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# A Study on the Varied Needs for Age-Friendly Home Adaptations Among Elderly Individuals Living at Home and Their Influencing Factors

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**Abstract**

This study investigates the varied needs for age-friendly home adaptations among community-dwelling elderly individuals and their influencing factors based on the national Long-Term Care Disability Grading Assessment Standard. By constructing a three-dimensional assessment framework encompassing disability severity, family support, and home environment, the research reveals that elderly disability levels are significantly influenced by age, family emotional relationships, caregiver presence, and home safety environment. The findings demonstrate that single-dimensional assessments are inadequate for comprehensively identifying care needs, highlighting the necessity of establishing an integrated multidimensional assessment mechanism matching functional impairment with environmental factors. The study provides empirical evidence for developing tiered and categorized renovation strategies and offers practical guidance for achieving the strategic goal of home-based care within China's "9073" elderly care service system.

**Keywords:** Age-Friendly Home Adaptation; Disability Grading; Ageing in Place; Person-Environment Interaction

## 1. Introduction

Presently, China's population ageing process continues to accelerate, ushering society into the "silver age". According to the Seventh National Population Census, by 2023, the national population aged 60 and above reached 296.97 million, accounting for 21.1% of the total population; those aged 65 and above numbered 216.76 million, representing 15.4% of the total population.With the persistent growth of the elderly population, China has entered a stage of deep ageing, where the challenges of an ageing society are becoming increasingly pronounced. Concurrently, research by Liu et al., (2024), measuring elderly disability through Activities of Daily Living (ADL) limitations indicates that the ADL disability rate among the elderly in

China's eastern, central, and western regions stands at 24.93% , highlighting the escalating severity of elderly disability issues.

Disability not only severely impacts the quality of life for the elderly but also imposes a heavy care burden on families and society. Currently, home-based care remains the preferred model for elderly care in China and most countries: according to survey data from the National Health (Commission, 2021), China's elderly care model follows a "90-7-3" pattern, meaning 90% of the elderly choose home-based care, 7% rely on community-supported care, and 3% reside in institutional care. Internationally, approximately 88% of Americans aged 50-80 wish to remain in their own homes for as long as possible. Globally, around 90% of older adults prefer ageing in place (Zhou and Walker, 2021). Consequently, demand for age-friendly housing that ensures safety and convenience has surged.

Due to declining physiological functions, elderly individuals with disabilities demand higher standards of safety, convenience, and accessibility in their living environments. Home adaptations for ageing have thus become a crucial intervention to delay disability progression and enable ageing in place. Consequently, investigating factors influencing disability among the elderly—particularly the modifiable factor of the home environment—holds significant practical importance for slowing disability progression and enhancing the quality of care.

In 2021, the National Healthcare Security Administration and the Ministry of Civil Affairs jointly issued the "Long-Term Care Disability Grading Assessment Standard (Trial)" (Office of the National Healthcare Security Administration, 2021), establishing the first nationally unified disability grading assessment system. This adopts a three-dimensional combined assessment of activities of daily living, cognitive abilities, and sensory perception and communication capabilities. This standard provides a scientific basis for accurately identifying the home adaptation needs of elderly individuals with varying degrees of disability. However, existing research predominantly focuses on single-dimensional environmental modifications, such as installing anti-slip facilities, lacking a systematic assessment of age-friendly requirements based on disability severity. This results in inefficient allocation of adaptation resources, failing to meet the diverse and differentiated home environment needs of disabled groups.

The 14th Five-Year Plan for National Ageing Development and Elderly Care Services explicitly proposes implementing the "Home-Based Age-Friendly Adaptation" initiative, yet significant practical challenges persist. The elderly population exhibits considerable heterogeneity, with structurally distinct environmental needs across varying degrees of disability: those with mild impairment prioritise convenience and participation-enhancing modifications, such as kitchen counter height adjustments and smart assistive devices; whereas those with severe impairment rely more heavily on fundamental safety measures, including bathroom grab rails and emergency call systems.Existing adaptation schemes predominantly adopt a "one-size-fits-all" approach, overlooking how cognitive function and sensory impairments modulate adaptation needs. This leads to certain modifications being either "excessive" or "insufficient". The HOME FAST (Home-based Fall and Accident Screening Tool) developed by Mackenzie et al., (2009) demonstrates that targeted adaptations based on environmental risk assessments can effectively reduce elderly fall risks. However, this tool primarily focuses on physical environmental safety

and does not yet integrate disability level assessment. Research by (Guthrie et al., 2018) based on Canadian interRAI data indicates that multidimensional integrated assessment combining cognitive impairment with sensory impairments (vision, hearing) significantly outperforms single ADL assessment in predicting functional difficulties. This finding suggests that assessments of ageing-in-place modification needs should transcend single dimensions, establishing a comprehensive assessment framework matching "functional impairment with environmental factors".

Against this backdrop, this study aims to systematically investigate the variations in age-friendly adaptation needs among community-dwelling older adults and their influencing factors, based on nationally standardised long-term care disability grading standard. It seeks to construct an integrated "assessment-matching-intervention" approach for optimising age-friendly environments. Specific research objectives include: (1) analysing differentiated needs characteristics across disability grades (0-5) regarding home environment safety, convenience, and accessibility; (2) identifying moderating effects of cognitive function, sensory perception, and family support on age-friendly modification requirements; (3) developing a "disability-environment" matching tool adapted to the local assessment system, providing empirical evidence for precision-targeted modifications.

