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Field Report

Improving the care stress, life quality, and family functions for family-caregiver in long-term care by home modification

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Abstract: This study examined whether interventions through barrier-free home environment improvements could reduce family caregivers' care stress, improve their family functions, and increase their quality of life. This study recruited family caregivers of older people with disabilities from a long-term care management center in central Taiwan. These older people required improvements related to a barrier-free home environment. A pretest was conducted before and a post-test was conducted 2 months after the improvements. The content of the pretest and the post-test questionnaires included: demographic characteristics, Caregiver stress scale, Family functions scale, World Health Organization Quality of Life-BREF (WHOQOL-BREF) Questionnaire. This study recruited 72 family caregivers; the average age was 56.25 ± 12.99 years. The results indicated that interventions through barrier-free home environment improvements could significantly reduce the family caregivers' care stress, improve their family functions (e.g., reducing conflicts), and enhance their quality of life. Additionally, after intervention, the family cohesion of family caregivers caring for those with mild disability improved to a greater extent than did that of those caring for people with other disease severities. This study revealed that interventions involving barrier-free home environment improvements have positive effects on family caregivers.

Key words: Care stress, Quality of life, Family functions, Family caregiver, Home modification

Introduction

Population aging is a major global concern, and the number of older adults with disabilities has increased substantially along with rapidly aging populations[1, 2]. The number of older adults with disabilities in Taiwan is estimated to

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increase from 410,000 to 610,000 from 2017 to 2026. Families are the primary caregivers for 67% of older adults with disabilities. The average number of years these family caregivers perform care tasks is 11.2, and the average number of hours of daily care is 14.2[3], which implies great physical or psychological burden on these family caregivers. Unfortunately, approximately half (49.22%) of family caregivers have no one to substitute them[3]. Performing care tasks for long periods may negatively affect family caregivers' care stress (physiologically and mentally), family functions (e.g., the relationships among family members), and quality of life[4–7].

Family caregivers often bear considerable stress as a result of their caring duties. For example, older adults with severe disabilities (or poor physical resilience) are mostly unable to walk or move independently and require caregivers to move them around in a wheelchair[8, 9]. The caregiver must overcome environment-induced obstacles to mobility—for example, uneven paths, insufficient width of the exit or entrance, or insufficient space for turning—by lifting the wheelchair or moving the care receiver, which increases the caregiver's burden of care. In addition, performing care tasks for extended periods results in heavy care stress, further affecting the caregiver's physical condition and causing symptoms such as muscular strain, chronic pain[10], and melancholy and anxiety[11], thereby affecting the care receiver's health status[12, 13]. Moreover, family caregivers are more likely to have disputes with family members because of onerous care tasks, further damaging the relationships among family members, reducing family cohesion, and increasing conflicts[14]. Relevant research suggested that being under immense stress and burden for an extended period leads to enhanced fatigue and triggers family problems such as conflict and even violence[2, 14]. Although studies have explored the problems of stress from the perspective of family caregivers (caring for older adults with disabilities), studies exploring effective interventions to reduce family caregivers' stress or family conflict are scarce[12, 13].

Care tasks affect family caregivers' quality of life. Because they must perform care tasks, many family caregivers cannot sleep for more than 4 hours at a time, which affects their sleep quality as well as their physical and mental health[15]. Moreover, care tasks are typically time consuming, meaning primary caregivers are often unable to engage in activities they enjoy, such as going out and travelling. More than half of family caregivers sacrifice private social activities because of care tasks[16]. This has a considerable influence on the quality of family caregivers' social life; for example, they may be unable to join social gatherings and interact with family and acquaintances or have insufficient time for leisure and entertainment[17]. Thus, it is essential to provide effective coping strategies for family caregivers and care receivers to improve the care receivers' independence as well as to reduce the burden and the number of care hours of the family caregivers. Improvements and interventions related to providing a barrier-free home environment is one effective coping strategy[18].

