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Assessment of fall risk in the home environment of Korean older adults: revision and validation of the K-HOME FAST

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Abstract

Background Most older adults experience falls inside their house. To prevent them, specially designed screening tools are required to assess fall risk in the home environment. As the home environment can vary significantly due to cultural differences and changes over time, it is essential to regularly update and validate these tools to ensure their continued accuracy and relevance. Therefore, this study aimed to develop the Revised K-HOME FAST (Korean version of the Home Falls and Accidents Screening Tool) and evaluate its validity and reliability.

Methods The Revised K-HOME FAST was developed in these phases: (1) development of the Revised K-HOME FAST, (2) feasibility test, (3) verification of content validity, and (4) data collection and verification of reliability. Verification of content validity involved the participation of ten experts. Internal consistency was confirmed by conducting home-visit assessments with 211 community-dwelling older adults who had experienced at least one fall in the local community. Verification of inter-rater reliability involved six investigators forming pairs and conducting individual evaluations of the homes of 20 older adults with a history of falls.

Results The final Revised K-HOME FAST consisted of 25 items categorized into seven home areas: bathroom/toilet, bedroom, living room, kitchen, stairs, entrance, and entire house. The item-content validity index of the Revised K-HOME FAST ranged from 0.8 to 1.0, except for one item. The internal consistency (Kuder–Richardson Formula 20) of the Revised K-HOME FAST was 0.65 (95% CI = 0.58–0.71). The agreement percentage for each item ranged from 92% to 100%, and the intraclass correlation coefficient ranged from 0.64 to 1.00, indicating high inter-rater reliability.

Conclusions The Revised K-HOME FAST has satisfactory validity and reliability for assessing the risk of falls in the home environment of community-dwelling older adults in Korea. By incorporating the characteristics of Korea, the Revised K-HOME FAST is positioned to contribute substantially to the reduction of home fall risks for Korea's aging population.

Keywords Accidental falls, Aged, Community, Home environment, Reproducibility of results

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Background

The aging population in Korea has rapidly increased from 7% of the total population in 2000 to 15.5% in 2019, with a projected increase to over 20% by 2025 [1]. Most older adults want to remain independent and safe in their homes and communities. A home environment that provides comfort and is devoid of hazards has become a critical need for aging in place [2]. However, the incidence of falls and the risk associated with them have been escalating among older adults, a trend observed globally. Falls represent a predominant cause of unintentional injuries and fatalities among older adults worldwide, with approximately 684,000 fatalities and 37,300,000 individuals requiring medical intervention annually due to falls [3]. In Korea, 64.9% of the individuals who experience a fall require hospital treatment, and older adults who have experienced falls have been found to fall repeatedly [4]. These statistics underscore the need to address the risk of falls among older adults urgently and precisely.

Environmental factors play a pivotal role in the occurrence of falls, accounting for 47.8% of fall occurrences among Korean older adults [4]. Most falls occur within the home, highlighting home settings as a critical focus for fall prevention strategies [5]. This is supported by research indicating that individuals who have experienced a fall are at an increased risk of subsequent falls within their homes [6]. Assessing factors in the home environment that may contribute to fall occurrence can help address such factors and serve as a starting point for interventions [7]. Given that this home environment-focussed approach should be based on regional and cultural characteristics [8], there is a need for tools that can assess the risk of falls in Korean homes.

The Home Falls and Accidents Screening Tool (HOME FAST), originally developed for English-speaking regions, is a tool for evaluating environmental factors related to the risk of falls [9]. The HOME FAST is easily applicable in community settings, as it contains only 25 items, allowing quick assessment of home environments [9]. Furthermore, a three-year longitudinal study involving 727 older adults found that the HOME FAST score is associated with the incidence of falls, thus establishing its predictive validity [10]. The Korean version of the HOME FAST (K-HOME FAST) was developed in 2019 [9, 11]. However, the items of the HOME FAST are not classified based on the area of the house, which makes it difficult to identify areas posing a higher risk of falls, even with a higher score. Additionally, its single-item approach to questioning multiple risk factors limits the identification and planning of specific improvements. In the K-HOME FAST, items cannot be rated with "not applicable," translation issues exist in some items, and the tool does not reflect the Korean living environment and lifestyle adequately [11]. These limitations necessitate targeted revisions to enhance the accuracy, reliability, and cultural relevance of the existing K-HOME FAST.

Therefore, this study aimed to develop the Revised K-HOME FAST for older adults in South Korea and evaluate its validity and reliability. By creating a tool that effectively assesses the risk of falls in Korean homes, we intend to improve fall prevention strategies for Korean older adults.

