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The Use and Appraisal of Home Modifications by Older Adults

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Abstract

Background: Good habits and appropriate ergonomic design, including personalized home modifications, contribute to human safety and function. However, professionals face challenges to convince people to change their environment and habits and to measure the outcomes of interventions.

Purposes of the study: a) to assess use of and satisfaction with home modifications by older adult users; b) to examine outcomes that explain the older adults' appraisal of their home modifications.

Methods: One year after the conclusion of a home modifications program, an occupational therapist assessed older adults (N=47; aged 62-89 years) by means of questionnaires (FES; UCHM; UIMH) and observational assessments (MMSE; SAFER HOME; Kettle Test).

Results: The installed home modifications were widely used and user satisfaction was moderate. The study found no correlation between the number of falls in the home and whether the participant considered that the modified home suits his or her needs. However, the greater the participants' fear of falling was, the greater the perceived contribution of home modifications to their safe functioning. Two regression models showed that more than a third of the variance in the perceived contribution of home modifications was explained by a cognitive test, certain aspects of mobility, and by a positive answer to a general query as to whether the modified home was suitable. Conclusion: People who are aware of a decline in their functioning (e.g., cognitive functioning or mobility) are more willing to change their habits and use home modifications. Incorporating assessments of the cognitive, emotional, and mobility domains and discussing their implications with clients and with their significant others can improve the use of home modifications by older adults and their satisfaction with them.

Key Words: Home adaptations; Assistive devices; Fear of falling; Usability of home; Safety

Abbreviation: FES: The Falls Efficacy Scale; ICC: Interclass Correlation Coefficient; MMSE: The Mini-Mental State Examination; OT: Occupational Therapy; UCHM: The Use and Contribution of Home Modifications Questionnaire; UIMH: The Usability in My Home Questionnaire

Introduction

A review of recent development and events led by the Society of Human Factors and Ergonomics with respect to aging [1] claimed that this expertise is not very popular. However, it emphasized the emerging needs and the potential contribution of the multidisciplinary ergonomic field to a few topics. Many of these age-related topics are still relevant worldwide: gaining a theoretical understanding of changes during aging that interact with rapid environmental and technological changes [2-5]; the aging workforce [6,7]; aging drivers [8]; fall prevention programs [9-11]; developing accessible leisure activities; and housing design and modifications adapted to changes in family needs along the lifespan [12-14].

In recent years, a consensus has developed that adapting environments and technologies so that they will be well suited to the older person living in or using them can bridge and overcome declined capabilities and enhance independence and active aging in place [15-18]. The most frequently-mentioned environmental changes for elderly people aim to reducing their risk of falls [13]. Falls are experienced on average once a year by over a third of adults aged 65 years and older, while half of people in this age group experience a sequence of several falls [19,20].

Many countries have established programs to evaluate what home modifications older adults require and to counsel them in the benefits of using them [16,21]. Simultaneously, most countries have also established standards for safety devices and other home modifications (e.g., the Canadian Standards Association (CSA) and the U.S Uniform Federal Accessibility Standards configuration). Most home modification programs place an emphasis on providing and installing assistive devices to facilitate independent and safe transfers and daily activities by older adults [22], as transfers and daily activities are considered very basic functions which, when performed safely, promote active aging and well-being and reduce risks to home care workers [13]. Nevertheless, there is little evidence that such standards and programs meet the functional capabilities and satisfaction of older adults [23,24]. Furthermore, the perceptions of users of home modification should be considered, given studies that show limited compliance with preventive programs intended to change the habits and environment of older adults, especially among the comparatively healthy and younger group, aged around 65-75 years [24]. In practice, home modification should be viewed as a process (rather than as a discrete event). Thus, achieving better aging in place requires that health professionals avoid the limited response of prescribing generic modifications in response to a medical diagnosis and instead undertake a comprehensive assessment of occupational functioning in daily activities, including an ergonomic evaluation of the context in which the activities take place (the home) [16,21].