The theoretical significance of this research lies in: filling the gap in domestic studies on age-friendly environmental needs based on the 128-point comprehensive assessment system; validating the applicability of the Person-Environment-Occupation (PEO) theory among China's elderly population; and advancing the translation of long-term care insurance assessment outcomes into actionable age-friendly renovation solutions. Its practical value lies in: providing tiered and categorised renovation standards for the "14th Five-Year Plan for Home-Based Age-Friendly Renovation Implementation Scheme", supporting the strategic goal of achieving "90% home-based care" within the "9073" elderly care service framework, and ultimately enhancing the quality of life and sense of security for disabled elderly individuals living at home.

## 2. Current State of Domestic and International Research

### 2.1. Domestic Research Status

Domestic scholars have conducted a series of explorations on age-friendly modifications and disability issues among the elderly. Regarding assessment tool development, research on a long-term care needs assessment questionnaire for the elderly based on ICF theory has established a research foundation integrating multidimensional indicators such as activities of daily living and cognitive function, providing a localised assessment tool for this field. Zhang et al., (2024) research on the care knowledge and skill requirements scale for family caregivers of disabled elderly individuals has established a research foundation incorporating home environment age-friendly modifications, though a standardised environmental assessment-disability matching scheme has yet to be developed.

Regarding disability assessment standards, Wang (2019) study on the consistency between national long-term care disability grading standards and local standards has established a research

foundation for verifying the compatibility of national assessment standards with Shanghai's unified elderly care needs assessment standard, providing a basis for the localised application of assessment tools. Yang and Song (2025) study on the current status of age-friendly home modifications for community-dwelling disabled elderly individuals has established a research foundation for analysing regional variations in modification scores. It found higher scores for bathroom and bedroom modifications, while kitchen modifications lagged relatively.

Regarding innovations in healthy ageing models, domestic scholars actively explore diversified intervention measures. Research on multidisciplinary collaborative care models for healthy ageing and chronic disease management has established a foundation for constructing cross-professional teams integrating medical, nursing, and rehabilitation resources. Studies on "Internet Plus" elderly care service models have laid the groundwork for providing smart elderly assistance services such as intelligent health monitoring and online health management consultations—through information technology (Chen and Liu, 2023). However, dedicated research on matching mechanisms between disability levels and age-friendly renovation requirements remains scarce. Existing literature predominantly focuses on single-dimensional assessments of environmental modification effectiveness, lacking differentiated needs analysis based on a comprehensive three-dimensional assessment framework.

### 2.2. International Research Landscape

Internationally, Research on intervention strategies for healthy ageing and chronic disease management has established a foundation categorised into five major areas. multidisciplinary collaborative care, evidence-based nursing, patient self-management, clinical information systems, and lifestyle interventions (Xi et al., 2014).

Regarding smart ageing models, the UK's Life Trust Fund has established research foundations for its "Smart Ageing" concept. This involves organically integrating various entities within the elderly care service system through internet, big data, and IoT technologies, providing a theoretical framework to overcome the temporal and spatial limitations of traditional care models and deliver high-quality services (Chen et al., 2019). Research on the UK's community-based home care model has established a foundation for creating smart elderly care service centres at the community level, facilitating convenient and diverse localised care conditions for community elders. Its core lies in community development, with community-based home care considered the most suitable model for the UK's national context (Xu and Wang, 2019).

Regarding environmental assessment tools, Mackenzie's HOME FAST (Home-based Falls and Accidents Screening Tool) research has established a foundation for reducing elderly fall risks through environmental hazard assessment and targeted modifications, confirming the tool's efficacy in identifying domestic environmental risk factors. Garner and Holland (2020) Age-Friendly Environment Assessment Tool (AFEAT) research has established a foundation for evaluating the age-friendliness of living environments from an older person's perspective, confirming that individual frailty significantly impacts environmental perception and adaptation needs.

Regarding multidimensional comprehensive assessment, Guthrie 's integrated assessment of cognitive and sensory impairments based on Canadian interRAI data has established research foundations for predicting functional difficulties through multidimensional integration of cognitive impairment and sensory impairments (vision, hearing). This approach has demonstrated significantly higher predictive efficacy than single ADL assessments. Dikken et al. (2020)'s Age-Friendly Cities and Communities Questionnaire (AFCCQ) research has established a foundation for validating the effectiveness of multidimensional environmental assessment in predicting older adults' quality of life across 12 countries.

Current research trends indicate an international shift from singular environmental modifications towards "intelligent age-friendly" solutions. Ma et al. (2022)'s systematic review on smart home adaptation design strategies has established research foundations exploring how smart home technologies dynamically adjust environmental support levels according to disability severity, providing theoretical underpinnings for achieving precise "environment-to-person" adaptation.However, most overseas assessment tools are developed based on the characteristics of residential environments in developed countries. They differ from the residential environments, cultural habits, and assessment standards of China's elderly population, and their applicability in the Chinese context requires further validation.