Methods

Study design

This is a methodological study to develop the Revised K-HOME FAST and evaluate its validity and reliability.

Participants and setting

The eligibility criteria were community-dwelling older adults aged 65 or more who resided in the Seoul or Gyeonggi regions of the Republic of Korea, had experienced at least one fall within the past two years, and had not moved house within the past two years. A fall was defined as an unexpected event in which the participant comes to rest on the ground, floor or lower level [12]. Older adults who could not communicate in Korean and those with difficulties understanding survey content were excluded. The participants were a convenience sample of community-dwelling older adults. The sample size was determined based on the recommendation of 5–10 participants per item to ensure a reliable sample size for validity studies [13]. Given that Revised K-HOME FAST consists of 25 items, the target range was set at 125–250 participants. Considering the number of participants realistically available for data collection within the study period, the target was set at 210.

Participants were either recruited directly from senior community centres, local welfare centres, and churches by six investigators affiliated with a research agency, or participated voluntarily after learning about the survey through an online information-sharing board. Only older adults who provided written informed consent were included in the study, and participant information sheets were provided to all participants.

Data collection

All data were collected by six investigators after obtaining approval from the Institutional Review Board. Six investigators contacted the individuals to explain the study's purpose, check their eligibility, and obtain their voluntary consent for participation. Only individuals who provided informed consent were recruited. During the simultaneous recruitment process across multiple channels, one additional participant was recruited. A total of 211 community-dwelling older adults were recruited, and home-visit surveys were conducted. The home visits were conducted from December 2022 to July 2023, and

all collected data were used for analysis, as there were no missing data. Compared to the sample sizes used in the development of the HOME-FAST tool (83 participants) [9], K-HOME-FAST (75 participants) [11], and Vietnamese version of the HOME-FAST (2 participants) [14], the number of participants in this study was considered sufficient to evaluate the reliability and validity of the tool.

The HOME FAST

The HOME FAST was developed in Australia by Mackenzie et al. [15]. It consists of 25 items that assess environmental factors that may contribute to the occurrence of falls in the home environment. It also evaluates functional factors that may interact with the environment. The items are answered with either "yes," "no," or "not applicable." The response of "yes" or "not applicable" denotes no hazards, while "no" denotes a hazard. The respondent receives a score of one for each hazard. The total score on the HOME FAST ranges from 0 to 25, and higher scores indicate a greater risk of falls in the home environment [15]. The HOME FAST has demonstrated content and predictive validity, with good inter-rater reliability (Intraclass Correlation Coefficient [ICC] = 0.82) [15–17]. Regarding the K-HOME FAST, its internal consistency (Kuder–Richardson Formula 20 [KR20]) has been found to be moderate (KR20 = 0.62) and it has demonstrated excellent inter-rater reliability (ICC = 0.97) [11, 17, 18].

Phases of the study

Development of the Revised K-HOME FAST

Incorporation of the cultural and environmental characteristics of Korea The original items in the K-HOME FAST, developed in the context of Western culture, have been deemed insufficient to reflect the home environment in Korea. Ju and Cho [11], who developed the K-HOME FAST, suggested revisions and development of items to incorporate Korea-specific home environment and lifestyle characteristics, which differ from those in the West. For example, in Korea, the entire tiled bathroom floor is often used as a wet area, while Western cultures typically separate water usage areas within bathrooms (Fig. 1). Accordingly, we enhanced the practicality of the tool by incorporating features specific to Korean homes, such as the use of bathroom tiles and bedroom floor coverings. Additionally, due to differences in height between Koreans and Westerners, we applied Korean standard measurements for bathtub height, handrail height, and stair width and depth. We also changed the measuring unit of illumination from watt (which denotes the power con-

Fig. 1 Korean and western bathrooms. Note: Left photo taken at participant's home; right photo taken from the researcher's collection

sumed by an electrical appliance) to lux to better reflect the actual brightness in the home environment. In many Korean homes, particularly those of older adults, a single central ceiling light is often used, making it difficult to assess the effective illumination using watts alone. Lux, on the contrary, directly measures the intensity of light as perceived in the environment, permitting a more accurate and objective evaluation of the home's lighting conditions.

Classification of items based on the area of the house In the original HOME FAST and its Korean version [11], items are not classified based on the area of the house. Thus, we grouped different areas of a house into seven categories: bathroom/toilet, bedroom, living room, kitchen, stairs, entrance, and entire house. Then, based on their content, we divided the 25 items into the seven categories. This approach was employed to identify risk factors in different areas of the house, devise tailored intervention strategies, and identify areas that require more attention.