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The home modification process is mostly important in light of the correlations found between independence in daily self-care activities, well-being, and self-efficacy [25]. Many self-care activities occur in the bathroom and toilet, yet such activities are highly physically demanding and risky in old age. Activities of personal care in the bathroom and toilet are highly physically demanding and risky: 55% of bathroom falls experienced by community-living older adults were associated with bathing, and of these 70% were related to unsuccessful transfers [10]. In the bathroom, the challenging movements required to undertake a successful transition combine with slow reactions, poor balance, and difficulty with flexible weight bearing. The environmental risks are hard, wet, soapy, and slippery surfaces in an intimate and therefore isolated room [24,26]. The challenges associated in these intimate and risky environments may also evoke emotions and dilemmas, sometimes intensified by dependency on care-givers [13].

Ambivalence regarding the installation and use of assistive devices has been demonstrated in studies that combined questionnaires about older adults' attitudes and perceptions with the analysis of video captures of their behavior while simulating actual use of different configurations of grab bars in a bathtub [24,26]. Thus, although all but one of the 103 participants were observed using the grab bars, many more participants claimed that they do not use them because they perceive them as awkward to use or unsafe [24].

The later study [24] demonstrated that existing bathroom grab bars were used effectively but not consciously, while a later study [26] demonstrated that, immediately after experiencing a specific fear of falling during an experiment (which evoked a balance perturbation), participants expressed their wish to purchase bathroom safety devices, such as grab bars. However, a follow-up investigation revealed that, irrespective of falls history, only 9.1% of the participants actually made the purchase [26].

The differences may be explained by the cognitive–emotional fear of falling. As documented by the literature, a fear of falling predisposes older adults to refrain from activities they are still capable of performing [27-29]. This results in decreased activity that in turn contributes to deterioration in their overall health condition, weakness, irregular walking patterns, and reduced functions, all of which further increase the risk of falls [30-32].

Given the complex picture reflected in the literature, and as experienced occupational therapists assess the need for home modifications and recommend specific changes, we asked three questions. What are the characteristics of older people who are open to and can benefit from home modifications [11]; what are the best outcomes to measure [33,34]; and, what is the most effective process improve uptake and actual usage of home modifications in the face of user ambivalence towards them [30,35].

In this context, the specific purposes of the current study were: a) to assess use of and satisfaction with the previously-installed home adaptations; b) to examine a combination of self-reported and observational outcomes that may be beneficial to measure and explain the older adults use and appraisal of home modifications.

Materials and Methods

Home modification program

This is a follow-up retrospective study that examined an 'aging in place' program operated in a peripheral city. The program was designed to prevent falls among elderly adults and included a functional assessment (undertaken by a multidisciplinary team), physical exercises at home (led by a physical therapist), and supervision of home modifications (by occupational therapists). The program was funded by the Ministry of Health and managed by a non-governmental organization.

Description of the population

Inclusion criteria were the first 50 older adults who could be recruited by and from an earlier fall-prevention program, who resided independently in the community, and who had home modifications installed in their home. Exclusion criteria were requiring 24 h continuous care, and lacking the cognitive capacity to understand the study questionnaires as determined by the Mini-Mental State Examination (i.e., scoring more than two standard deviations below-average on the Mini-Mental assessment; described below in the instruments section). Among eighty-two individuals who met the preliminary inclusion criteria, 50 (60.2%) were willing to participate and three were excluded due to a low Mini-Metal score. The 47 participants (Table 1) had a mean age of 77.4 years (SD=6.5; range, 62-89 years) and an average of 11.3 years of education (SD=6.25).

Variables and instruments

Following a consent procedure, an experienced occupational therapist undertook home visits during which she presented participants with a demographic questionnaire (which also covered health status and falls), three questionnaires, and two observational assessments (described below).