## 3. Subjects and Methods

### 3.1 Subjects

This study employed a cross-sectional survey design. Between August 2024 and February 2025, an online questionnaire was administered to community-dwelling older adults to assess their needs for age-friendly home modifications. Questionnaire data were collected from electronic responses submitted by community-dwelling older adults in Zhejiang Province, Anhui Province, and other regions. A total of 335 valid questionnaires were ultimately obtained.

#### 3.1.1. Sample Sources and Inclusion standard

Inclusion standard: (1) Age ≥ 60 years; (2) Community residence with a preference for home-based care; (3) Clear consciousness and ability to complete the questionnaire assessment; (4) Informed consent and voluntary participation in the study.Exclusion standard: (1) Long-term hospitalisation or residence in care facilities; (2) Severe mental illness or cognitive impairment preventing assessment cooperation; (3) Incomplete questionnaires or those containing obvious logical errors; (4) Questionnaires completed in excessively short (<60 seconds) or long (>120 minutes) durations failing quality checks.

### 3.2. Research Tools

This study employs the "Assessment standard for Long-Term Care Disability Grades (Trial)" (Medicare Office Document (2021) No. 37), jointly issued by the National Healthcare Security Administration and the Ministry of Civil Affairs, as the basis for determining disability severity. This is supplemented by assessments of family support and the home safety environment, forming

a comprehensive tripartite assessment system encompassing "disability severity – family support – home environment".

### 3.2.1. Assessment Standards for Long-Term Care Disability Grading

This standard employs a combined assessment method to evaluate disability grades, with the core rationale being that single-dimensional functional assessments cannot comprehensively reflect elderly care needs. It necessitates integrating three interrelated dimensions—physical function, cognitive function, and sensory-perceptual function—through a matrix-based cross-determination process adhering to the principle of "taking the higher value" to achieve precise disability grading.

The standard employs a composite method for comprehensive disability grading, specifically integrating assessment results from three dimensions: the Activities of Daily Living (ADL) Assessment Form (Form C1, maximum 100 points), the Cognitive Function Assessment Form (Form C2, maximum 16 points), and the Sensory and Communication Function Assessment Form (Form C3, maximum 12 points).

The scoring standard for each dimension are as follows: In the Activities of Daily Living assessment, 100 points indicate full capacity; 65–95 points denote mild impairment; 45–60 points indicate moderate impairment; and 0–40 points signify severe impairment. In the Cognitive Function assessment, 16 points indicate full capacity; 4–15 points denote mild impairment; 2–3 points indicate moderate impairment; and 0–1 points signify severe impairment.For sensory and communication ability assessment: 12 points indicates intact ability; 4–11 points indicates mild impairment; 2–3 points indicates moderate impairment; 0–1 points indicates severe impairment. By combining the impairment levels of these three primary indicators, the final classification comprises six grades: Grade 0 (essentially normal), Grade 1 (mild impairment), Grade 2 (moderate impairment), Grade 3 (severe impairment I), Grade 4 (severe impairment II), and Grade 5 (severe impairment III). Where Levels 1–2 correspond to mild to moderate disability, and Levels 3–5 to severe disability.

The theoretical basis for this combined assessment logic lies in the fact that cognitive impairment and sensory impairment significantly amplify the impact of physical functional limitations. These three factors exhibit synergistic effects, necessitating integrated assessment to accurately identify the genuine care needs of older adults.

However, this standard primarily serves the determination of long-term care insurance benefits and does not yet encompass assessments of family support systems or the physical home environment. To comprehensively explore the interactions between "impairment-environment-support", this study builds upon the standard by supplementing it with a family member assessment scale and a home safety environment assessment scale, thereby forming a complete assessment toolkit.

### 3.2.2. The Five Assessment Scales in This Study

The five assessment scales employed in this study are internationally established measurement tools.

**(1) Activities of Daily Living (ADL) Assessment Scale**

Existing functional assessment studies by (Mahoney and Barthel, 1965), using the Barthel Index scale. This scale evaluates an individual's ability to perform ten aspects of daily living independently: eating, bathing, grooming, dressing, bowel control, bladder control, using the toilet, transferring between bed and chair, walking on level ground, and climbing stairs. With a total score of 100 points, a higher score indicates greater independence, providing the theoretical foundation for assessing activities of daily living in this research.

The scale demonstrates sound reliability and validity: test-retest reliability of 0.89 and inter-rater reliability of 0.95. Regarding validity, its correlation coefficient with the SF-36 physical functioning dimension is 0.74, and it effectively predicts hospitalisation duration, rehabilitation outcomes, and care requirements among elderly individuals.The Chinese version of the Barthel Index has undergone localisation validation, achieving a Cronbach's α coefficient of 0.89 and a content validity index (CVI) of 0.92. It is widely applied in the field of geriatric care assessment in China.

**(2) Cognitive assessment scales**

Existing research using the Mini-Mental State Examination (MMSE) employs this scale (Folstein et al., 1975), which assesses cognitive function across orientation, memory, attention and calculation, recall ability, and language skills. With a maximum score of 30, higher scores indicate better cognitive function, providing the theoretical foundation for cognitive assessment in this study.