Distinction of items reflecting the functional status of the participants The HOME FAST evaluates factors in the physical environment that may contribute to fall occurrence. It also assesses fall-inducing behaviours resulting from the individual's interaction with the environment [9, 11]. In this study, we differentiated the items reflecting the functional status of the participants from those that assessed only the physical environment and emphasized them by underlining and italicizing them.

Addition of the "Not Applicable" response option The K-HOME FAST has only "yes" and "no" response options [11]. Taking cues from the original tool, we differentiated items that could be rated with "Not Applicable" from those that could not be rated with "Not Applicable." We also specified the criteria for rating an item with "Not Applicable." Items marked as "Not Applicable" are considered to have no risk factors and are therefore scored the same as "yes," with a score of 0.

Development of detailed sub-items for each item The 25 items of the existing K-HOME FAST address multiple risk factors within a single item [11]. This limits the derivation of specific improvement directions from respondents who acknowledge the presence of risk factors in their home environment. Therefore, we introduced detailed sub-items for each item, thus prompting the respondents to specify concrete risk factors. For example, in the bathroom section, if the response to the question, "Is the person able to get on and off the toilet easily and safely? (Definition: Toilet is of adequate height, person does not need to hold on to the sink/towel rail/toilet roll holder to get up, rail exists beside the toilet if needed)" was "no," the respondent was subsequently asked to check which of the following risk factors apply through a sub-item: the toilet height is inadequate (enter toilet height); a squat toilet is used instead of a seated toilet; a safety rail is needed but not installed; the person holds onto something other than a handle when getting up; other. In addition, the respondent was asked to answer the sub-items if they had answered an item with "no." In some items related to the "entire house," respondents were required to provide details for the specific area, which enhanced the interpretability of the results.

Development of an evaluation manual A manual was prepared to describe the evaluation criteria. In the manual, we provided clear criteria for assessing aspects such as the toilet height, stair height/width, bathtub height and railing height [19] and illumination [20]. Photographic images depicting risk factors also facilitated an objective assessment. Specific details such as the recommended model of the luxmeter (LT company LM81X) and the method of illuminance measurement (KS 5-point method) were also explicitly outlined.

Development of the draft of the Revised K-HOME FAST After the abovementioned processes, we created a draft of the Revised K-HOME FAST for the feasibility study. Major modifications were communicated to the developers of the original HOME FAST [9] and the K-HOME FAST [11], and we obtained their consent to make the changes.

Feasibility test

A feasibility test was conducted to assess the appropriateness and feasibility of the revisions made to the Revised K-HOME FAST. Five researchers who participated in developing the draft of the Revised K-HOME FAST evaluation manual visited the homes of adults aged 60 or above in their respective communities. The application of the Revised K-HOME FAST took a minimum of 8 min and a maximum of 20 min. After the assessment, the researchers discussed the appropriateness and feasibility of the draft. Subsequently, the draft was revised based on their discussion.

Verification of content validity

Based on previous studies that recommend content validity evaluations on a 4-point scale by three or more experts [21], ten health professionals calculated the content validity index to evaluate the appropriateness and feasibility of the 25 questions of the Revised K-HOME FAST. These 10 professionals included the first author of the study that developed the K-HOME FAST [11], nursing professors with expertise in frailty and fall

assessment, home-visiting nurses, public health nurses, family medicine physicians, and occupational therapists. On average, these experts had 6.5 years of experience in their fields (range: 1.7 ~ 14.0 years).

Data collection and verification of reliability

The data collected from the homes of 211 older adults with a history of falls were used to confirm the KR20 reliability of the Revised K-HOME FAST. Six skilled investigators affiliated with a research agency, who had completed 10 h of both online and offline training, collected data using the evaluation manual for home environment assessment. They used both a tablet PC and a printed Revised K-HOME FAST during the assessments. The investigators conducted additional assessments using the follow-up sub-items when the participants answered "no" to the main item. To facilitate ease of reference, they affixed stickers related to the evaluation criteria for illumination, length, and height to the light meter and ruler that they used.

Inter-rater reliability was assessed by six investigators visiting the homes of 20 older adults as comparison raters. These older adults resided in various regions and different types of houses, such as apartments and villas. Pairs were formed among six investigators, and they independently conducted evaluations using the Revised K-HOME FAST. The results were compared after the completion of the assessment.