A barrier-free home environment refers to a space that people of all ages, sexes, or physical conditions can use freely and safely, enabling everyone to retain their dignity and have the utmost autonomy[18]. Improvements related to a barrier-free home environment includes measures such as adding handrails, using ramps or constructing sloped pathways to eliminate uneven ground on frequently-used paths, using reflective tape to increase visual reminders, applying antislip material on the ground, reducing or removing thresholds, widening exits or entrances, and introducing lever faucets or electronic sensor faucets. These measures can reduce the caregiver's burden in performing care tasks and improve the security and autonomy of older adults with disabilities who live autonomously[18]. The health authorities of various countries provide a social welfare pension to people with disabilities to improve their living environment[19]. However, most studies on interventions through barrier-free home environment improvements have focused only on the feelings of those with disabilities[20], whereas the effects on the caregivers (e.g., the care stress, family functions, and the quality of life) are typically overlooked. Consequently, these studies have not provided sufficient evidence to facilitate efficient and optimal usage of social welfare pensions.

This study investigated whether interventions involving barrier-free home environment improvements could reduce family caregivers' care stress, improve their family functions, and enhance their quality of life. The results of this study provide a crucial reference for family caregivers involved in long-term care; the results may also guide related social welfare institutions and government agencies in determining how to reduce caregiver burden by implementing interventions related to barrier-free home environments.

Methods

Study Design and Participants

This study explored outcomes regarding care stress, family functions, and quality of life of family caregivers performing care tasks before and after interventions through

barrier-free home environment improvements. Family caregivers provided feedback on a self-completed structured questionnaire. To explore the effect of implementing barrier-free home environment improvements on family caregivers, a pretest (baseline) was conducted before the improvements, followed by a post-test questionnaire survey 2 months after the improvements. This study recruited family caregivers of older people with disabilities from a long-term care management center in central Taiwan; these older people required improvements related to a barrier-free home environment.

People with disability served by long-term care management centers who required improvements related to a barrier-free home environment first applied to the local long-term care management center. After the center approved the request, professionals qualified in assistive technology assessment were dispatched to the houses of the older adults to assess relevant improvements before commencing construction according to the assessment results (the construction lasted 1–3 days). Once the construction was completed, the older adults and their primary caregivers were instructed on the correct usage of the assistive technology. The interventions in this study were performed by physical therapists qualified in assistive technology assessment who assessed the houses of the disabled older adults for improving the barrier-free home environment (the baseline questionnaires were completed simultaneously). Two months after the construction was completed, the same physical therapist conducted a post-test questionnaire at the home of the older adults with disabilities. In this study, the interventions included eight items: building handrails, constructing slip-resistant flooring, eliminating ground unevenness, widening the exit or entrance, improving the bathtub, improving the toilet, changing door panels, and room repartitioning. The aforementioned construction was implemented according to the disability and needs of each study participant. The experimental flow chart is shown in Fig. 1.

The recruitment conditions were as follows: (1) being a family member playing the role of the main family caregiver (who provides care for the longest period and for more than 3 days per week); (2) having the ability to communicate in Mandarin and understand the questionnaire; (3) being aged 20 years or more; (4) having the ability to complete the questionnaire. In this study, the research assistant first explained the research objectives to the potential participants, obtained their written consent, and issued the questionnaires. The data were collected between September 2019 and March 2020. Ethical approval for the study was obtained from the Central Regional Research Ethics Committee China Medical University (No. 108-101).

Questionnaire

The structured questionnaire of this study was divided into four parts: the demographic characteristics survey, the caregiver stress test, the family functions scale, and Taiwan version of the brief version of the World Health Organization Quality of Life (WHOQOL-BREF) questionnaire. The demographic characteristics included sex, age, marital status, educational attainment, the disability level of those receiving care (mild, moderate, or severe), family income, care tenure, and the average hours of care provided per day.

The caregiver stress test adopted the family caregiver stress scale of the Taiwan Association of Family Caregivers; the scale is typically provided to family caregivers for self-testing. The scale comprises 14 items and is rated using a 4-point Likert scale[21]. The participants rated each item as “never”, “seldom”, “sometimes”, or “often”. The participants circled the rating according to their feeling when performing care tasks. The total score was obtained by adding the points of the 14 items, ranging from 0 (the lowest) to 42 (the highest). A score of 0 indicated that the primary caregiver could overcome the various problems and stresses they encountered during care tasks, and their quality of life was favorable. A score of 1–13 represented mild care stress in the primary caregivers, a range that allows for adaptation; 14–25 represented moderate care stress, implying that some signs caused by stress may have emerged; and 26–42 represented high care stress, indicating that the primary caregiver bears a heavy burden of care[21]. The scale had favorable reliability and validity[22]. The Cronbach’s alpha of the pretest and post-test of the family caregiver stress scale was 0.92 and 0.92, respectively.