A). The Use and Contribution of Home Modifications (UCHM) Questionnaire was written for this study by the authors to examine the first four variables that represent the appraisal of the home modifications to the older adults daily function: (1) Use and satisfaction (7 items): participants stated which home modifications and assistive devices they had purchased and installed, how frequently they use each of them (on a scale from 1 to 5), and their degree of satisfaction

Characteristic	Criterion	Number	Percentage
Gender	Male	6	13
	Female	41	87
Family status	Married	14	30
	Widowed	24	51
	Divorced	5	11
	Single	4	8
Living arrangement	Lives alone	29	61.7
	Lives with partner/spouse	18	38.3
Country of birth	Israel	6	13
	Former-USSR	13	28
	Asia/Africa	11	23
	Europe	12	26
	Other	5	10
Socio-economic status	Low	11	23
	Moderate	36	77
Residence	Multi-story building without elevator	33	72.2
	Multi-story with elevator	2	4.2
	Ground floor	12	25.5
Health status	Moderate, bad and very bad	38	80.8
	Good and very good	2	19.2
Mood	Moderate, bad and very bad	27	57.4
	Good and very good	20	19.2

Table 1: Demographic characteristics of the sample.

with each item (on a scale from 1 to 5). (2) Contribution of home modifications (9 items): participants stated the degree of independence and safe function (on a scale from 1 to 5) that they achieved using home modifications in performing daily activities. Cronbach's alpha indicates that the 'contribution' scale has good internal consistency (α=0.79). (3) Number of falls: participants reported the number of falls they had experienced in the past year inside the home (0=No falls; 1=One fall; 2=Two falls), or 3=more than two falls). For each fall, the participant stated whether he/she was hospitalized or underwent treatment, to quantify the severity of the injury. (4) The UCHM Questionnaire concluded with an open-ended summarizing question: "Is your home suitable for you now?" (1=Very suitable; 2=Somewhat suitable; or 3=Not at all suitable). The score for this question represents the participant's appraisal of the contribution of the home modifications to the current suitability of his or her home.

B). The Falls Efficacy Scale (FES) [36]. The FES assessed variable 4, the fear of falling [37,38]. The participants responded to each of ten questions on a scale from 1 (low fear of falling) to 10 (high fear of falling). This study used the 1980 version of the FES as it includes questions about self-care and toileting activities that were of more relevance to the modifications made in the participants' homes, confirmed by a high internal consistency as tested by Cronbach's alpha (α=0.93). C). The Usability in My Home (UIMH) Questionnaire [39] was used to assess variable 5, the degree to which the respondent considered the physical environment of his/her home to be usable and comfortable in that it supported the performance of daily activities. The participant responded to various statements on a scale from 0 ("do not agree at all") to 5 ("totally agree"), with higher scores indicating a subjectively more usable and comfortable home. Cronbach's alpha indicated good internal reliability (α=0.75) between the items that deal with the usability of the physical environment and moderate internal reliability (α=0.67) for items relating to activities in the home [40]. This study revealed a high internal consistency for the total score used, as tested by Cronbach's alpha (α=0.87).

Following the self-reported questionnaires, two observational tools were used by an occupational therapist with 25 years of experience in home-care: a) The Safety Assessment of Function and the Environment for Rehabilitation-Health Outcome Measurement and Evaluation called the Safer home (version 3) [41,42]. Safer home is an observational tool used by occupational therapists to examine the safety of a person when functioning in his/her home. This tool measured variable 6, actual functioning. The assessment covered 74 items divided into 12 categories: living conditions (3 items), mobility (10 items), environmental safety hazards (13 items), activities in the kitchen (8 items, one of which was the Kettle Test (see below)), home management (9 items), eating (2 items), self-care (8 items), bathroom and toilet (11 items), medication (3 items), leisure (1 item), communication and time organization (3 items), and wandering (3 items).

