities⁴. A comprehensive literature review⁵ examined the empirical evidence on home modifications and disability-related outcomes (mobility, instrumental and basic activities of daily living). Ten randomized controlled trials were identified by the review, five of which supported that redesigning the environment enhances functional ability. Rogers et al.⁶ assessed constraints on daily living tasks among older adults in a focus group analysis. A coding scheme was used to determine whether a specific problem was correctable or not. Half of the problems were classified as being correctable by design changes, training, or some combination of the two; the other half was classified as being uncorrectable due to fatigue or severe conditions such as stroke.

The evidence suggests that design changes in the environment can narrow the gap between individual function and activity demand in later life. More specifically, it is possible that at least 50% of the difficulties older people encounter with daily activities can be corrected. In order to investigate this, we obtained data from a survey of older people in Great Britain that assessed functional status at a high level of specificity. Independent variables were selected based on a task analysis of daily activities in older people⁷, which specified the motor demands associated with cooking, housework, laundering, and shopping. We then estimated the degree to which performance could potentially be improved by design changes based on the premise that all motor limitations are correctable. The activities studied here are necessary for independence in the community⁸, although it is acknowledged that independent living is likely to require much more.

METHODS

Survey

Data from the Disability Follow-Up Survey (DFS) were obtained for analysis, which is described in detail elsewhere⁹. The DFS was

conducted in Great Britain between July 1996 and March 1997 to estimate the severity of disability among the community-living adult population. An initial survey was conducted to identify individuals with a possible disability who met eligibility for the DFS. More than 7,000 interviews were completed over the field period (response rate: 83%).

Variables

The participants were asked a set of binary questions (yes/no) about whether they had difficulty preparing a hot meal, using a vacuum cleaner to clean the floor, washing clothes or bed linen, and doing the household shopping on their own. Clark et al.⁷ found that the following motor functions are involved in cooking, housework, laundering, and shopping: (i) standing, (ii) bending/stooping, (iii) reaching, (iv) lifting, (v) holding, (vi) pushing, and (vii) finger grip. The DFS assessed motor ability by difficulty (i) standing, (ii) bending down and straightening up again, (iii) reaching in different directions (front/side/head/back), (iv) picking up a pint of milk, (v) holding a mug of tea or coffee, (vi) squeezing water from a sponge, and (vii) turning a tap or control knobs of a cooker (variables involving arms/hands were assessed for the dominant arm/hand). A binary variable was generated to indicate whether or not participants were limited in their motor ability.

Analysis

We calculated attributable fractions (AFs) and 95% confidence intervals (CIs) from adjusted logistic regression models to estimate the degree to which difficulties with cooking, housework, laundering, and shopping were due to limitations in motor ability. The logistic regression models were adjusted for age, gender, and the number of chronic conditions; in a sub-analysis, we also adjusted for the presence of problems with vision, hearing, and cognition. Logistic regression compares the odds of difficulty between individuals with motor limitations and those without limitations, and gives no account of the prevalence in the sample. We used

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Table 1. Sample characteristics; n = 3,710

Characteristic	n	%
Age, years		
65-74	1,256	34
75-79	1,221	33
80+	1,233	33
Gender		
Women	2,125	57
Men	1,585	43
Chronic conditions		
0-1	1,897	51
≥2	1,813	49
Motor limitations		
Yes	1,995	54
No	1,715	46

AFs to assess the potential impact of design changes by considering not only the individual associations with the variables of interest, but also their prevalence in the sample. The AFs incorporate both the odds ratio and prevalence of motor limitations to estimate the proportion of individuals with instrumental activities of daily living (IADL) difficulties, assuming causality, that are due to motor limitations. AFs are calculated as the difference between the overall risk of IADL difficulty and the risk in those without limitations, expressed as a percentage of the overall risk¹⁰. We investigated gender dif-

ferences by running the regression models separately for men and women. STATA was used to run the regressions, and the package *aflogit*¹¹ to calculate the AFs.