This study employs the Cognitive Function Assessment Form (Form C2) from the Long-Term Care Disability Grading Assessment Standards. It comprises four secondary indicators: temporal orientation, personal orientation, spatial orientation, and memory, with a total score of 16 points. Scores are categorised into four levels: intact (16 points), mild impairment (4–15 points), moderate impairment (2–3 points), and severe impairment (0–1 point).

MMSE reliability and validity metrics: test-retest reliability ranged from 0.80 to 0.99, with inter-rater reliability at 0.95. Regarding validity, the correlation coefficient with the Wechsler Adult Intelligence Scale (WAIS) was 0.78, demonstrating 87% sensitivity and 82% specificity for dementia diagnosis.The Chinese version of the MMSE was adapted by the Department of Neurology at Peking Union Medical College Hospital, yielding a Cronbach's α coefficient of 0.85 and test-retest reliability of 0.91, demonstrating sound cultural adaptation and clinical utility.

**(3) Sensory and Communication Assessment Scale**

Existing research by Heine and Browning (2002) on sensory impairment and psychosocial consequences, involving analyses of the association between sensory function assessment and home environment adaptation, confirms that sensory impairment leads to difficulties in receiving environmental information, necessitating environmental compensation (e.g., brighter lighting, noise reduction, tactile signage). This provides a theoretical foundation for investigating the relationship between sensory function assessment and age-friendly environmental modifications.

Relevant research indicates this three-dimensional assessment framework possesses good convergent validity, with a correlation coefficient of 0.68 against the WHOQOL-OLD (World Health Organization Quality of Life for the Elderly) scale. It significantly predicts older adults' social participation and incidence of home safety incidents. Domestic validation studies show the scale's Cronbach's α coefficient is 0.76, with inter-rater reliability Kappa value of 0.82.

**(4) Family Member Assessment Scale**

The Long-Term Care Disability Grading Assessment Standard does not encompass assessment of the family support system, yet familial support constitutes a vital resource for elderly individuals receiving care at home. Existing research by Tang and Lee (2011) on social support networks and expectations for ageing in place has analysed the influence of social support networks on elderly individuals' willingness to remain in their own homes. This research confirms that the distance of children's residence and family support resources are significantly correlated with elderly individuals' choice to age in place, providing a theoretical foundation for assessing family member support.

The supplementary Family Member Assessment Scale developed for this study comprises seven indicators: basic information on the elderly individual, family structure, children's employment status, family emotional relationships, presence of a caregiver, caregiver experience, and caregiving time. This scale evaluates the completeness of the elderly person's family support system to investigate the influence of family support on the demand for age-friendly home modifications.

**(5) Home Safety Environment Assessment Scale**

The Long-Term Care Disability Grading Assessment Standard does not address home physical environment assessment, yet the environment is a key factor constraining elderly individuals' functional capabilities.Existing research on the HOME FAST (Home-based Fall and Accident Screening Tool) by Mackenzie and Byles addresses home environmental risk assessment and renovation effectiveness assessment. This tool comprises 25 inspection points, assessing home fall risks across lighting, flooring, staircases, furniture, and other aspects. With a maximum score of 25 points, higher scores indicate greater risk, providing the theoretical foundation for developing home safety environment assessment tools.

The supplementary home safety environment assessment scale developed in this study comprises 40 inspection indicators, including lighting, flooring, bathroom handrails, kitchen layout, stair anti-slip measures, furniture arrangement, and emergency call devices. It comprehensively evaluates the degree of home environment adaptation for ageing across three dimensions: environmental safety, convenience, and accessibility. This aims to investigate the relationship between disability levels and home environmental risks.

The tool's reliability and validity metrics are as follows: test-retest reliability of 0.95 and inter-rater reliability of 0.88. Regarding validity, it correlates with a history of falls among older adults at 0.42 ($p<0.01$), identifies 85% of households at high risk of falls, and reduces fall incidence by 36% following environmental modifications.Building upon this foundation, the study expanded the tool to 40 indicators covering dimensions such as lighting, flooring, bathroom handrails,

kitchen layout, stair anti-slip measures, furniture arrangement, and emergency call devices. Expert review yielded a content validity index (CVI) of 0.90, while a pre-survey (n=30) demonstrated a Cronbach's α coefficient of 0.82, indicating good internal consistency.

### 3.2.3. Integrated Application of the Assessment System

This study integrates the aforementioned five scales into a three-dimensional assessment framework: "Degree of Disability – Family Support – Home Environment". The Degree of Disability dimension: assesses disability levels from 0 to 5 through the combined assessment of Tables C1, C2, and C3. The Family Support dimension: identifies support resources and care gaps via the Family Member Assessment Scale. The Home Environment dimension: quantifies environmental risks and renovation needs through the Home Safety Environment Assessment Scale.

The integrated application of these three dimensions aims to overcome the limitations of single-dimensional assessment, establishing an age-friendly renovation needs assessment system grounded in disability level, conditioned by family support, and targeted at the home environment. This provides a scientific basis for designing precise, personalised age-friendly renovation solutions.

## 3.3. Statistical Methods

Data entry, organisation, and statistical analysis were conducted using SPSS 26.0 software, with $\alpha=0.05$ as the significance level.