The family functions scale adopted the family functions scale of Wang[23], revised by Shieh[24]. The scale is comprised of eight subscales: the cohesion, conflict, emotional involvement, emotional expression, communication, problem-solving, independence, and family roles and responsibilities subscales. The scales adopted a 4-point Likert scale; the participants rated each item as “strongly disagree”, “disagree”, “agree”, or “strongly agree”; the respondents circled the option that was the most representative of their feelings when providing care. The higher the total score (of the subscales), the more favorable the family functions. This scale and its subscales all had favorable reliability and validity[24]. Only the cohesion subscale (five items) and the conflict subscale (six items) were used in this study; higher scores on the subscales represented greater cohesion and

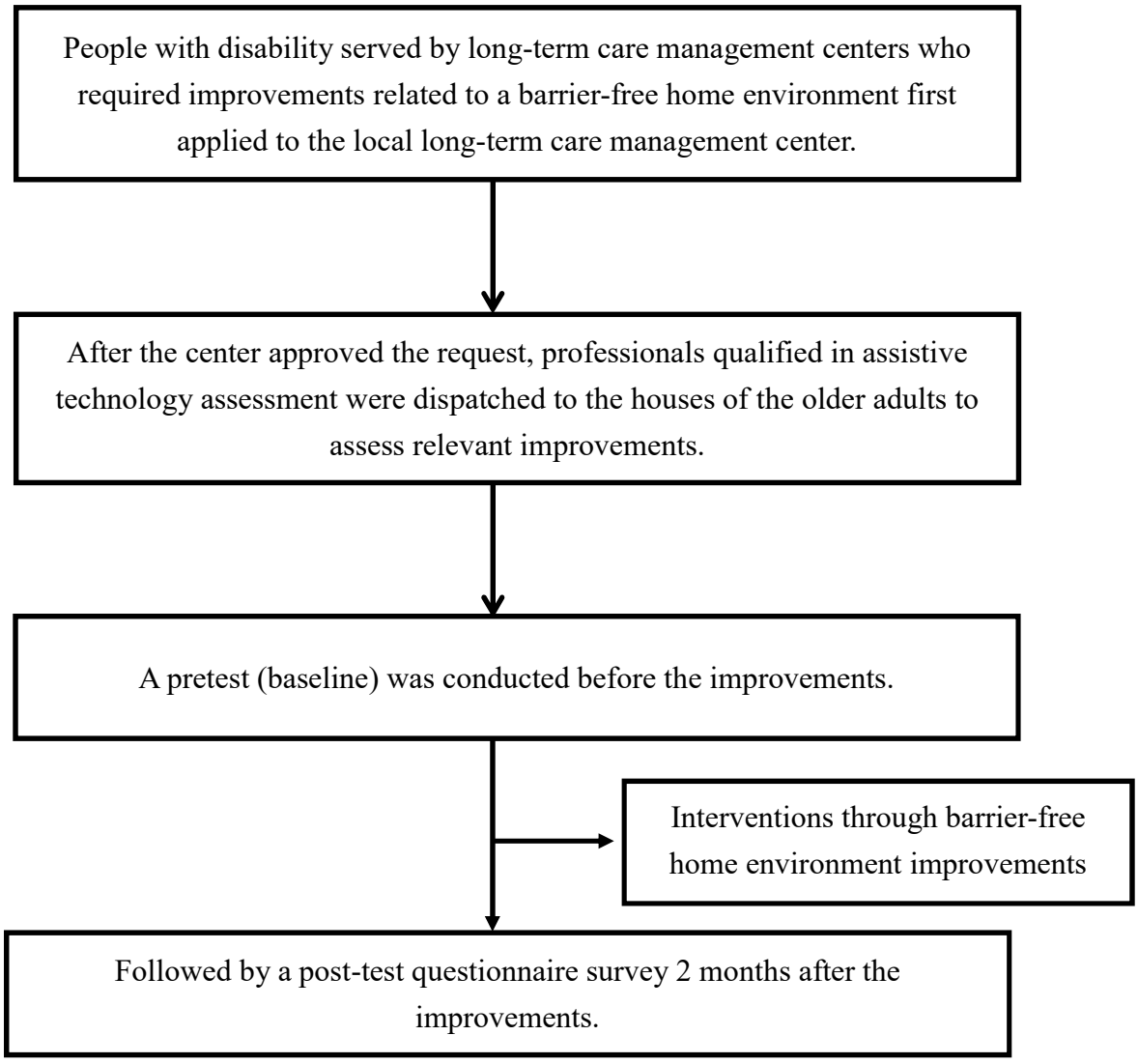

Fig. 1. Flowchart of the experiments.

fewer conflicts. The pretest and post-test Cronbach's alpha of the cohesion subscale were 0.91 and 0.83, respectively; the relevant values of the conflict subscale were 0.80 and 0.80, respectively.

The questionnaire on quality of life adopted the WHOQOL-BREF, which comprised 28 items. The participants answered the items on the questionnaires with reference to the preceding 2 weeks[25]. The questionnaire content covered four domains: the physical (seven items), psychological (six items), social (four items), and environmental (nine items) domains. A 5-point Likert scale was employed; the higher the score, the higher the quality of life of the respondent. The WHOQOL-BREF Questionnaire has been widely applied to measure the quality of life of employees in various professions; it has favorable reliability and validity[2, 7, 25]. Regarding the physical, psychological, social, and environmental domains, the respective Cronbach's alpha of the pretest (post-test) were 0.80 (0.77), 0.86 (0.78), 0.98 (0.76), and 0.96 (0.84).

Statistical analysis