RESULTS

There were 3,710 participants with complete data for all of the variables considered (Table 1). The sample had a mean age of 77 years (range: 65-100 years), and contained fewer men than women. More than half reported to have none or one chronic condition and at least one motor limitation (men 47% vs. women 58%).

Difficulty with shopping was most frequently reported, then housework, laundering, and cooking (Table 2). Men and women were similar in terms of cooking and laundering difficulty, but housework and shopping difficulty were more common among women. Participants with limited motor ability reported much higher levels of difficulty than their counterparts with full motor ability.

In the multivariable logistic regression models, 64% of the difficulty with cooking was attributable to motor limitations, 61% of the difficulty with housework, 59% of the difficulty with laundering, and 43% of the difficulty with shopping. Among men, limita-

Table 2. Difficulty with daily activities by gender and motor limitations; n=3,710

Activity	Overall		Gender				Motor limitation			
			Men		Women		Men		Woman	
	n	%	n	%	n	%	n	%	n	%
Cooking	526	14	221	14	305	14	465	23	61	4
Housework	1,018	27	300	19	718	34	898	45	120	7
Laundering	736	20	292	18	444	21	638	32	98	6
Shopping	1,453	39	444	28	1,009	48	1,196	60	257	15

Table 3. Attributable fractions and 95% confidence intervals for difficulty with daily activities in relation to motor limitation; n = 3,710; AF=Attributable Fraction; CI=Confidence Interval

Activity	Overall		Men		Women	
	AF	95% CI	AF	95% CI	AF	95% CI
Cooking	64.1	54.8-71.5	57.0	42.9-67.6	72.2	58.7-81.3
Housework	61.3	54.9-66.8	70.7	60.6-78.2	56.0	47.5-63.1
Laundering	59.4	51.6-65.9	58.2	46.6-67.2	60.3	48.9-69.1
Shopping	42.7	37.4-47.5	47.5	38.2-55.4	40.7	34.2-46.6

tions in motor ability accounted for 57% of cooking difficulty, 71% of housework difficulty, 58% of laundering difficulty, and 48% of shopping difficulty. Among women, limitations in motor ability accounted for 72% of cooking difficulty, 56% of housework difficulty, 60% of laundering difficulty, and 41% of shopping difficulty (*Table 3*).

DISCUSSION

In this survey of older people in Great Britain, more than 50% of the difficulties with activities necessary for independence in the community were attributable to motor limitations. Thus, based on the premise that the limitations can be fully corrected by design changes, it may be possible to enhance independent living accordingly. Previous research has suggested that this may be achieved through design solutions that assist strength and balance, reduce the need to bend down, avoid requiring reaching above head level, reduce the need to reach below waist level, facilitate the grasping of objects and the manipulation of controls¹². For example, even the healthiest older adults experience significant performance declines at around 75 years¹³. Many individuals will first lose their locomotion and reaching abilities, causing them difficulty to bend down and reach overhead shelves. Using storage pedestals and lowering shelves could reduce demand and help overcome the difficulty¹². The results indicate the degree to which an activity can be improved if motor limitations are removed from the population. As this is unlikely to be achieved in practice, the results should be viewed as a theoretical maximum.

Shopping, the only activity performed outside the home, had less potential for improvement (43%) than activities performed within the home (59-64%), suggesting that other factors are involved. A study investigating patterns of functional decline among older non-disabled people in the community¹² found that disability in shopping occurs first, even before the loss of the ability to move around in the environment. Shopping may consequently require not only

maximum functional ability, but could be dependent on factors relevant to the experience. For example, older people prefer shops that are easy to enter and move around in, which are spacious without being too large¹⁴. Online shopping has been proposed as a solution, yet the ability to shop for groceries provides a feeling of control over the environment¹⁵, and at present only a small proportion of older people have access to the internet¹⁶. It may be that practical, immediate solutions related to the environment inside the home can be done more quickly and within existing budgets.

