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Development of a Korea-specific Home Safety Assessment Tool for the Elderly

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ABSTRACT

With the advent of aging society,the expectations for welfare servicesare continuously on the rise. In this context, it is necessary to evaluate the home environment suitable for the common living environment in Korea. This study was conducted to develop a Korea-specific home safety assessment tool for the elderly and to verify its reliability and validity. After collecting existing home safety assessment items, we performed a Delphi survey with an expert panel. We selected 57 preliminary items by analyzing the content validity ratio, convergence, consensus, andconcurrence, followed by data collection from 116 older adults with the preliminary items. By analyzing the internal reliability and construct validity of the assessment items composing each factor, we developed an assessment tool consisting of 55 items grouped together into nine factors, namely, porch/entrance, living room/bedroom (movement + floor), bathroom, kitchen, utility room and balcony, interior and exterior stairs, prevention of accidents (emergency + general).The Korea-specific home safety assessment tool for the elderly developed in this study is expected to be useful for creating a safe home environment for community-based older adults.

Keywords
Assessment, Community, Elderly population, Environment modification, Home safety

Introduction

In Korea, the elderly population is increasing rapidly as life expectancy is increasing due to medical advances and improved living standards [1], and the proportion of safety accidents among older adults is also increasing every year [2]. In particular, safety accidents at home account for the largest proportion with 60.5%, according to an in-depth analysis of safety accidents among older adults conducted by the Korea Consumer Agency in 2017, most frequently during basic daily life activities (49.7%), followed by unpaid work (23.9%), and leisure activities (6.8%) [2]. However, home safety awareness is low despite the fact that the majority of safety accidents among older adults occur at home, and there is a compelling need for home safety management and education [3].

With increasing age, our living area gradually narrows to the residential space, and the time spent at home during the day becomes longer. For this reason, the home environment is more significant to older adults compared to other age groups [4, 5]. Not only does a home environment suitable and stable for older adults reduce physical risk, but it also serves the functions of ensuring individual autonomy and promoting social participation [6]. While the home environment meant in fact only physical space in the past, increasing importance is attached to other factors such as physical and emotional health, social relationships, and safety and social security [7]. In line with these changes, a safe and efficient home environment induces older adults to actively participate in society and has important implications for improving their health and quality of life [8].

Most older adults wish to continue to live in their own home and thus have low residential mobility, and it is thus necessary to provide them with facilities for residential convenience and modify their living environment to ensure to maintain independent living in their own home [9]. A simple arrangement such as a safety handle can prevent falls. Such modifications of the home environment can have the effect of helping older people better manage their lives and maintain independent daily activities by providing an environment that enables them to continue to live in the familiar living space. As such, it can also function as a home welfare measure for the elderly [9].

However, the home environment of most of older people in Korea is designed for an unspecified majority, and does not consider universal design or barrier-free design customized for each individual [10]. Although various housing policies for the elderly population are in place in Korea, such as the "Home Renovation Manual for the Elderly" and the "Act on Support for Underprivileged Group, Disabled Persons and Age, etc.," the home environment of many senior citizens does not meet even the minimum standards for safety. Unfavorable home environment conditions of

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older adults automatically lead to abnormal housing forms, which is becoming a social problem [10, 11]. In fact, "social hospitalization," a phenomenon of seniors who are not provided with a safe and efficient home environment staying in hospitals or residential care centers although they do not require healthcare or aged care services, is even taken for granted [12]. In 2016, 48.1% of the mid-to-long-term elderly inpatients receiving medical benefits were hospitalized for reasons other than healthcare, such as lack of caregivers and poor living conditions [13], and most of them were found to be capable of independent living with some assistance [14].

To address this problem, the Ministry of Health and Welfare launched a community care project in 2019 and set up a system to provide social services for senior citizens and people with disabilities to help them live an independent life in community settings, and the project is spreading rapidly [15]. These social services come with increasing demand for home environment improvement, and some local governments, e.g., Gwangju, Jeonju (Jeollabuk-do), Cheonan (Chungcheongnam-do), and Ansan (Gyeonggi-do), provide home environment evaluation and customized home environment interventions according to individual conditions under the involvement of occupational therapists [16].
Advanced countries have long been implementing projects for stabilizing life in old age in preparation for an aging society, of which the UK community care and Japanese regional comprehensive care are prime examples [17]. In addition, Japan has been implementing various housing policies since the 1990s to improve senior citizens' independent living and reduce the healthcare burden, such as the development of housing design guidelines for the elderly, house remodeling support, and enactment of a law on residence stability for the elderly [18].