SPSS 25.0 for Mac was used for the statistical analysis. Descriptive statistics-based analysis was employed to present the demographic characteristics of the family caregivers, family caregivers' scores on the family caregivers stress scale, and the score of the family functions scale; the scores of the WHOQOL-BREF Questionnaire are presented by averages and standard deviations. The Kruskal–Wallis test was adopted to examine the presence of significant changes (i.e., post-test score vs. pretest score) in the care stress scores, family functions, and the quality of life of the primary caregivers of those with mild, moderate, and se-

Table 1. Demographic characteristics of the participants

Demographic characteristics	n=72
Sex	
Male	39
Female	33
Age (mean± SD)	56.25 ± 12.99
Marital status	
Single/Divorced/Widowed	19
Married/cohabiting	53
Years of education	
≤12 years	40
>12 years	32
Disability level (care receiver)	
Mild	11
Moderate	44
Severe	17
Monthly family income (NTD)	
<20 thousands	28
20–40 (<40) thousands	23
≥40 thousands	21
Care tenure (years)	5.34 ± 6.11
Hours per day (hours)	13.04 ± 7.21

SD: standard deviation, NTD: New Taiwanese Dollars.

vere disability before and after the interventions involving barrier-free home environment improvements (each scale score did not conform to the normal distribution). The Mann–Whitney U test was used for post hoc testing to verify the differences between the two groups. Finally, by controlling for demographic variables, linear mixed-effects models were used to test for significant differences among the score of the family caregiver stress scale, the score of the family functions scale (the cohesion subscale and the conflict subscale), and the scores of the WHOQOL-BREF Questionnaire (including the four domains). The scores of the family caregiver stress scale, the family functions scale, and the WHOQOL-BREF Questionnaire served as the dependent variables, whereas demographic variables (including sex, age, marital status, educational attainment, the disability level of the person receiving care, family income, care tenure, and the average hours of care provided per day) and Intervention served as the independent variables. Based on the caregivers and disabled people viewpoints, this study attempts to look for endogenous variables. Therefore, this study mainly explores the relationships between variables themselves by the linear mixed-effect model (LMM) analysis. Using the LMM method in randomness (fixed effects, random effects) might better understand the primary endogenous factor in the barrier-free home environment.