The occupational therapist assessed the home environment by interviewing the participant and observing the participant's level of mobility and functioning at home while performing specific tasks (e.g., opening doors, preparing hot drinks, and the transferring from a wheelchair to the toilet) [42]. Following the holistic evaluation, each item was scored on a 1–4 scale: 1 (no identified problem); 2 (a mild problem with a 1%-33% chance of negative outcomes); 3 (a moderate problem with a 34%–66% chance of negative outcomes); or 4 (a severe problem with a 67%-100% chance of negative outcomes).

The total Safer-home score was used together with six of its sub-scales that were deemed relevant for this specific study, namely: mobility, environment, kitchen, household maintenance, self-care, and bathroom and toilet. Two experienced occupational therapists independently assessed the same observations of 10 subjects to establish interrater reliability. Results showed a high Intraclass Correlation between the total mean scores of the raters on the Safer-home assessment (ICC=85), with similar agreement between both occupational therapists' scores for the subscales, except home maintenance (ICC=50), and the single item for environment (ICC=58). The Safer-home observation of the kitchen was particularly comprehensive because we expanded to include the Kettle Test procedure (see below), which simulates a daily kitchen activity.

The kettle test

The Kettle Test [43] is a structured dynamic observation of preparing a hot drink. The participant is scored on each of the 13 steps required to prepare a hot drink for him/herself and the therapist, while ignoring standard distractors. Each item is scored on a 4-point scale: 0 (intact performance), 1 (delayed performance), 2 (received general cues), 3 (received specific cues), 4 (received demonstration or physical help). The total score can range from 0 (no assistance required) to 5 (considerable assistance required) and correlates strongly with two functional tests, so demonstrating concurrent validity [43]. The kettle test served two purposes: (a) it provided a stand-alone measure of cognitive functions; and (b) it was one of the eight Safer-home kitchen items. In this study, scores on the Kettle Test ranged from 0-27, with a mean of 7.29 (SD=6.5), which revealed a large cognitive functioning range among the participants.

The mini-mental state examination (MMSE)

The MMSE [44] is the most common cognitive screening assessment used to evaluate the clinical-cognitive status of patients suspected of having functional central nervous system processing deficits. As in many cases, it was used in the current study as a screening test. The first fifty older adults recruited to the study had mean raw scores of 25.54 (SD=3.95). Three of them were eliminated from the study because they scored more than two standard deviations beneath the mean, according to the norm.

Procedure

After receiving approval from the University of Haifa Ethics Committee, the trust that conducted the intervention re-contacted those who had participated in the program during 2012 to take part in the current study. The visits took place at participants' homes and lasted approximately two hours. Participants who signed the consent and passed the MMSE underwent a comprehensive assessment composed of the questionnaires 1) UCHM; 2) FES; 3) the UMIH; and the combined safer home and Kettle Test.

Data Analysis

The Statistical Package for the Social Sciences (SPSS 19, SPSS Inc., Chicago, IL) was used to describe the participants, the distribution of the study's variables, and analyze the data. Spearman's correlations were used to examine correlations between the study variables and the major outcome examined, namely, older adults' appraisals of the contribution of their new home modifications. A t-test was calculated to examine group differences with respect to demographic variables, except for gender, due to the small number of men (n=6). Following the correlation analyses, a multiple regression was applied in order to examine which variables. A confidence level of $p<0.05$ was chosen for statistical significance.

Results

Descriptive results

In most cases, family members were involved in encouraging the old adults to purchase subsided home modifications (primarily safety and assistive devices). Approximately half of the participants (44.7%) purchased home modification devices, up to a maximum of five (M=2.75). Table 2 presents (in descending order) the results regarding use and satisfaction and shows that most purchasers used the modifications "usually" or "always" (50%-100%; M=68.7%) and were "satisfied" or "very satisfied" with them (50-100%; M=75.9%). Most (83%) participants would recommend the purchase of such home modification devices to others. However, the total mean score of the UCHM questionnaire (9 items) revealed that respondents reported that the home modification devices made only a moderate contribution to the safe function of their daily activities in terms of falls prevention (M=3.5 on a scale from 1-5; SD=0.93).