Assessment tools commonly used in Korea are the Korean versions adapted from the tools developed in foreign countries, which has the advantage of introducing verified tools of widespread international use into Korea. However, the characteristics of the home environment are formed by reflecting various factors such as climatic conditions, cultural traits, and social and economic structures of each country. Therefore, countries like the United States and Australia have developed home environment assessment tools taking into account their own characteristics. If a Korea-specific home environment assessment tool is developed, it will be used more widely and efficiently[19]. In addition, the assessment tools currently used in Korea are focused on falls and space arrangement and it is difficult to assess other risk factors such as fire or gas leakage at home. According to previous research, safety accidents among older adults involves not only loss of balance due to deteriorated physical ability and falls due to reduced capacity of walking, but also fire, gas leakage, and electric shock due to deterioration in sight, hearing, cognition, and perception capacities. which need to be taken into consideration [20]. Therefore, it is necessary to develop a home safety assessment tool that provides a safety checklist more sensitive to these aging-related risks while taking Korea-specific sociocultural features into account.

In view of these aspects, this study collects assessment items and composes a set of objective items suitable for the housing types in Korea, and develops a Korea-specific home safety assessment tool that can be used to improve the home environment of older people by assessing all risks associated with the home environment, let alone fall prevention.

Literature Review

The American Occupational Therapy Association recommends the use of SAFER-HOME (Safety Assessment of Function and the Environment for Rehabilitation) and I-HOPE (In-Home Occupational Performance Evaluation) designed to assess home environment and to measure ability to perform daily activities at home at the same time [21, 22]. Australia has also developed and uses its own assessment tools that reflect the home environment and culture of the country, such as HOME FAST (Home Falls and Accidents Screening Tool)andWeHSA (Westmead Home Safety Assessment) [23, 24]. Other advanced countries also use assessment tools developed to assess the home environments, such as Cougar Home Safety Assessment (CHSA) and the Housing Enabler [25, 26].

Two Korean studies verified the reliability and validity of the home safety assessment tools adapted into Korean: Home Falls and Accidents Screening Tool (K-HOME FAST) and Home Safety Self-Assessment Tool (K-HSSAT)[19, 27]. Also reported are Home Environmental Checklist (HEC) and Checklist for Home Fall Hazard (CHFH) [28, 29].

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Methods

Subjects

A panel of experts for the Delphi survey

We conducted a 3-round Delphi survey from October to November 2020. The questionnaire was delivered to and collected from a panel of experts by email. The selection criteria for the panelists were (i) at least five years' career experience in a specialized agency related to older people's safety and security and (ii) past and current experience of providing home environment modification services. The expert panel consisted of a total of 9 members (two professors of occupational therapy, one professor of architectural engineering, four occupational therapists, one social worker, and one architecture engineer). Prior to the survey, the purpose of the study was explained to the panelists in great detail, and written consent to participate was obtained from each of them (Table 1).

Table 1. The Characteristics of Participations for Delphi Survey

Characteristics		N	%
Gender	Male	5	55.6
	Female	4	44.4
Age	20's	2	22.2
	30's	5	55.6
	40's	1	11.1
	50's	1	11.1
Level of education	Bachelor	2	22.2
	Master's course	2	22.2
	Master	2	22.2
	Doctor's course	1	11.1
	Doctor	2	22.2
Period of working	5-9 years	3	33.3
	≥ 10 years	6	66.7
Job	Professor of Occupational Therapy	2	22.2
	Occupational Therapist	4	44.4
	Social worker	1	11.1
	Professor of Architectural Engineering	1	11.1
	Specialist of Architectural Engineering	1	11.1

Home environment assessment of community-based older adults

Using the assessment items selected through the Delphi process, we collected the responses to the items from 116 senior citizens living in Seo-gu, Gwangju. Subjects were recruited using purposive sampling and snowball sampling, which are non-probability sampling methods. Data were collected from November to December 2020.

Research process

The Home Safety Assessment Tool for Korean Older Adults was developed in five sequential phases (Figure 1).

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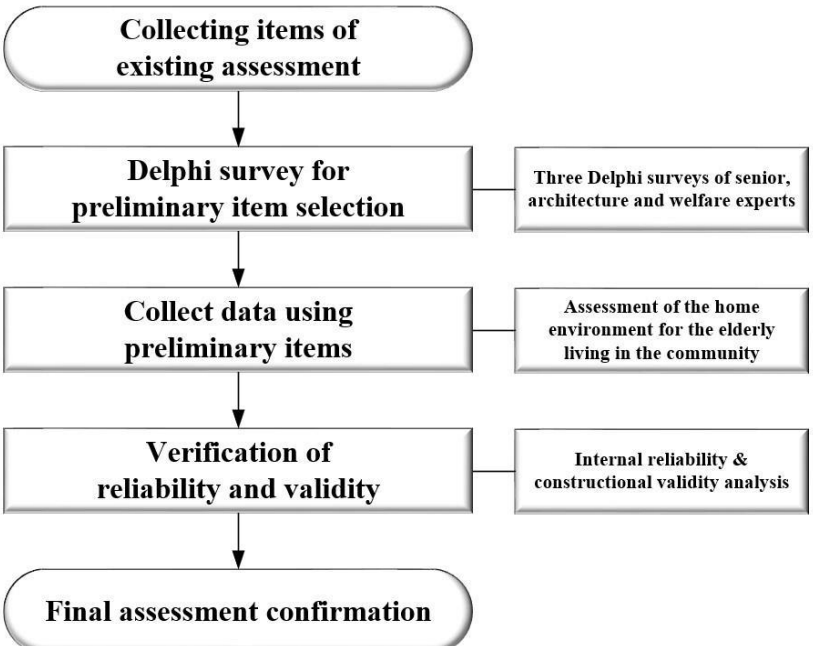