Results

Demographic characteristics of the participants

This study recruited a total of 72 family caregivers; their demographic characteristics are presented in Table 1. The caregivers comprised 39 men and 33 women; their average age was 56.3 years. Among the older adults being cared for by family caregivers, 11, 44, and 17 had mild, moderate, and severe disabilities, respectively. The average number of years of care of these family caregivers was 5.3 years; the average number of hours of care provided per day was 13.0. In addition, the details of the intervention are presented in Appendix1. The mean and standard deviation for the three outcomes (including subscales) before and after home modification intervention were as follows: caregiver stress scale (27.13 ± 9.12; 17.08 ± 8.44), family cohesion (16.07 ± 2.55; 16.46 ± 2.29), family conflict (17.79 ± 2.93; 18.83 ± 2.88)), physical domain (21.33 ± 3.87; 23.42 ± 3.28), psychological domain (17.14 ± 3.42; 18.65 ± 2.85), social domain (12.96 ± 1.60; 13.71 ± 1.60), environmental domain (27.28 ± 4.65; 29.56 ± 4.39).

Comparison of post-intervention changes in caregiver stress scale, family function, and WHOQOL-BREF among

Table 2. Comparison of post-intervention changes in caregiver stress scale, family cohesion subscale and the family conflict subscale, and WHOQOL-BREF among caregivers who take care of cases with three different levels of disability

	Mild (n=11)	Moderate (n=44)	Severe (n=17)	Kruskal-Wallis test	
	Mean (SD)	Mean (SD)	Mean (SD)	*p*-value	post hoc
Caregiver stress scale	−7.91± 5.34	−10.52 ± 7.16	−10.18 ± 5.88	0.63	
Family function	-				
Family cohesion	1.00 ± 0.63	0.34 ± 1.08	0.12 ± 0.86	0.01*	Mild>Moderate^; Mild>Severe^
Family conflict	17.79 ± 2.93	18.83 ± 2.88	18.83 ± 2.88	0.88	
WHOQOL-BREF					
Physical domain	1.82 ± 1.72	1.93 ± 2.65	2.65 ± 3.52	0.93	
Psychological domain	0.64 ± 2.20	1.70 ± 2.06	1.59 ± 1.37	0.24	
Social domain	0.64 ± 0.67	0.77 ± 1.24	0.76 ± 1.03	0.89	
Environmental domain	1.36 ± 2.29	2.34 ± 2.82	2.71 ± 2.80	0.40	

Note: WHOQOL-BREF: World Health Organization Quality of Life-BREF; SD: standard deviation

*: $p<0.05$; post hoc analysis using Mann-Whitney U test (the *p*-value was corrected by Bonferroni correction , dividing 0.05 by 2 ; ^: $p<0.025$)

caregivers who take care of cases with three different levels of disability

Regarding family caregivers taking care of people with mild, moderate, and severe disabilities, Table 2 reveals the pre-to-post-intervention changes in the scores of the stress scale, the family functions scale (the cohesion subscale and the conflict subscale), and the four domains of the WHOQOL-BREF Questionnaire. Regarding the cohesion subscale under the family functions scale, the three groups differed significantly ($p<0.05$). A post hoc test revealed that the scores of the family caregivers caring for those with mild disability increased more significantly than did those of caregivers caring for people with moderate (or severe) disability ($p<0.01$; $p=0.01$). That is, after the interventions involving barrier-free home environment improvements, the family cohesion of the family caregivers caring for older people with mild disability was significantly improved (compared with that of those caring for older people with moderate or severe disability).

The effectiveness of the caregiver stress scale, family function, and WHOQOL-BREF among family-caregivers after two months of intervention

Table 3 lists the results of the linear mixed-effects models. When the demographic variables were adjusted, the results indicated that the time or times variable was significantly correlated with six items, namely the family caregiver stress scale, the conflict subscale, and the four domains of the WHOQOL-BREF Questionnaire. The interventions significantly reduced the stress on the family caregivers ($p<0.01$) as well as the family conflicts ($p<0.05$). Moreover, family caregivers' quality of life in the physical ($p<0.01$), psychological ($p<0.01$), social ($p<0.01$), and environmental ($p<0.01$) domains were significantly improved.