### 3.3.1. Data Description Methods

Count data were statistically described using frequency (n) and percentage (%). For quantitative data, after normality testing (Shapiro-Wilk test), those meeting normal distribution were expressed as mean ± standard deviation ($\bar{x} \pm s$), while those not meeting normal distribution were expressed as median (interquartile range) [M (P25, P75)].

### 3.3.2. Univariate Analysis Methods

Independent samples t-tests or one-way analysis of variance (ANOVA) were employed to compare intergroup differences in disability levels among elderly individuals with varying characteristics.Levene's test was employed to assess homogeneity of variances. Where variances were unequal, Welch's t-test or Brown-Forsythe corrected ANOVA was used. Post-hoc multiple comparisons were conducted using LSD or Tamhane's T2 method. Categorical variables were compared between groups using $\chi^2$ test or Fisher's exact test.

### 3.3.3. Multivariate Analysis Methods

Multivariate linear regression analysis was employed to investigate the impact of the home safety environment on disability levels, with disability grade as the dependent variable and total home safety environment score as the independent variable, controlling for confounding factors such as age, gender, and household registration status. Regression model diagnostics included residual normality testing, multicollinearity testing (VIF < 10), and Durbin-Watson testing.

## 4. Results

### 4.1. Basic Information of Elderly Participants

This study included 335 community-dwelling older adults. The distribution of basic demographic characteristics and health status is presented in Table 1. Basic information comprised demographic characteristics, residential status, housing type, presence of chronic diseases, and history of falls at home within the past year. Demographic characteristics included gender, age, household registration status, medical insurance participation, and monthly income.

Table 1 indicates that women constituted 54.9% of the cohort, with the majority aged 60–74 years (62.4%). Rural residence accounted for 73.7%. The overwhelming majority were enrolled in the Urban and Rural Residents' Medical Insurance scheme (77.0%), and the predominant monthly income bracket was ¥1,000–3,000 (40.0%). Living arrangements predominantly involved cohabitation with spouses (55.8%). Chronic conditions affected 51.3% of participants, while 15.8% had experienced a fall at home within the preceding year.

**Table 1. Basic Information of Elderly Participants (N=335)**

| Question | Option | Frequency | Percentage (%) |
|---|---|---|---|
| Gender | Male | 151 | 45.1 |
| | Female | 184 | 54.9 |
| Age | 60–74 | 209 | 62.4 |
| | 75–89 | 115 | 34.3 |
| | Over 90 | 11 | 3.3 |
| Household registration | Urban | 88 | 26.3 |
| | Rural | 247 | 73.7 |
| Medical insurance coverage | Urban and Rural Residents' Medical Insurance | 258 | 77 |
| | Urban Employee Medical Insurance | 22 | 6.6 |
| | State-funded Medical Care | 32 | 9.6 |
| | Other | 23 | 6.9 |
| Monthly income (RMB) | 1000-3000/month | 134 | 40 |
| | Below ¥1,000/month | 134 | 40 |

| | | | |
|---|---|---|---|
| | Over 3000/month | 67 | 20 |
| Living Arrangements | Living alone | 51 | 15.2 |
| | Living with other family members | 10 | 3 |
| | Other | 3 | 0.9 |
| | Living with spouse | 187 | 55.8 |
| | Living with children | 84 | 25.1 |
| Type of residence | Flats with lifts | 55 | 16.4 |
| | Staircase building | 183 | 54.6 |
| | Bungalow | 84 | 25.1 |
| | Other | 13 | 3.9 |
| Chronic conditions | No | 163 | 48.7 |
| | Yes | 172 | 51.3 |
| Have you had a fall at home within the past year? | No | 282 | 84.2 |
| | Yes | 53 | 15.8 |

### 4.2. Univariate Analysis of Factors Influencing Disability Levels in the Elderly

Using the disability level (0-5) determined by the National Long-Term Care Disability Assessment Standard as the dependent variable, a single-factor analysis was conducted with gender, age, place of residence, whether children work locally, whether family can be contacted in emergencies, emotional relationship with family members, and presence of a caregiver as independent variables.Results indicated that age, emotional relationship with family members, and presence of a caregiver significantly influenced disability level. No statistically significant differences were observed for gender, place of residence, whether children worked locally, or whether family could be contacted in emergencies.

Independent samples t-tests and one-way ANOVA confirmed that gender ($t = -0.832$, $p = 0.406$), household registration (urban vs rural, $t = 0.945$, $p = 0.345$),whether children worked locally ($F = 1.234$, $p = 0.297$), and whether family members could be contacted in emergencies ($F = 0.876$, $p = 0.419$) showed no statistically significant effect on the degree of disability in older adults ($p > 0.05$). These variables were therefore excluded from subsequent analyses.

#### 4.2.1. Impact of Age on Elderly Disability Levels

Table 2 presents the results of the one-way ANOVA, indicating that age significantly influences the degree of disability ($F = 18.243$, $p < 0.001$). This demonstrates statistically significant differences in disability levels across different age groups.This finding aligns with previous research by Guthrie et al., where advancing age is associated with progressive physiological decline. Deterioration in musculoskeletal, neurological, and sensory organ function progressively limits activities of daily living.In this study, the 60–74 age group constituted 62.4% of participants and exhibited relatively mild disability levels. Conversely, disability grades significantly increased in the 75–89 age cohort and the ≥90 age cohort, suggesting advanced age is a key predictor of disability risk.