Figure 1. Process of Study

Phase 1: Preliminary item collection of existing assessment tools

In order to collect the items of the existing home safety assessment tools, we searched academic databases, such as PubMed, Medline, ProQuest, Science Direct, Wiley Online, and Taylor & Francis Online, from September 1 to 30, 2020, using the search terms such as "safety home," "home assessment," "elderly," "home environmental assessment" and derivatives and combinations thereof. A total of nine psychometric tools were retrieved, of which five were finally selected under the selection criteria of being the most widely used tool in the countries concerned and containing not only fall or space arrangement, but also the ability to perform daily activities (Table 2).

Table 2. Assessment Tools for home safety by Literature Search

Assessment	Studies
Cougar Home Safety Assessment 5.0	Fisher, et al. (2019)
A Home Hazard Checklist for Seniors	Lynn Shaw, et al. (2005)
The Housing Enabler	Steinfeld, et al. (1979)
Korean Version of the Home Falls and Accidents Screening Tool (K-HOME FAST)	Ju, et al. (2019)
Korean Version of the Home Safety Self-Assessment Tool (K-HSSAT)	Park, et al. (2017)

Phase 2: Delphi survey for preliminary item selection

After converging similar items by comparing the contents of the items extracted from the selected tools, 193 items were selected in the first screening. After correcting the preliminary items taking account of their meanings and deleting or reintegrating similar items, 84 items were finally selected. Then we drafted an open-ended questionnaire for round 1 Delphi survey to solicit opinions from the panelists about the item correction, integration, deletion, and insertion. Based on the responses received from the panelists through round 1 Delphi survey, we reformulated a structured questionnaire for round 2 Delphi survey, with the questionnaire provided with a 5-point Likert scale (1 = Strongly agree, 2 = Agree, 3 = Neutral, 4 = Disagree, 5 = Strongly disagree) to test the adequacy. Based on the responses received from the experts through round 2 Delphi survey, we integrated, corrected, inserted, or deleted items. In the third round, each Delphi panelist was provided with a questionnaire that includes the items with the ratings he/she gave in the previous round with a request to revise the opinion. Based on the results of the third round

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Delphi survey, we selected preliminary items by analyzing the content validity ratio, convergence, consensus, and concurrence.

Phase 3: Data collection using preliminary items

A home safety self-assessment was administered to 116 older adults using 57 items selected using a 3-round Delphi process. Each item was rated on a 3-point Likert scale (1 = Not appropriate, 2 = Appropriate, 3 = Excellent).

Phase 4: Verification of reliability and validity

The collected data were used for analyzing the internal reliability of the items constituting each factor to check whether they were estimating a consistent concept. In addition, to verify the validity of the construct validity, we performed an exploratory factor analysis and reconstructed the initially constructed factors.

Phase 5: Assessment tool composition

We named each factor based on the results of reliability and validity analysis and completed the assessment tool development process by setting the order of the items, finalizing the questionnaire, and naming the assessment tool.

Data Analysis

Data analysis was performed using the Microsoft Excel 2010, SPSS v23.0 program. To identify the subjects' characteristics, the collected data was analyzed with descriptive statistics such as frequency, percentage, mean, and standard deviation. To construct Korea-specific home safety self-assessment items for the elderly, we verified the content validity by converging expert opinions by means of a 3-round Delphi survey. Based on the theory presented by Lawshe (1975), the cut-off content validity ratio was set to 0.33.

To construct the assessment tool, we performed reliability and validity verification. The response reliability of each item was established by analyzing Cronbach's α. There are five levels of item-total correlation coefficient: < 0.2 indicates a very low reliability; < 0.4 low reliability; < 0.6 reliable; < 0.8 high reliability; ≥ 0.8 very high reliability. When eliminating an item, its item-total correlation coefficient was checked [31].

We classified the factors that compose the assessment scale based on the results of an exploratory factor analysis performed on the items verified through reliability analysis. For factor analysis, we applied the principal component analysis with varimax rotation. In the interpretation of the analysis results, the sampling adequacy was determined under the following criteria: the significance probability of the Bartlett test of sphericity; the Kaiser-Meyer-Olkin (KMO) test value ≥ 0.5 or higher [32]; the eigenvalue of each factor ≥ 1.0; factor loading of each item ≥ 0.4 for being a social science study [33].

Results

Selection of preliminary items

Table 3 presents the response rates of the 3-round Delphi survey conducted on the expert panel using 84 items selected from among the existing assessment items.