To the summary final question "Is your home suitable for you now?" 30 participants (60%) responded with an answer of "very suitable", 16 (36%) answered "somewhat suitable", and only two participants (4%) said that their home was "not at all suitable" for them. This finding in line with the result of the relatively moderate mean score for answers to this question (M=3.37; SD=0.98; range, 0-5).

With respect to the participants' health and functioning status, a large majority of the participants (80.8%) described their physical health as moderate or less, while only 19.2% defined their physical health as good to very good. In contrast, 57.4% described their mental health as moderate or less and 42.6% described their mental health as good to very good.

Less than half of participants (42.5%) had experienced a fall in their home in the last month, while 13 (27.7%) reported a fall of sufficient severity to require hospitalization. About a quarter of the group (25.5%) reported that they had experienced more than one fall. Despite the high prevalence of falls, the overall mean score for fear of falling (10 FES items) was not particularly high (M=3.18; SD=2.22; range, 1–8.6).

Participants' appraisal of the home modifications

This study aimed to learn from older adults who had complied with a prevention program and purchased recommended subsided home modification devices. Spearman's rho for non-parametric correlations was used to investigate the factors that correlated with a high subjective appraisal of the home modifications. The results showed a correlation between the total score regarding the contribution of the home modifications (as measured by the UCHM) and the number of devices purchased by the participants (r_s=0.34, p<0.05), meaning that participants who purchased more of the devices recommended to them attributed a greater safety contribution to home modifications than did those who purchased fewer of the devices that were recommended to them. The results also showed that the contribution of the home modifications significantly positively correlated with fear of falling (r_s=0.31, p<0.05), but not with the reported occurrence of falls. Number of falls in the home also did not correlate with the cognitive Kettle test. Interestingly, the results revealed a significant inverse correlation (r_s=-0.32, p<0.05) between the number of falls in the home during the preceding year and participants' perceptions of the usability of their home (by UIMH). Thus, the more falls a participant experienced in the home, the less usable they considered it, but they did not directly relate their falls to the absence of home modifications.

Fear of falling correlated with most of the variables examined. On one hand, it correlated with older adults' health status (r_s=-0.66, p<0.01) and mood (r_s=-0.46, p<0.01), and on the other hand, as mentioned above, it moderate correlation with their appraisal of the usability of their home. Fear of falling also correlated highly with the occupational therapists' total Safer-home score (r_s=0.88, p<0.01), during her observational assessment of older adults functioning in activities. As part of the safer- home observation, participants were asked to prepare a hot drink for them and for the visiting occupational therapist, as administered in the standard Kettle cognitive test. The findings revealed that the objective Kettle test score correlated with self-reported health status (r_s=-0.40, p<0.01), and even more with mood status (r_s=-0.43, p<0.01), and with the perceived contribution of the home modifications (r_s=0.40, p<0.01). Specifically, better cognitive functioning correlated with attributing a greater contribution to the home modifications.

Similarly to the correlations found between the subjective fear of falling and the total mean safer home score determined by the occupational therapist, moderate to high positive correlations were found with its various sub-scores: mobility (r_s=0.85, p<0.01), kitchen (r_s=0.61, p<0.01), household maintenance (r_s=0.74, p<0.01), self-care (r_s=0.80, p<0.01), and bathroom and toilet (r_s=0.68, p<0.01). These results indicate that the safer the home is, the less the participants fear falling, and so suggest that adapting the home to the needs of elderly adults allays their fears of falling.