Among the demographic variables, sex, marital status, educational attainment, and the average hours of care provided per day were significantly correlated with the score of the family caregiver stress scale ($p<0.05$–0.01; Table 3). Sex, educational attainment, family income, and the average hours of care provided per day were significantly correlated with the cohesion subscale ($p<0.05$–0.01). Educational attainment was significantly correlated with the score of the conflict subscale ($p<0.05$). Moreover, sex, age, the disability level of the person receiving care, and the average hours of care provided per day were significantly correlated with the score of the physical domain ($p<0.05$–0.01). The disability level of the person receiving care was significantly correlated with the psychological domain ($p<0.05$). Sex and marital status were significantly correlated with the score of the environmental domain ($p<0.05$).

Discussion

This study is among the few to explore the effects of interventions involving barrier-free home environment improvements from the perspective of caregivers. The findings of this study confirmed the positive benefits of such interventions for family caregivers. Because of the effect of culture and importance of filial piety, Chinese families or families in Asia typically regard caring for older family members as an obligation. However, once an older family

Table 3. The effectiveness of the caregiver stress scale, family function, and WHOQOL-BREF among family-caregivers after two months of intervention

	Gender	Age	Marital status	Years of education	Degree of disability		Family income (NTD)		Year of care	Hours per day	Intervention
	Male/ Female#		Single/ Married#	≤12 years / >12 years#	Mild/ Severe#	Moderate/ Severe#	<20/ >40#	20-40/ >40#			Baseline/ Follow-up#
Caregiver stress scale	−5.99**	−0.00	−3.97*	−3.60*	−1.94	−2.10	−2.96	−0.30	−0.04	0.37**	10.04**
	(1.38)	(0.06)	(1.72)	(1.63)	(2.25)	(1.61)	(1.97)	(1.96)	(0.11)	(0.09)	(1.29)
Family function											
Family cohesion	−0.91*	0.02	0.36	1.07*	0.91	−0.24	−2.50**	−1.67**	−0.00	0.10**	−0.39
	(0.39)	(0.02)	(0.48)	(0.46)	(0.63)	(0.45)	(0.55)	(0.55)	(0.03)	(0.03)	(0.36)
Family conflict	0.18	0.04	0.73	1.40*	1.52	0.57	−0.94	−0.76	0.03	0.05	−1.04*
	(0.50)	(0.02)	(0.63)	(0.60)	(0.82)	(0.59)	(0.72)	(0.71)	(0.04)	(0.03)	(0.47)
WHOQOL-BREF											
Physical domain	2.06**	−0.09**	1.18	0.54	1.79*	0.81	0.67	0.20	0.02	−0.09*	−2.08**
	(0.55)	(0.02)	(0.69)	(0.65)	(0.89)	(0.64)	(0.78)	(0.78)	(0.04)	(0.04)	(0.52)
Psychological domain	0.93	0.00	0.95	0.28	1.88*	1.39*	−0.48	0.04	0.01	−0.02	−1.51**
	(0.54)	(0.02)	(0.68)	(0.64)	(0.89)	(0.64)	(0.78)	(0.77)	(0.04)	(0.04)	(0.52)
Social domain	0.05	−0.01	0.18	0.04	0.39	0.38	0.21	0.20	0.01	−0.01	−0.75**
	(0.29)	(0.01)	(0.37)	(0.35)	(0.48)	(0.34)	(0.42)	(0.42)	(0.02)	(0.02)	(0.27)
Environmental domain	2.10*	0.01	2.40*	−0.38	0.93	0.51	−1.67	−0.15	0.02	−0.08	−2.28**
	(0.76)	(0.03)	(0.95)	(0.90)	(1.24)	(0.89)	(1.09)	(1.08)	(0.06)	(0.05)	(0.71)

NTD: New Taiwanese Dollars; WHOQOL-BREF: World Health Organization Quality of Life-BREF
*: $p<0.05$, **: $p<0.01$, #: reference group

member becomes disabled, most families choose to provide care at home until home care becomes unfeasible and the elder family member is sent to a long-term care institution. Such responsibilities result in considerable care stress in young family members[26]. Caregivers performing care tasks for extended periods were reported to have inferior health outcomes; such people may also be susceptible to a higher mortality rate and disease prevalence rate[27]. Taking care of a person results in considerable physical burden and probably leads to a certain degree of psychological resistance in caregivers. However, the improvement of the physical environment might help caregivers perform their tasks in a more relaxed and effective manner, reduce their stress, and improve their quality of life[28].