Table 3. Personnel Selection and Response Rate of Delphi unit : n (%)

Job	Personnel selection	Response rate		
		1st Delphi	2nd Delphi	3rd Delphi
Professor of Occupational Therapy	2	2 (100)	2 (100)	1 (50)
Occupational Therapist	4	4 (100)	3 (75)	3 (75)
Social worker	1	1 (100)	1 (100)	1 (100)
Professor of Architectural Engineering	1	1 (100)	1 (100)	1 (100)
Specialist of Architectural Engineering	1	1 (100)	1 (100)	1 (100)
Total	9	9 (100)	8 (88.8)	7 (77.7)

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Results of the first round Delphi survey

Based on the panelists' opinions received through the first round Delphi survey, the selected items were converged, corrected, added, deleted, and rearranged based on the opinion of the panelists. Modifications made by factor are as follows: (i) Living room/bedroom: convergence of items 1 + 2; (ii) Bathroom: convergence of items 4 + 8 and 5 + 6 + 8; (iii) Kitchen: convergence of items 7+ 8, deletion of item 10; (iv) Change from laundry room and basement area to utility room and balcony. and 8 in the bathroom area, Units 5, 6 and 12 in the kitchen area, Units 7 and 8 in the kitchen area, Delete Unit 10, modifying laundry and basement areas to utility rooms and balconies. As a result, 84 items were selected for the second round Delphi survey.

Results of the second round Delphi survey

Based on the panelists' opinions received through the second round Delphi survey, we combined the living room and bedroom into a single factor and corrected/converged the lighting-related items to assess the entire house. As a result, 59 items were selected for the third Delphi survey.

Results of the third round Delphi survey

As a result of the third round Delphi survey, items 8 of the factor "porch/entrance" and item 2 of the factor "prevention of accidents (emergency)" were deleted because they did not reach the minimum content validity ratio of 0.33 (Table 4).

Table 4. Deleted Items through 3rd Delphi Survey

Factor	No.	M	SD	CVR	Convergence	Consensus	Concurrence
Porch·Entrance	8	4.60	0.99	0.143	1.00	0.22	0.60
Prevention of accidents (Emergency)	2	4.00	0.83	0.143	0.75	0.21	0.63

CVR: Content Validity Ratio

The final 55 items were analyzed to be suitable for home safety assessment, and item numbers were reassigned to these finally selected items for reliability and validity analysis. (Table 5).

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Table 5. The Final Selected Items based on Delphi Survey

Factor	No.		Items	CVR	Convergence	Concurrence	Consensus
	S	F					
Porch ·Entrance	1	1	The road around the house is smooth and level without being narrow, irregular or unstable.	0.429	0.75	0.70	0.19
	2	2	The road around home has no broken tiles, and the obstacles such as snow, ice and fallen leaves are well cleaned.	0.429	0.75	0.70	0.19
	3	3	A space for safe movement through or use of the Porch·Entrance (enough space for opening the door of the Porch·Entrance, wide space for wheelchair, ramp, etc) is secured.	1.000	0.00	1.00	0.07
	4	4	The environment for safe movement through or use of the Porch·Entrance (ceiling and threshold height, safe handles, non-skid tiles or mat, chair, etc) is established.	1.000	0.25	0.90	0.10
	5	5	A cabinet that can hold shoes and other items is placed in the Porch·Entrance, and organized well so that there is no danger or inconvenience in movement.	1.000	0.50	0.75	0.11
	6	6	The Porch·Entrance and all of its exterior passages have lighting, and brightness is appropriate.	0.714	0.25	0.90	0.15
	7	7	A doorbell is installed and usable at the Porch·Entrance.	1.000	0.50	0.80	0.11
	8	D	The home address is written clearly (well visibly) in front (on the front door).	0.143	1.00	0.60	0.22
	9	8	There is a post box that can be used easily and safely.	0.429	0.50	0.75	0.17
Livingroom Bedroom	1	1	The sitting area in the living room (chairs, sofa, and sitting on the floor) is safely created without damage to the structure.	0.714	0.50	0.75	0.16
	2	2	It is easy and safe to sit and stand up in the sitting area of the living room (chairs, sofa and sitting on the floor) (the height of a chair or sofa, arrangement of auxiliary tools such as railings and sticks if necessary, etc.).	1.000	0.50	0.80	0.10
	3	3	It is easy and safe to lie down and get up in the space (bed, lying down on the floor) for lying down in the bedroom (the height of the bed, arrangement of auxiliary tools such as railings and sticks if necessary, etc.).	1.000	0.50	0.80	0.10
	4	4	Moving to the living room is safe (the height of the ceiling and threshold, etc.), and there are no obstacles or dangerous objects (furniture, household appliances, electric wires, etc.).	1.000	0.50	0.80	0.11
	5	5	Moving to the bedroom is safe (the height of the ceiling and threshold, etc.), and there are no obstacles or dangerous objects (furniture, household appliances, electric wires, etc.).	0.714	0.25	0.90	0.17