Men and women in our sample reported similar levels of difficulty in terms of cooking and laundering, while men reported fewer difficulties with housework and shopping. This could be due to gender differences in the amount of housework or shopping performed. A study² examining time use data has reported that older men spend around 20 hours per week on housework and older women around 30 hours per week. Alternatively, men could have less difficulty because of greater physical strength; older women have been reported to have around 60% of the strength of men¹⁷. However, data on time use and strength were not available in our study. Our results suggest that older men and women may benefit differently from interventions. While both could benefit equally in terms of laundering and shopping, the potential to reduce difficulty would be greatest for housework among men (71%) and for cooking among women (72%). This is not to suggest that only men or only women need be taken into account when designing products, but the potential to reduce difficulty varies.

Apart from motor ability, sensory ability is also required for interaction with products and services (for instance, seeing objects, differentiating surfaces, and discriminating sounds); motor and sensory functions are controlled by the brain and therefore demand cognitive ability (for instance, making decisions and responding to information). Although people use a range of abilities

to perform activities, it is primarily motor ability that is involved in the activities studied here¹⁸, which have been referred to as 'physical IADLs'¹⁹. In the sub-analysis to adjust for the presence of problems with vision, hearing, and cognition each of the variables was associated with IADL difficulty, but the AFs for motor limitation were only slightly attenuated (that is to say, the results can be assumed to be independent of sensory and cognitive problems). The activities handling finances, managing medications, and using the telephone have been referred to as 'cognitive IADLs'¹⁹, and future work should aim to investigate the potential impact of design changes for these. For example, a decrease in difficulty with handling finances among older people in the United States is deemed to be due to the introduction of a direct deposit system²⁰.

Our study has several drawbacks: the results are based on cross-sectional data and no causal interpretation is possible; the survey from which data were obtained for analysis was conducted over 10 years ago; and there could have been selection bias. Although the measures were binary and self-reported by the respondents, asking older people "Do you have difficulty..." has been found to accurately measure actual performance in the home surroundings²¹. Despite any limitations, the estimates still shed light on the potential impact of design changes on the ability of older people to perform activities necessary for independent living. Furthermore, they are in line with findings that half of the difficulties older people encounter with daily activities can be corrected⁶.

In their review, Wahl et al.⁵ defined home modification as any effort to improve the physical setting of the house or apartment and its immediate surroundings. This resulted in a wide variation of modifications

whose specific role was difficult to determine. It could be derived, however, that the likelihood of supportive findings was generally higher for intense and skilled interventions. That is, studies targeting one aspect of the home environment (for instance, improving the kitchen) and a disability area closely related to this aspect (for instance, difficulty with cooking) had a higher impact than more diffuse interventions. Rogers et al.⁶ similarly concluded that while there is potential for design, it is difficult to know what solutions should look like. General recommendations can be made to address capability losses as people age, but field research will always be needed to examine the effectiveness of specific modifications and to learn how older people adapt to the environment. We are currently planning a user observation study in a living laboratory research apartment with several inclusive design features, including modular work surfaces and shelves on railings for electronic operation.

Much of the research to date has been valuable in understanding the link between aging and disability, focusing primarily on the characteristics of the individual. Less attention has been paid to the environment and the products used in this context. Research on design and independent living in old age should be encouraged and expanded, taking also synergistic effects into account such as the contribution of regular hot meals to daily energy intake²², gains in self-rated health associated with the performance of certain activities²³, and exercise and social contacts through shopping¹⁴. Currently, inclusive design is not considered as an important factor by many designers²⁴. Educating policymakers about the potential impact of design changes may contribute to the development of frameworks that create incentives to design environments and products with older people in mind.

Acknowledgements

The first author is supported by a grant from the Engineering and Physical Sciences Research Council.

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