Table 1 Participants' characteristics (*N*=211)

Socio-demographic characteristics		**Mean ± SD or *n* (%)**
Age		74.4 ± 6.5
	65–74	118 (55.9)
	75–84	84 (39.8)
	≥ 85	9 (4.3)
Educational level	Elementary or below	94 (44.5)
	Middle	46 (21.8)
	High school or over	71 (33.7)
Cohabitant	No	58 (27.5)
	Yes	153 (72.5)
Recipient	No	199 (94.3)
	Yes	12 (5.7)
Number of falls within 2 years		1.5 ± 0.9
Use of indoor mobility aid	Not Use	208 (98.6)
	Use	3 (1.4)
Chronic disease [a], yes, n(%)	No	19 (9.0)
	Yes	192 (91.0)
Environmental characteristics		**Mean ± SD or n (%)**
Duration of residence (year)		15.3 ± 10.0
Housing type	Apartment	106 (50.2)
	Townhouse/ Multiplex housing	72 (34.1)
	Detached house	30 (14.2)
	Other	3 (1.5)
Level of floor	Ground	199 (94.3)
	Basement [b] /Semi-basement [c]	12 (5.7)
	Rooftop	0 (0.0)
Convenience of residential life [d]	Convenience	177 (83.9)
	Not convenient	34 (16.1)
Ownership type	Owned	175 (82.9)
	Rental – Lump-sum housing lease	21 (10.0)
	Rental – Monthly lease	6 (2.8)
	Rental – Free rental	8 (3.8)
	Other	1 (0.5)

[a] Whether the participant has any chronic diseases (cardiovascular, musculoskeletal, respiratory, digestive, endocrine, nervous, genitourinary, mental, or eye/ear disorders)

[b] A space located below ground level, with no windows except for an entrance into the house

[c] A space partially located below ground level, with the remainder above ground and connected to the exterior

[d] Whether the participant considers the structure and facilities of their residence to be convenient for living

Statistical analyses

The content validity of the survey items was evaluated using the Item-Content Validity Index (I-CVI) and Scale-level Content Validity Index/ Averaging (S-CVI/Ave). The I-CVI refers to the proportion of raters evaluating an item as quite relevant or highly relevant. An I-CVI value of 0.78 or higher and an S-CVI/Ave value of 0.90 or higher are considered acceptable [21]. The reliability of the tool was assessed based on KR20 for internal consistency. ICC estimates and their 95% confident intervals were calculated based on a single-measurement, absolute agreement, 2-way mixed-effects model [17]. All statistical analyses were performed using SPSS Statistics Version 24.0 (IBM, Armonk, New York).

Results

Characteristics of the participants

The mean age of the participants was 74.4 ± 6.5 years, and a high proportion (78.2%) were female. More than half of the participants (50.2%) lived in apartments, and the average number of falls over the past two years was 1.5 ± 0.9. Participants' demographic and environmental characteristics are presented in Table 1.

The final Revised K-HOME FAST

The final Revised K-HOME FAST consisted of 25 items categorized into seven home areas: bathroom/toilet, bedroom, living room, kitchen, stairs, entrance, and entire house. Table 2 presents the differences between the K-HOME FAST [11] and Revised K-HOME FAST.