The results indicated that the family cohesion of family caregivers caring for older people with mild disability was further improved after interventions involving barrier-free home environment improvements (Table 2). Compared with older adults with moderate or severe disability, those with milder symptoms typically have a greater day-to-day functioning ability. Interventions related to a barrier-free home environment, such as handrails, could help those with mild disabilities improve their ability to independently complete everyday tasks, such as walking and going to the toilet or bathing[28]. Following the increase in the independence of older people with disabilities, the time saved on caring could be used for engaging with other family members, enhancing family cohesion. In addition, the results indicated that interventions involving barrier-free home environment improvements could reduce caregivers' care stress and improve their quality of life, in turn indirectly improving interactions and increasing cohesion among family members.

The results indicated that the caregivers' care stress and family conflicts decreased significantly, and their quality of life increased significantly after the interventions (Table 3). This suggests that improvements by means of a barrier-free home environment considerably reduced caregivers' physical burden in performing care tasks (e.g., reducing the need for repeated lifts or rotations), decreasing damage to muscle and bone. Furthermore, the autonomy of those receiving care was enhanced, reducing their dependence on the primary caregivers and the difficulties they experience in performing daily activities, ultimately decreasing the primary caregivers' workload and stress. These results are consistent with the findings of Fänge and Iwarsson[29] and Gitlin, Winter[30]. Moreover, family conflict and the caregivers' health were strongly correlated, which is consistent with prior studies[31]. The evolution of an older person's disability affects not only themselves but also their families, in both physical and psychological aspects. In particular after one becomes incapable of self-care, they may have to depend on a caregiver's help in daily life. The caregivers not only have to manage the patient's physical care but probably also have to assist in housework; some caregivers may even hold a job while providing care. Thus, family members acting as the primary caregivers often experience substantial pressure, leading to a heavy burden on their lives and a heightened tendency to have disputes with other family members, including with the person receiving care[32].

Assessing the benefits of interventions involving barrier-free home environment improvements according to quality of life indicators is useful[33]. The current results revealed that the four domains of the WHOQOL-BREF

Questionnaire were all significantly improved after the interventions. That is, family caregivers' quality of life in the physical, psychological, social, and environmental domains improved significantly. Demographic data indicated that these family caregivers were mostly approaching old age. The physical condition of older caregivers is likely to be inferior to that of younger caregiver (e.g., because of chronic diseases). The heavy care tasks and the necessity of frequently assisting the person they care for in their activities of daily living, alongside their accumulated stress, might have various negative effects on caregivers. For example, the caregiver may be unable to join social gatherings and interact with family members and acquaintances or have insufficient time for leisure and entertainment. These factors might indirectly affect the caregivers' quality of life. Improvement of the home environment may reduce older people's dependence on caregivers[29] and the accident rate in their homes (e.g., falls)[34], thus allowing the caregivers more time to engage in activities they enjoy.

This study also explored the effect of the improvement of the home environment on the family caregiver and the person being cared for. The results revealed that the quality of life in the physical and psychological domains of family caregivers taking care of older people with mild disability was higher than that of family caregivers caring for older people with severe disabilities; the quality of life in the psychological domain of family caregivers caring for those with moderate disability was also higher than that of family caregivers caring for people with severe disability (Table 3). The results suggest that relative to those caring for other groups, those caring for older people with severe disability be in poorer physical conditions and bear heavier psychological stress. Thus, relevant agencies are reminded to provide more social and environmental support to those caring for people with severe disability. In addition, the quality of life in the physical domain of family caregivers with more hours of care was inferior to that of those spending less time on such tasks (Table 3). This also suggest that performing care tasks over an extended period negatively affects caregivers' physical health. Thus, in addition to improving the barrier-free home environment, family care tasks should be considered a "workplace job", and attention should be paid to workplace safety; for example, providing related educational and training courses to reduce physiological harm to caregivers.