Post hoc multiple comparisons (LSD) revealed thatthe disability levels in the 75–89 age group and the 90+ age group were significantly higher than those in the 60–74 age group ($p < 0.001$). However, no statistically significant difference was observed between the 75–89 age group and the 90+ age group ($p > 0.05$), potentially attributable to the small sample size in the 90+ group ($n = 11$, 3.3%). This finding suggests that 75 years may represent a critical age threshold for a steep increase in disability risk. Age-friendly adaptations should therefore prioritise individuals aged 75 and above, implementing preventive interventions to delay the progression of disability.

**Table 2. Results of univariate analysis of variance for age on disability severity**

| Group | SS | *df* | MS | *F* | *p* |
|---|---|---|---|---|---|
| Between groups | 14.053 | 2 | 7.026 | 18.243 | .000 |
| Within group | 127.106 | 330 | .385 | | |
| Total | 141.159 | 332 | | | |

#### 4.2.2. Influence of Emotional Relationships with Family Members on the Degree of Disability in Older Adults

Table 3 presents the results of a one-way ANOVA, indicating that emotional relationships with family members significantly influence disability levels ($F = 30.888$, $p < 0.001$). This demonstrates that elderly individuals with differing levels of emotional support exhibit significant variations in disability severity. This finding highlights the importance of "quality" within the family support system—compared to structural support such as whether children work locally or can be contacted urgently, the closeness of emotional relationships exerts a more direct protective effect on the functional status of older adults.

Analysing the underlying mechanisms, positive family emotional bonds may influence disability levels through the following pathways: Firstly, emotional support alleviates psychological stress among the elderly, reducing depression and anxiety, with mental health being

closely linked to physical functioning;Secondly, harmonious intergenerational relationships encourage older adults to actively express care needs, facilitating timely access to daily assistance. Furthermore, emotional bonds enhance older adults' sense of self-worth and life purpose, motivating sustained participation in daily activities and thereby delaying functional decline. These findings resonate with Tang and Lee's research on social support networks and expectations for ageing in place, confirming the central role of familial emotional support in healthy ageing.

**Table 3. Univariate analysis of variance results for emotional relationships with family members and degree of disability**

| Group | SS | *df* | MS | *F* | *p* |
|---|---|---|---|---|---|
| Between groups | 31.021 | 3 | 10.340 | 30.888 | .000 |
| Within group | 110.138 | 329 | .335 | | |
| Total | 141.159 | 332 | | | |

### 4.2.3. Impact of Caregiver Presence on Elderly Disability Levels

Levene's test indicated unequal variances between groups ($F = 47.351$, $p < 0.001$), suggesting marked heterogeneity in the distribution of disability levels between cared-for and uncared-for cohorts. This may reflect an interaction between care needs and disability severity—elderly individuals with higher disability levels are more likely to receive care arrangements, thereby forming a dichotomy of "high disability-cared for" and "low disability-no care" polarisation. Consequently, this study employed a t-test without assuming equal variances for correction analysis.

Table 4 results indicate that care provision status significantly influences disability levels ($t = 4.011$, $df = 76.967$, $p < 0.001$). Elderly individuals with care support exhibit significantly lower disability levels than those without. This seemingly paradoxical finding (as care is typically assumed for the severely disabled) may reflect care's "health-protective effect" (Li et al., 2022): namely, continuous family care enables timely responses to elderly individuals' needs, preventing secondary functional impairments such as falls, malnutrition, and activity limitations caused by lack of assistance, thereby maintaining their existing functional levels. Furthermore, the presence of a caregiver may also signify earlier identification of health issues, more regular medication management, and more proactive supervision of health behaviours.

However, this finding also highlights potential risks associated with the caregiver burden—while the level of disability among older adults with caregivers in this study was relatively low, caregivers themselves may face multiple challenges including physical and mental exhaustion, social isolation, and financial strain.Therefore, age-friendly adaptations should not only focus on the elderly themselves but also incorporate caregiver support into systematic design. This includes environmental modifications to reduce caregiving burdens (such as installing hoists and handrails

to minimise physical exertion) and providing supportive measures like respite services and skills training(Yan et al., 2023).

**Table 4. Independent samples t-test results for degree of disability with and without caregivers**

| | | Levene's test for equality of variances | | Mean equality t-test | | |
|---|---|---|---|---|---|---|
| | | *F* | *p* | *t* | *df* | *p (sig.)* |
| Disability Level | Assumed equal variance | 47.351 | .000 | 5.666 | 331 | .000 |
| | No assumption of equal variance | | | 4.011 | 76.967 | .000 |

### 4.3. Linear regression analysis of home safety environment on disability level

Table 5 regression analysis results indicate that the total home safety environment score exhibits a significant negative predictive effect on disability level ($\beta = -0.316$, $p < 0.001$), with the model explaining 10.0% of the variance in disability level ($R^2 = 0.100$). Specifically, a one-point increase in the home safety environment assessment score was associated with an average reduction of 0.040 units in the disability level among older adults, suggesting that improving the home safety environment may help delay the progression of disability.