The benefit of combining self-reports with an observational assessment was further confirmed by the significant inverse relationship between the safer home assessment scores and the participants' perceptions of the usability of their homes (by UIMH). Significant relationship were found for both the total score (r_s=-0.79, p<0.01), and its composite home safety factors: mobility (r_s=-0.72, p<0.01), kitchen (r_s=-0.64, p<0.01), home maintenance (r_s=-0.63, p<0.01), self-care (r_s=0.71, p<0.01), and bathroom and toilet (r_s=-0.61, p<0.01). Thus, the safer the participant's home (a low "identified problems" score), the more useable it was in terms of supporting functionality and independence (a high score).

Participants' characteristics and their appraisal of their home modifications

Mann-Whitney analysis revealed no significant difference between the younger and older participants with respect to the total score for the contribution of home modifications in the UCHM. Nevertheless, a closer analysis of the data revealed differences between the younger and older participants regarding their use of and satisfaction with certain home modification devices. For example, more of the older participants (M=4.5, SD=1.0) purchased bathtub seats compared with younger participants (M=3.5, SD=1.931). The older purchasers used their bathtub seat significantly (p<0.5) less frequently than the few younger purchasers, who were significantly (p<0.001) more satisfied with it (M=5.0, SD=0.0) than the older participants (M=3.5, SD=1.93).

Table 3 demonstrates that health status correlated significantly with most variables examined, and explained the interaction of older adults with their home environment more than other personal characteristics.

The variables explaining the appraisal of home modifications

Following the correlation analyses, a multiple linear regression was applied in order to examine which variables explain the participants' appraisal of their home modifications. Two different models (Table 4) represent the combination of significant cognitive and motor variables:

		Usefulness										Satisfaction
Assistive devices		**Total**	**Not at all**	**Rarely**	**Sometimes**	**Usually**	**Always**	**Not at all**	**Slightly satisfied**	**Somewhat satisfied**	**Very satisfied**	**Extremely satisfied**
Grab-bars	N	46.0	6.0	-	7.0	-	33.0	5.0	-	6.0	1.0	34.0
	%	97.9	13.0	-	14.9	-	70.0	10.9	-	13.0	22.0	73.9
Rubber -mat	N	30.0	5.0	1.0	1.0	1.0	22.0	6.0	-	1.0	-	23.0
	%	63.8	10.6	2.1	2.1	2.1	46.7	12.7	-	2.1	-	49.0
Bathtub seat	N	15.0	4.0	-	2.0	-	9.0	4.0	-	1.0	-	10.0
	%	31.9			4.2	-	19.1	8.5	-	2.1	-	21.2
Raised toilet seat	N	9.0	4.0				5.0	4.0				5.0
	%	19.19	10.6				10.6	10.6				10.6
Reacher	N	7.0			3.0	-	4.0			1.0	-	6.0
(helping hand)	%	14.9			6.4	-	8.5			2.1	-	12.8
Furniture raisers	N	3.0					3.0					3.0
	%	6.5					6.5					6.5
Other	N	19.0	4.0	1.0	1.0	-	13.0	5.0	1.0			13.0
	%	40.4	8.5	2.1	2.1	-	27.6	10.6	2.1			40.4

Table 2: Use of and satisfaction with the home modifications.

Measure	Age	Reported Physical Health	Reported Mood	Number of falls in the home	Contribution of home modifications	Fear of falls
Self-reports						
Contribution of home modifications	0.13	-0.14	-0.22	0.02	10.00***	0.31*
"Is your home suitable for you now?"	-0.01	0.30*	0.28	-0.45**	0.31*	
Usability of home	-0.01	0.67**	0.46**	-0.32*	-0.19	0.80**
Fear of falls	-0.09	-0.66**	-0.46**	0.25	0.31*	10.00***
Observational assessments						
Total SEFER-HOME	-0.10	-0.66**	-0.46**	-0.31*	0.25	0.88**
Mobility sub-scale	-0.14	-0.59**	-0.40**	0.15	0.39*	0.85**
Kitchen sub-scale	0.04	-0.61**	-0.50**	0.22	0.27	0.61**
Household sub-scale	-0.04	-0.43**	-0.39**	0.36*	0.32*	0.74**
Personal care sub-scale	-0.12	-0.61**	-0.33*	0.23	0.26	0.80**
Toilet and bathroom		-0.49**	-0.55**		0.06	0.68**
Environment sub-scale	0.11	-0.08	0.01	0.14	-0.05	0.04
Kettle test	0.29	0.40**-	-0.43**	0.24	0.40**	
*p<00.05 **p<00.01						

Table 3: Spearman Correlations between the main study variables.