Limitations

Some limitations should be considered when interpreting the results of this study. First, the participants were family caregivers of older people with disabilities who were introduced by a long-term care management center in central Taiwan. Random sampling would have resulted in excessive logistical challenges; thus, the current study's explanatory power is limited. Second, this study collected data through self-completed questionnaires and excluded those who could not complete the questionnaires. Therefore, participants required a certain level of Chinese comprehension to participate in the study. During participants recruitment, the researchers noted that some primary caregivers were non-nationals and were unable to complete the questionnaire. Consequently, this study collected data mostly from family caregivers with higher educational attainment or who were Taiwanese nationals. Therefore, the sample of this study likely does not reflect the actual demographic makeup of caregivers in Taiwan. The aforementioned situation also explains the relatively small sample size. Third, because this study included no control group, the researchers are unable to confirm whether all the research outcomes originated from interventions involving barrier-free home environment improvements. Fourth, this study did not assess caregiving burden and caregiving stigma, and the two factors could be confounders to the present study[35–40]. Fifth, this study did not collect the background information of the care receivers, and these factors may affect the results of this study. Finally, social desirability bias might have affected the questionnaire data's authenticity because of the cultural and circumstantial expectations of the current participants. Despite the aforementioned limitations, this study provides findings on the effects of interventions related to a barrier-free home environment on caregivers. The outcomes may help social welfare-related institutions or government agencies comprehend the cruciality of improving barrier-free home environments.

Conclusion

Care of an older adult with disabilities imposes heavy physical and psychological stress on a caregiver. If family caregivers are healthy, those they care for are more likely to obtain quality care, with the additional benefit of a more harmonious family atmosphere. The results of this study suggest that interventions that involve improving the barrier-free home environments of those with disability can effectively reduce family caregivers' care stress, improve their family functions (e.g., reducing conflicts), and increase their quality of life. In addition, this study revealed that, after interventions related to a barrier-free home environment, the family cohesion of the family caregivers car-

ing for those with mild disability was further improved. Therefore, families with family members who are disabled should adopt improvements related to barrier-free home environments to reduce the caregiver's burden of performing care tasks.

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Conflicts of Interest

The authors declare that they have no conflict of interest.

Data Accessibility Statement

The datasets used and/or analyzed during the current study are available from the corresponding author on reasonable request.

Ethical Statement

Ethical approval for the study was obtained from the Central Regional Research Ethics Committee China Medical University (No. 108-101).

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Appendix 1. Barrier-free environment construction items

Participants	Building handrails	Constructing slip-resistant flooring	Eliminating ground unevenness	Widening the exit or entrance	Improving the bathtub	Improving the toilet	Changing door panels	Room repartitioning
1	V	V			V			
2				V		V		
3	V	V		V		V		
4	V	V				V	V	V
5	V	V	V	V				
6	V	V	V					
7	V	V						
8				V				
9	V	V						
10		V						
11		V						
12		V						
13		V	V					
14	V	V						
15	V	V	V					
16	V							
17	V			V	V	V		V
18			V					
19		V						
20	V							
21	V							
22	V							
23	V							
24	V							
25	V							
26		V	V		V			V

Appendix 1. Continued

Participants	Building handrails	Constructing slip-resistant flooring	Eliminating ground unevenness	Widening the exit or entrance	Improving the bathtub	Improving the toilet	Changing door panels	Room repartitioning
27				V				V
28	V	V						
29	V							
30	V							
31	V	V						
32		V						V
33		V	V					
34		V	V					
35			V					V
36			V	V				
37	V				V			
38				V	V	V		
39	V			V		V		
40	V				V			
41		V						
42	V							
43	V							
44	V		V	V		V		
45		V						
46			V			V		V
47		V						
48			V	V				
49		V						
50	V							
51	V			V		V		V
52	V					V		
53	V	V						V
54		V						

Appendix 1. Continued

Participants	Building handrails	Constructing slip-resistant flooring	Eliminating ground unevenness	Widening the exit or entrance	Improving the bathtub	Improving the toilet	Changing door panels	Room repartitioning
55		V	V					
56		V	V					
57		V	V					V
58			V	V				
59			V	V				
60	V		V					
61	V		V					
62	V							
63	V	V						
64	V					V		V
65	V	V						V
66			V					
67	V					V		
68			V	V				
69	V			V				
70	V			V				
71	V				V			
72	V			V				