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	6	6	The flooring of the living room (linoleum, wood floor, etc.) is level and not slippery without any damage (worn, torn, cracked, etc.).	1.000	0.50	0.75	0.11
	7	7	The carpet (mat, etc.) on the living room floor is level and securely fixed without any damage (worn, torn, etc.) (2 points if nothing is on the floor).	0.714	0.50	0.75	0.16
	8	8	The flooring of the bedroom (linoleum, wood floor, etc.) is level and not slippery without any damage (worn, torn, cracked, etc.).	0.714	0.50	0.75	0.16
	9	9	The carpet (mat, etc.) on the bedroom floor is level and securely fixed without any damage (worn, torn, etc.) (2 points if nothing is on the floor).	0.714	0.50	0.75	0.16
Bathroom	1	1	Moving to the bathroom is safe (the height of the ceiling and threshold, etc.), and the foot mat is securely fixed at the entrance.	0.714	0.25	0.90	0.16
	2	2	The width/height of the wash basin is designed for easy and safe use (if necessary, auxiliary tools such as safety handles are arranged).	1.000	0.00	1.00	0.07
	3	3	The height of the toilet is designed for easy and safe use (if necessary, auxiliary tools such as safety handles are arranged)	1.000	0.25	0.90	0.09
	4	4	The space for showering or bathing (bathtub, booth, etc.) is secured and its access is easy. It is installed for easy and safe use (if necessary, auxiliary tools such as safety handles and bath chairs are arranged).	1.000	0.50	0.80	0.10
	5	5	The environment for safe and easy movement (safety handles, non-skid tiles or mats, wearing shoes that fit the feet, etc.) is created inside the bathroom.	1.000	0.00	1.00	0.07
	6	6	The bathroom is close to the bedroom and there is no difficulty moving back and forth.	0.714	0.50	0.75	0.16
Kitchen	1	1	The kitchen is well organized and there are no obstacles or dangerous objects (furniture, appliances, kitchenware, etc.)	0.714	0.50	0.75	0.16
	2	2	The floor of the kitchen does not make movement difficult or dangerous (the condition of the flooring material, the condition of the foot mat, the presence of obstacles such as electric wires, etc.).	1.000	0.50	0.80	0.10
	3	3	The height of the cabinet for putting things in and out is appropriate (considering safety and efficiency if a compensatory environment such as a chair is used).	0.714	0.50	0.80	0.16
	4	4	Safety and efficiency are considered for the storage location of the items, such as frequency of use, weight, and size.	0.714	0.50	0.80	0.152
	5	5	A safe and efficient space for cooking countertop (not sharp edges, height, width, etc.)is secured.	1.000	0.50	0.80	0.10
	6	6	A safe and efficient space in the sink for washing dishes (not sharp edges, height, width, etc.)	1.000	0.50	0.75	0.11

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			is secured.				
	7	7	A safe and efficient space around the gas stove (including countertop and step) is secured without unnecessary obstacles.	1.000	0.25	0.90	0.09
Utility room and balcony	1	1	Objects (furniture, home appliances, flower pots, etc.) in the utility room and balcony are safely placed without disrupting movement.	0.714	0.50	0.75	0.16
	2	2	There are no obstacles (wires, etc.) on the floor of the utility room and balcony.	0.714	0.50	0.75	0.16
	3	3	Non-skid tiles or mats are used on the floors of the utility room and balcony, or shoes that fit the feet are used there.	0.714	0.50	0.80	0.17
	4	4	A washing machine can be used easily without using a chair or leaning overly.	0.714	0.50	0.80	0.15
	5	5	The brightness of the utility room and balcony lighting is appropriate.	1.000	0.25	0.90	0.10
Interior and exterior stairs	1	1	The gap of the entire interior and exterior stairs are not steep, and the number of steps is appropriate.	1.000	0.50	0.80	0.10
	2	2	The surface of the entire interior and exterior stairs is not slippery (including non-skid pads, etc.).	1.000	0.25	0.90	0.09
	3	3	There are no unnecessary objects (flower pots, etc.) that make movement difficult on the entire interior and exterior stairs.	1.000	0.50	0.80	0.10
	4	4	There are no defects or damages (cracks, etc.) affecting the safety of the entire interior and exterior stairs.	1.000	0.25	0.90	0.09
	5	5	Sturdy handrails or safety handles are installed on at least one side of the entire interior and exterior stairs.	1.000	0.25	0.90	0.09
	6	6	The safe environment of exterior stairs is created (identification of stair ends, roof, etc.).	1.000	0.50	0.75	0.11
	7	7	Lighting is installed on the entire interior and exterior stairs, and the brightness of the lighting is appropriate.	1.000	0.00	1.00	0.07
Prevention of accidents	1	1	There is at least one fire extinguisher inside the house and it works without problems.	1.000	0.00	1.00	0.00
	2	D	How to use a fire extinguisher is learned well.	0.143	0.75	0.63	0.21
	3	2	Fire alarms, smoke detectors, carbon monoxide detectors, sprinklers and automatic gas shut-off devices are installed throughout the house.	1.000	0.00	1.00	0.00
	4	3	All flammable/inflammable substances are far away from the fire source.	1.000	0.25	0.90	0.09
	5	4	There is no risk of electric leakage and short circuit (using multiple cords, unplugging unused cords, using individual power sources, using separate power sources, using old cords, etc.).	0.429	0.75	0.70	0.19
	6	5	Electric appliances are used away from heat or water sources (sink, gas stove, etc.).	0.714	0.25	0.90	0.16