In terms of effect size, the standardised regression coefficient $\beta = -0.316$ indicates a moderate effect of environmental factors, demonstrating practical significance among univariate predictors (Cohen, 2013). This finding resonates with conclusions from studies using the HOME FAST tool developed by Mackenzie et al., confirming the association between home environmental risks and functional status in older adults. However, the relatively limited explanatory power of environmental factors in this study (10%) suggests that disability levels are also influenced by multiple factors such as age, chronic diseases, cognitive function, and family support. Future research should develop more comprehensive predictive models.

It is noteworthy that this study employed a cross-sectional design. The negative relationship between the environmental composite score and disability level may reflect a bidirectional causal mechanism (Wang et al., 2026): on the one hand, a safe home environment can indeed reduce fall risks, enhance confidence in mobility, and promote functional maintenance; on the other hand, older adults with higher levels of disability may "passively avoid" environmental risks due to mobility limitations, or be unable to improve their living environment due to financial constraints, thereby forming the association of "low disability-high environmental score" and "high disability-low environmental score".

From a practical implementation perspective, the home safety environment assessment scale developed in this study encompasses 40 indicators including lighting, flooring, bathroom handrails, kitchen layout, stair anti-slip measures, furniture arrangement, and emergency call

devices. This provides an operational assessment tool for community-based home adaptations for ageing in place. Guided by the "disability-environment" matching principle, it is recommended that bathroom safety modifications (installing grab rails, anti-slip mats, and toilet seats), bedroom emergency call system installations, and kitchen counter height adjustments be prioritised for moderately to severely disabled elderly individuals. For those with mild disability, emphasis should be placed on lighting improvements, floor levelling, and the introduction of smart assistive devices, thereby achieving tiered and categorised precision modifications.

**Table 5. Linear regression analysis results of home safety environment on disability level**

| Model | Unstandardised Coefficient | | Standardised Coefficient | *t* | *p* |
|---|---|---|---|---|---|
| | B | SE | Beta | | |
| (Constant) | 2.487 | .200 | | 12.463 | .000 |
| Home safety | -0.040 | .007 | -0.316 | -6.064 | .000 |

Note: The dependent variable is disability level; $R^2$= 0.100; adjusted $R^2$= 0.097.

## 5. Discussion

### 5.1. Multifaceted Mechanism Analysis of Factors Influencing Disability Severity

This study systematically examined the influence of age, family emotional relationships, presence of caregivers, and home safety environment on the degree of disability among community-dwelling older adults through univariate analysis and linear regression analysis. The findings revealed a multidimensional determinants mechanism for disability levels, providing empirical evidence for understanding the "person-environment-support" interaction.

Age emerged as the strongest predictor in this study, with its significant influence ($F = 18.243$, $p < 0.001$) aligning with the objective patterns of physiological ageing. Notably, this study identified 75 years as a critical threshold for a steep increase in disability risk, aligning with Liu Ying et al.'s findings on regional disparities in disability among middle-aged and elderly individuals across eastern, central, and western China. That research indicated advanced age as the core driver of rising disability rates, alongside significant regional heterogeneity. Within this study's sample, 73.7% resided in rural areas and 54.6% lived in staircase dwellings. This residential configuration, compounded by advanced age, further amplified the impact of environmental barriers on functional limitations. Consequently, age-friendly adaptations should establish an age-stratified mechanism, implementing preventive and proactive environmental interventions for individuals aged 75 and above to delay the progression of disability.

The significant impact of familial emotional relationships on disability severity ($F = 30.888$, $p < 0.001$) reveals the core characteristic of "quality over quantity" within family support systems. In this study, older adults with harmonious emotional ties to family members exhibited significantly lower disability levels, whereas structural factors such as whether children worked

locally or whether family could be contacted in emergencies showed no significant effect.This finding aligns with Tang and Lee's research on social support networks and expectations for ageing in place, which confirmed significant correlations between children's residential proximity, family support resources, and elderly individuals' choice to remain at home. However, this study further demonstrates that the quality of emotional relationships exerts a stronger functional protective effect than geographical proximity. Regarding the mechanism of action, positive family emotional relationships may influence functional status through three pathways: psychological buffering (alleviating depression and anxiety), behavioural motivation (enhancing activity participation), and care responsiveness (timely access to assistance). These findings hold significant implications for long-term care insurance assessment systems: the current three-dimensional assessment framework , primarily focusing on activities of daily living, cognitive abilities, and sensory-perceptual and communication capacities, should incorporate a socio-emotional dimension to comprehensively identify older adults' genuine care needs.

Analysis distinguishing between those with and without caregivers revealed the double-edged sword effect of care support. Levene's test indicated significant variance heteroscedasticity between groups ($F = 47.351$, $p < 0.001$), suggesting a dichotomy of "high dependency with caregivers" versus "low dependency without caregivers". Corrected t-tests revealed that older adults with caregivers exhibited significantly lower levels of disability ($t = 4.011$, $p < 0.001$), reflecting caregiving's "health-protective effect": sustained family care prevents secondary functional decline and maintains existing functional levels.However, this finding also signals potential risks associated with caregiver burden. Research by Zhang Sisi et al. on the knowledge and skill requirements of family caregivers for disabled elderly individuals indicates that caregivers face multiple challenges, including inadequate knowledge and skills, significant psychological pressure, and insufficient social support. Therefore, age-friendly modifications must adopt a dual-centred perspective focusing on both the elderly and their caregivers. This involves installing facilities such as hoists and handrails to reduce physical strain on caregivers, complemented by supportive measures including care skills training and respite services. Such an approach achieves the social impact of modifying one person's environment while liberating an entire family.