	Unstandardized Coefficients		Standardized Coefficients		
Model 1	B	SE B	β	t	Sig0.
1 (Constant)	1.37	0.66		2.08	0.04
Fear of falling	1.68	0.07	0.32	2.31	0.03
Kettle test	0.05	0.02	0.30	2.15	0.04
House suitability	0.30	0.14	0.29	2.16	0.04
R-square		0.33			
$F_{(3,38)}$		6.12**			
Model 2					
1 (Constant)	10.34	0.66		2.01	0.05
Mobility	0.57	0.25	0.31	2.27	0.03
Kettle test	0.05	0.02	0.33	2.41	0.02
House suitability	0.29	0.14	0.28	2.12	0.04
R-square		0.32			
$F_{(3,38)}$		6.03**			
*p<0.05 **p<0.01 $Y = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 + \varepsilon 0$.					

Table 4: Two models of regression explaining the contribution of home modifications.

The first model (F (3.38)=6.12, p=0.002) explained 32.6% of the variance for the contribution of the home modifications in terms of three variables: two self-reported measures about participants' perceived fear of falling (β=0.32) and the suitability of their home to their needs and function (β=0.32); and one observational measure, namely, the cognitive Kettle test (β=0.29).

The second model (F (3.38)=6.03, p=0.002), explained 32.3% of the variance for the contribution of the home modifications in terms of three variables: two observational sub-scales of the safer home, namely, mobility (β=0.31), and the cognitive Kettle test (β=0.33); and the self-reported single-item measure about whether participants perceived their home as suitable to their needs and functioning (β=0.28).

Both models were examined following the surprising finding that none of the safer home scores entered the regression model, although its mobility sub-test correlated significantly with the perceived contribution of home modifications. This may be that the high correlation between the mobility sub-test and fear of falling resulted in two distinct models (Table 4) that summarize the four significant variables that explain participants' appraisal of the subsided home modification devices that they purchased to improve the ergonomics of their home. The variance inflation factor of VIF<2 found in both models indicates low multicollinearity.

Discussion

This study achieved its first aim of assessing older adults' use of and satisfaction with home modification devices that they purchased following a comprehensive ergonomic and occupational assessment of their needs. The current findings of widespread use of the home modification devices, high satisfaction levels, and a willingness to recommend them to others are encouraging. The finding that the more home modification devices participants purchased, the greater their contribution to improved functioning in the eyes of the user is cheering, in light of the literature regarding the gap between the prescription of assistive devices and ergonomic consultation and the actual use and abandonment rates [45]. The study's use of a combination of observational assessments of actual performance during home visits and self-reporting questionnaires enabled to us to gather data that better reflected the complex process of adopting home modifications and the gap between using installed devices and the appraisal of their contribution.

With respect to our second aim of examining whether a correlation exists between home modifications and the safe domestic functioning of older adults, our results suggest no direct correlation with reduced falls, similarly to others [46,47]. An explanation for these findings may be found in Kruse and colleagues, who echoed their participants who claimed that falls are situations not addressable through home modification, since they are an uncontrollable occurrence in old age [48].