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7	6	A telephone (cell phone) or emergency bell is installed within easy reach, and family numbers and emergency numbers such as 119 are known or noted near the telephone.	1.000	0.50	0.75	0.11
8	7	All medicines (first aid kits, etc.) including those being taken are stored in an appropriate place (in an accessible place), and the expiration date of the medicine has not passed.	1.000	0.50	0.80	0.10
9	8	All chemicals are labeled and stored in safe containers (or original containers).	0.714	0.50	0.75	0.16
10	9	The brightness of all the lights in the house is appropriate.	0.714	0.50	0.80	0.17
11	10	All the lights in the house can be turned on and off easily, and the switches are easily accessible (distance, height, etc.).	0.714	0.50	0.80	0.16
12	11	All faucets are clearly marked for hot and cold water.	1.000	0.50	0.75	0.11
13	12	The boiler works well without failure (heating, hot water, etc.).	0.429	0.75	0.63	0.19
14	13	Power for all electrical and electronic appliances is clearly (appropriately) marked.	0.429	0.75	0.63	0.19

S: Item number of Delphi Survey, F: Item number of Final, D: delete

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General characteristics of the subjects

A total of 116 community-based older adults participated in this study. The subjects' general characteristics are as follows: women strongly outnumbered men with 75 (64.7%) vs. 41 (35.3%); the mean age was 79 years, with 10 (8.6%) in their 60s, 53 (45.7%) 70s, 45 (38.8%) 80s, and, 8 (8.6%) 90s+. while those in the majority age groups, 70s and 80s, could be equally recruited (45.7% and 38.8%, respectively), those in the minority age groups, 60s and 90s+, accounted for only 8.6% and 6.9%, respectively, because of recruitment difficulties encountered in the process of the snowball sampling process; apartments/villas and houses were evenly distributed at 50.0% each; more than half of the subjects (56.9%) were living alone without a protector; and 56.9% answered that they had a fall experience (Table 6).

Table 6. General Characteristic of Subject

Characteristics		N (%) / M±SD
Sex	Female	75 (64.7)
	Male	41 (35.3)
Mean age (year)		79.52 ± 7.102
Age	60-69 year	10 (8.6)
	70-79 year	53 (45.7)
	80-89 year	45 (38,8)
	≥ 90 year	8 (6.9)
House Type	Apartment·Villa	58 (50.0)
	House	58 (50.0)
Protector	Yes	50 (43.1)
	No	66 (56.9)
Fall history	Yes	60 (56.9)
	No	50 (43.1)

Composition of assessment instruments in terms of reliability and validity

Results of internal reliability analysis (Cronbach's α)

The reliability of each factor exceeded 0.8, indicating high reliability, except for the factor general of accident prevention (0.783), which was confirmed to be within the range of reliable level. As a result of the internal reliability analysis of each item, all items showed an item–total correlation exceeding 0.4, indicating satisfactory correlation of each item with the assessment tool (Table 7).

Table 7. Item Internal Reliability Analysis Results by Sub-Area

	Factor	Items	Corrected Item-Total	Cronbach's α	
				Item deleted	Total
Safety for each space	Porch· Entrance	1	.727	.843	.871
		2	.727	.844	
		3	.566	.861	
		4	.533	.865	
		5	.504	.867	
		6	.693	.847	
		7	.637	.854	
		8	.618	.856	

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	Livingroom· Bedroom	1	.787	.870	.893
		2	.776	.871	
		3	.778	.871	
		4	.547	.890	
		5	.508	.892	
		6	.598	.886	
		7	.614	.885	
		8	.683	.879	
		9	.578	.887	
	Bathroom	1	.442	.805	.809
		2	.782	.729	
		3	.685	.751	
		4	.563	.781	
		5	.421	.808	
		6	.551	.789	
	Kitchen	1	.726	.916	.924
		2	.757	.914	
		3	.706	.918	
		4	.755	.914	
		5	.841	.905	
		6	.842	.905	
		7	.719	.918	
	Utility room and balcony	1	.843	.877	.912
		2	.824	.886	
		3	.718	.906	
		4	.803	.886	
		5	.716	.904	
	Interior and exterior stairs	1	.854	.956	.961
		2	.884	.953	
		3	.787	.961	
		4	.896	.954	
		5	.817	.959	
		6	.923	.950	
		7	.898	.952	
Prevention of accidents	Emergency	1	.641	.916	.917
		2	.616	.917	
		3	.807	.902	
		4	.831	.900	
		5	.770	.904	
		6	.658	.913	
		7	.833	.897	