The significant negative predictive effect of home safety environments on disability levels ($\beta = -0.316$, $p < 0.001$) confirms the importance of environmental interventions. However, the explanatory power of $R^2 = 0.100$ indicates the limitations of relying solely on environmental factors. This finding resonates with research on the HOME FAST tool developed by Mackenzie et al., which demonstrated that targeted modifications following environmental risk assessments effectively reduce elderly fall risks. Nevertheless, the home safety environment assessment scale developed in this study, encompassing 40 indicators, proved more comprehensive than HOME FAST's 25 checkpoints yet still failed to fully account for disability variance. This underscores that disability represents a complex outcome intertwining multiple factors including age, disease, cognition, environment, and support. Guthrie et al.'s study based on Canadian interRAI data indicates that multidimensional integrated assessment combining cognitive impairment with sensory impairment significantly outperforms single ADL assessment in predicting functional

impairment. This suggests future development of comprehensive predictive models integrating physical function, cognitive status, sensory perception, environmental characteristics, and family support.

### 5.2. Research Limitations

#### 5.2.1. Sample Limitations

The study sample primarily comprised community-dwelling older adults from Zhejiang Province (91.0%) and Anhui Province (7.5%), with geographical distribution concentrated in eastern regions. Samples from central, western, and northeastern regions were absent. Given China's vast territory, significant regional variations exist in economic development levels, residential environment characteristics, and elderly care cultural practices. For instance, the study did not account for northern regions' central heating requirements or southwestern regions' mountainous housing features.Furthermore, 73.7% of the sample held rural household registrations. While this aligns with the current reality of higher rural ageing rates than in urban areas, the urban-rural imbalance may lead to an underestimation of urban age-friendly renovation needs. Future research should expand the sampling scope, employing stratified random sampling to include samples from more provinces and regions with varying levels of economic development, thereby enhancing the generalisability of the findings.

#### 5.2.2. Limitations of Data Collection Method

Data collection utilised an online questionnaire format, which, while enhancing efficiency, carries significant risks of selection bias. Elderly individuals capable of completing questionnaires via smartphones or computers typically possess higher educational attainment, better cognitive function, and more proactive health awareness. Conversely, those with lower education levels, cognitive decline, or mobility issues may be systematically excluded. The high proportion of participants with intact cognitive abilities (16 points) in this study may relate to this selection mechanism. Furthermore, electronic questionnaires preclude on-site environmental observation, leaving assessments of home safety environments reliant on self-reports from older adults. This introduces potential recall bias and social desirability bias (e.g., overestimating home safety). Future research should adopt a blended "online + offline" approach, conducting in-person home visits for older adults unable to use electronic devices and incorporating on-site environmental observations to enhance data authenticity and reliability.

## 6. Conclusion

This study, grounded in the national "Long-Term Care Disability Grading Assessment Standard (Trial)", constructed a "Disability Level-Family Support-Home Environment" three-dimensional assessment framework. A survey of 335 community-dwelling elderly individuals regarding their needs for age-friendly home modifications revealed that disability levels are influenced by multiple factors including age, family emotional relationships, presence of caregivers, and home safety environment. Key findings include: 75 years being a critical threshold for disability risk; family emotional support being superior to structural support;

caregivers exhibiting a "health protection effect";Each 1-point improvement in home environment reduces dependency level by 0.040 units, confirming significant "person-environment-support" interactions. Single-dimensional assessments prove inadequate for comprehensively identifying care needs. A five-dimensional integrated assessment mechanism must be established. This informs categorised renovation strategies: prioritising foundational safety for moderately to severely dependent individuals, focusing on functional convenience for mildly dependent individuals. Policy recommendations include incorporating the socio-emotional dimension into long-term care insurance assessments and adopting a dual-centred perspective for both elderly individuals and caregivers. These findings provide graded classification standards for the Implementation Plan for Home-Based Age-Friendly Renovations under the 14th Five-Year Plan, offering practical value for achieving the strategic objectives of the "9073" elderly care service system. Future research should expand sample sizes and employ prospective designs to validate the causal effects of environmental interventions.Implementation Plan for Age-Friendly Home Adaptations," offering practical value for achieving the strategic goal of the "9073" elderly care service system. Future research should expand sample sizes and employ prospective designs to validate the causal effects of environmental interventions.

**Author Contributions:**

Luyao Pan contributed to the conceptualization, methodology, and data analysis of the study. Wanting Lin provided guidance on theoretical framing and critical revisions of the manuscript. Xiangyu Chen supervised the overall project and coordinated the research process. All authors have read and agreed to the published version of the manuscript.

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**Conflicts of Interest:**

The authors declare no conflict of interest.

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