Neither demographic variables nor the prevalence of falls were shown to correlate with the contribution of home modifications and safe functioning, as indicated by the safer home. The mobility sub-score of the Safer-home and the cognitive Kettle test conducted by an experienced occupational therapist were useful to identify older adults' ability to safely function in their home, and their correlations with the participants' appraisal of the home modification devices. The comprehensive assessment, including the Kettle test, where the participant prepared and served the examiner hot drink, demonstrated that even small modifications to improve the match between and their home settings lead to greater and safer independent performance in daily functioning, in transitions, and in bathing and toileting. Indeed, in our study, those who were assessed with cognitive and motor decline expressed greater satisfaction with the modifications and considered them to make a greater contribution to their functional needs than those with in-tact cognitive and motor functions. These findings are consistent with the relationship found between mobility and cognitive functional decline, in which the cognitive functional decline increases the rate of falling and reduces the performance of activities of daily living, so reducing mobility [49].

Furthermore, the results of our study are consistent with studies that found that people with the poorest health due to aging or disability are more willing to use adaptive devices compared with younger healthy people who go through a falls prevention program [22]. Looking into the descriptive findings about the different modifications showed that not all devices are equally used. People prefer devices that are more normative or that are perceived as making real difference in their life [50].

The challenge for professionals seeking to enhance older adults' appraisal of home modifications was raised by Kruse and others [28,48] who found that older adults did not regard falls as a problem and expressed an unwillingness to make even minor changes in their homes. These findings call upon researchers to identify the characteristics of potential older adults who can benefit from home modification and the best practices to conduct the assessment and intervention [13] as partially addressed by our study.

The most significant findings of this study are the central role of the cognitive emotional measures of feeling that the modified home is suitable and, especially, fear of falling. Greater installation and use of home modifications were found to be associated with a greater fear of falling. Our study strengthens the claim [26] that only people who are aware of a decline in their functioning are willing to make home adaptations. In an experimental study, Guitard and others [26] demonstrated that people were open to installing bath grab bars following the fear evoked by an experiment of balance perturbation, without any correlation to their own falls history. The evoked fear of falling effect did not last very long; only immediately after the experiment was a higher proportion of adults were willing to purchase home modifications, but follow-up revealed that few actually made the purchase and installation. This suggests that part of the ergonomic consultation should include a functional assessment to raise the client's awareness as to the presence of functional decline and the need for modifications in order to reduce potential risks.

Conclusion

The theoretical conclusion of our findings supports the combination of the cognitive human factors together with ergonomic principals, while examining and designing interventions for aging in place, of older adults with motor and cognitive declined functioning [1-5]. The practical implication for professionals is the call to relate to subjective and psychological factors, in addition to health status mobility and cognitive function assessments, as part of the ergonomic intervention. The study identified significant elements that should be incorporated into future home modification interventions and suggested outcome measures to be considered, specifically, the SAFER-HOME assessment, Usability of My Home, the Kettle test or a similar cognitive ecological test. Additionally, a single general question about the extent to which participants perceive their home as suitable to their needs and functioning was found to be very meaningful. In some

ways, it was more meaningful than the answers to more complicated questionnaires.

As for the intervention, the findings suggest that it is insufficient to prescribe the installation and use of home modifications. Rather, home modification is a process that must also include emotional and cognitive elements, together with the user confidence that can be achieved through training and active use of assistive devices [11]. Specifically, in the described intervention, older adults and their significant others (mostly one of their siblings) were active participants and were required to pay a symbolic fee for each device, enabling them to feel directly involved. The modifications they chose were then installed by the program and were frequently used, although sometimes without awareness of their daily use and contribution [35].

The current study was a follow up cross sectional study. A RCT pre-and post-program longitudinal design would have been preferable. However, it involved retrospective theoretical and practical examination of a home modification project intervention conducted by occupational therapists, at the point at which policy makers examined its continuity. A modest sample size was set of the first 50 older adults recruited because of the time required to locate and recruit participants. Future research should seek to expand our understanding of ergonomic interventions for older adults and the process of environmental adaptation adoption in other contexts and among other at-risk populations.

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