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		8	.772	.903	
	General	9	.613	.725	
		10	.512	.762	
		11	.710	.687	.783
		12	.508	.759	
		13	.466	.771	

Results of constructional validity analysis

As a result of the exploratory factor analysis, which was performed to classify the factors of the assessment tool, 42 items pertaining to the domain "safety for each space" were classified into seven factors named according to their contents as porch/entrance, living room/bedroom (movement + floor), bathroom, kitchen, utility room and balcony, and interior and exterior stairs. The factor analysis model fit for "safety for each space" was established based on the following test results: the KMO value = .836 (≥ 0.5: adequate for the use in the factor analysis); the eigen values of each factor ≥1.0; the Bartlett test of sphericity p=0.000 (statistically significant correlation). The factor loading of each item was ≥ 0.4, indicating that the model has sufficient explanatory power (Table 8).

The 13 items pertaining to the domain "accident prevention" were classified into two factors named according to their contents as emergency and general. The factor analysis model fit for "accident prevention" was established based on the following test results: the KMO value = .833; the eigen values of each factor ≥1.0; the Bartlett test of sphericity p=0.000. The factor loading of each item was ≥ 0.4, indicating that the model has sufficient explanatory power (Table 9).

Table 8. Exploratory Factor Analysis for Sub-Areas Safety for Each Space

Items	1	2	3	4	5	6	7	h^2
1	.873							.861
2	.883							.856
3	.501							.451
4	.647							.572
5	.488							.520
6	.560							.613
7	.585							.616
8	.419							.646
1		.816						.865
2		.758						.796
3		.849						.881
4		.641						.639
5		.619						.464
6			.796					.723
7			.718					.685
8			.796					.777
9			.755					.668
1				.409				.413
2				.789				.786
3				.781				.727
4				.632				.629
5				.679				.508
6				.601				.488
1					.702			.667

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2	.696		.706
3	.767		.670
4	.810		.720
5	.766		.807
6	.772		.810
7	.706		.641
1		.828	.826
2		.821	.790
3		.752	.652
4		.828	.771
5		.730	.680
1			.898 .822
2			.925 .871
3			.828 .754
4			.899 .865
5			.839 .761
6			.929 .890
7			.903 .883

Comment of factor	Porch ·Entrance	Livingroom ·Bedroom (movement)	Livingroom ·Bedroom (floor)	Bathroom	Kitchen	Utility room and balcony	Interior and exterior stairs
Eigen-value	12.229	6.439	3.502	2.390	1.919	1.791	1.502
Variance Explained (%)	29.117	15.330	8.339	5.692	4.570	4.263	3.577
Cumulative Variance (%)	29.117	44.447	52.786	58.478	63.048	67.311	70.888
Kaiser-Meyer-Olkin					.836		
Bartlett sphericity		Chi-square				4519.691	
		df				861	
		Sig.				.000	

h²: Communality

Table 9. Exploratory Factor Analysis for Sub-Areas Prevention of Accidents

Items	1	2	h²
1	.689		.507
2	.687		.482
3	.827		.751
4	.851		.798
5	.819		.716
6	.712		.552
7	.825		.774

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8	.727		.743
9		.662	.542
10		.578	.447
11		.797	.730
12		.640	.481
13		.757	.576

Comment of factor	Prevention of accidents (Emergency)	Prevention of accidents (General)
Eigen-value	6.626	1.471
Variance Explained (%)	50.972	11.317
Cumulative Variance (%)	50.972	62.289
Kaiser-Meyer-Olkin	.883	
Bartlett sphericity	Chi-square	982.591
	df	78
	Sig.	.000

h^2: Communality

Discussions

Old age is associated with a wide range of problems as a result of natural aging, such as chronic diseases and balance disorders [34]. Among them, as the life radius narrows, safety accidents occur at home increasingly frequently, which makes older adults vulnerable to injury [35]. According to previous research, home environment modification improves the older adults' ability to perform daily activities, thus increasing independence and self-confidence, which has a positive effect on their quality of life and work performance at home [6, 36]. In line with the global trend of rapid aging, many advanced countries, such as the US, Australia, and Japan, have developed home safety assessment tools optimized for their own countries and are actively using them in home environment modification policies.In this study, we selected assessment items suitable for Korean housing types from among the items extracted from existing home safety assessment tools, and developed an assessment tool and named it the Home Safety Assessment Tool for Korean Older Adults after reliability and validity verification.

Home environment modification helps the elderly to lead a safe and independent life by supporting their social, physical, and personal functions that are weakened with age [5]. Advanced countries have long been implementing housing policies in preparation for an aging society, of which Japanese regional comprehensive care and the UK community care are prime examples [17]. In Korea as well, community care projects are in place in many different regions, and assessments and interventions are being conducted for home environment modifications [16].

At home and abroad, home safety assessment tools are widely used as a method to assess safety risk factors in the home environment to provide an environment that enables older adults to continue to live in their familiar living space. [5].Australia developed and has been using HOME FAST (Home Falls and Accidents Screening Tool) that reflects the home environment and culture. In Japan, where sedentary lifestyle is dominant as in Korea,WeHSA (Westmead Home Safety Assessment) was adopted and modified to suit typical Japanese housing types and lifestyle [23, 37]. In Korea, however, there are not many assessment tools that reflect Korean housing types, and extant ones are designed to assess the home environment related to falls and space composition, which hampers their broader use. Therefore, the Korea-specific home safety assessment tool developed in this study takes into account Korea's sociocultural characteristics including safety risk factors, such as fire or gas leakage, in addition to fall risk prediction. This 55-item assessment tool consists of two domains and nine factors, and each item is rated on a 3-point scale, which allows a succinct and comprehensive assessment of the home safety status of senior households within 30 minutes.Therefore, it can be used as an assessment tool for improving the home environment of senior citizens in the continuously expanding community care project.

Content validity was verified through a 3-round Delphi survey with a 9-member expert panel composed of geriatric, architectural, and welfare professionals. With the verified items, the reliability and validity were also established. targeting the elderly, architecture, and welfare experts, and reliability and validity were secured with verified items.
In the course of this study, based on the expert opinions received through the first and second rounds Delphi survey, term corrections were made, such as "door knocker" was corrected to "doorbell" and "basement" to "utility room." The assessment tools developed in Western countries, such as HOME FAST and HSSAT, and their Korean versions are composed of items involving only the use sofa and bed use, and rating of sedentary life is not specified [10, 19]. For example, toilet and bathroom is one item in the proposed assessment tool, whereas they are designed to be rated separately in WeHSA[24]. This reflects the Korean cultural trait that toilet and bathroom functions are arranged in one space [38]. On this note, the home safety assessment tool developed in this study can be considered a tool with a salient feature of objectively reflecting sociocultural characteristics of Korea.
Through exploratory factor analysis, the 55 items were classified into nine factors: porch/entrance, living room/bedroom (movement + floor), bathroom, kitchen, utility room and balcony, interior and exterior stairs, accident prevention (emergency + general). Unlike existing assessment tools in which living room and bedroom are separate factors [21, 24. 25], the reality of older people, for whom living room and bedroom do not greatly differentiate from each other, was reflected in the decision of treating them as a single factor [38]. The separation of floor as a stand-along factor in the living room and bedroom areas is attributable to the sedentary nature of Korean lifestyle. Also, the existing assessment tools used in Korea tend to focus only on falls and space arrangement[19]. The limitation of this exclusive focus on fall and space factors was addressed by separating the safety accident prevention area as the emergency area and including all risk factors in it, such as fire, gas leakage, electric shock or short circuit, emergency bell, and drug management, which can easily lead to serious accidents in the home environment. In fact, it has been reported that the proportion of accidents occurring in emergency situations is even higher than that of accidents occurring while performing basic daily activities [2]. In previous research on the occurrence of safety accidents in the households of older adults, safety accidents occurred in decreasing order of place in bathroom, outdoor, room, kitchen, stairway, living room, entrance, and balcony, and the types of safety accidents were reported to be, in addition to damage from falls (slip, trip), collisions, and falling objects, burns by cooking utensils, gas accidents, and fire accidents, and the need for safety devices, such as automatic gas circuit breaker and fire alarm, was highlighted[39]. Among the assessment tools developed in foreign countries, CHSA and A Home Hazard Checklist for Seniors include many items related to prevention of safety accidents. This is consistent with the approach adopted by the assessment tool developed in this study, which can comprehensively assess the home safety status of community-based senior citizens.
Taking these results together, the home safety assessment tool developed in this study is significant for its feature of assessing the home environment according to the living conditions in Korea and for its advantage of assessing risk factors other than falls. It is expected that the Home Safety Assessment Tool for Korean Older Adults developed in this study will be usefully utilized by occupational therapists for the elderly who wish to improve their home environment in community settings. It is also expected that the proposed tool will be useful not only for the general elderly population, but also for age- or disease-specific subjects.
As the limitations of this stud, two aspects may be pointed out. First, since the data were collected by recruiting the subjects within a limited area, the results of this study have the problem of generalizability to the entire elderly population. Second, only the internal reliability and construct validity of the assessment tool were verified in this study, and information on its measurement consistency, such as test-retest reliability and interrater concordance, could not be obtained.Therefore, in follow-up research, it is necessary to expand the number and regions of the subjects to better estimate the population-wide tendency on the one hand, and to repeat the study with different subjects to prove the consistency of the test.

Conclusion

In this study, we developed a home safety assessment tool for Korean older adults and tested its content validity, internal reliability, and construct validity. This assessment tool was structured to assess the safety accident prevention area in addition to the safety of each space. Moreover, it has the advantage of rapidly assessing the items that reflect the characteristics of Korean sociocultural residential environment. With continuing aging of Korean society, it is expected that the assessment tool developed in this study will be actively used to improve the home environment of community-based older adults, contributing to the stabilization of life in old age in Korea.

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