Table 2 Differences between K-HOME FAST and Revised K-HOME FAST

Overall		**K-HOME FAST**	**Revised K-HOME FAST**	
		- Can answer items with "yes" or "no," not with "not applicable" - No detailed questions (sub-items) - No classification of items based on the area of the house - No differentiation of items assessing functional status - Translation of the HOME FAST into Korean	- Can answer items with "yes," "no," or "not applicable" - Respondents must answer detailed questions (sub-items) if they answer an item with "no" - Classification of items based on the area of the house - Differentiation of items assessing functional status - Incorporation of the cultural characteristics of Korea	
Items		**K-HOME FAST**	**Revised K-HOME FAST**	**Revisions**
Bathroom/Toilet	1	Is the bathroom close to the bedroom? Definition: I do not cross two or more doors between the bathroom and the bedroom (including the bedroom door). And when I go to the bathroom, I do not need to leave the house and the doors are not locked.	Is the bathroom close to the bedroom? Definition: I do not cross **more than two doors** between the bathroom and the bedroom (including the bedroom door). And when I go to the bathroom, I do not need to leave the house and the doors are not locked.	- Revised the translation error of "two or more" to "more than two"
	2	Is the person able to get on and off the toilet easily and safely? Definition: Toilet is of adequate height, person does not need to hold on to sink/towel rail/toilet roll holder to get up, rail exists beside toilet, if needed.	*Is the person able to get on and off the toilet easily and safely?* Definition: Toilet is of adequate height, person does not need to hold on to the sink/towel rail/toilet roll holder to get up, rail exists beside the toilet if needed. **- Not applicable: Person always uses a commode.** - **Adequate toilet height: 40cm–45cm**.	- Added the "Not applicable" response option - Specified objective criteria for assessing the height of the toilet
	3	Is the person able to get in and out of the bath easily and safely? Definition: Person is able to step over the edge of the bath without risk, and can lower himself or herself into the bath and get up again without needing to grab onto furniture (or uses bathboard, or stands to use shower over bath without risk).	*Is the person able to get in and out of the bath easily and safely?* Definition: Person is able to step over the edge of the bath without risk (or uses a bathboard or stands to use the shower over the bath without risk). **- Adequate bath height: 40cm–45cm** - **Not applicable: There is no bath in the house, or the bath is never used.**	- Removed "can lower himself or herself into the bath and get up again without needing to grab onto furniture" from the definition to reflect the considerations for the content validity index - Specified objective criteria for assessing the height of the bath - Added the "Not applicable" response option
	4	Is the person able to walk in and out of the shower recess easily and safely? Definition: Person can step over shower stall, or screen tracks without risk and without having to hold onto anything for support.	*Is the person able to walk in and out of the shower stall easily and safely?* Definition: Person can step over shower stall, or screen tracks without risk and without having to hold onto anything for support. **- Not applicable: There is no shower stall in the house, or the shower stall has not been used in the last two years.**	- Added the "Not applicable" response option
	5	Is there an accessible/sturdy grab rail/s in the shower or beside the bath? Definition: Grab rails which are fixed securely to the wall, which are not towel rails, and which can be reached without leaning enough to lose balance.	Is there an accessible/sturdy grab rail/s in the bath/**bathroom**/shower stall? Definition: Grab rails which are fixed securely to the wall, which are not towel rails, and which can be reached without leaning enough to lose balance.	- Added "bathroom" to be consistent with Item 6 and include spaces for bathing that are not limited to the bath and shower stall

Table 2 (continued)

	6	Are slip resistant mats used in the bath/bathroom/shower recess? Definition: Resistant rubber mats or non-slip strips are installed on the base of the bath or shower stall.	Are slip-resistant mats **or non-slip strips** used in the bath/bathroom/shower recess? Definition: Resistant rubber mats or non-slip strips are installed on the base of the bath or shower stall, **and they function adequately.**	- Added "non-slip strips" to the question so that it encompasses the contents of the definition. - Added "they function adequately" in the definition to reflect "well maintained" written in the definition in the original HOME FAST
Bedroom	7	Can the person easily and safely lie down and get up from the bed? Definition: Bed is of adequate height and firmness. Person does not need to pull self-up on bedside furniture.	*Can the person easily and safely lie down and get up from the bed?* Definition: Bed, **not a floor mattress**, is used. The bed is of adequate height and firmness. Person does not need to pull self-up on bedside furniture.	- Added "A bed, not a floor mattress, is used" to reflect the cultural characteristics of South Korea
	8	Can the person switch a light on easily from his or her bed? Definition: Person does not have to get out of bed to switch a light on at night – has a flashlight or bedside lamp for going to the bathroom.	Can the person switch a light on easily from his or her bed **(sleeping area), or is there appropriate night lighting?** Definition: Person does not have to get out of bed **(sleeping area)** to switch a light on at night – has a flashlight or bedside lamp for going to the bathroom.	- Added "sleeping area" to accommodate the use of floor mattresses in Korean culture - Included "appropriate night lighting" into the main question which written in the definition in the original HOME FAST
Living room	9	Can the person get up from the living room sofa easily and safely? Definition: Sofa is of adequate height, chair arms are accessible to push up from, seat cushion is not too soft or deep.	*Can the person get up from the living room sofa easily and safely?* Definition: Sofa is of adequate height. **Backrest and** chair arms are accessible to push one up from **if needed.** Seat cushion is not too soft or deep. - **Not applicable: Person always uses a wheelchair.**	- Added "backrest" and "if needed" to the definition to provide flexibility - Added the "Not applicable" response option
Kitchen	10	Can the person easily reach items in the kitchen that are used regularly without climbing bending or upsetting his or her balance? Definition: Cupboards are accessible between shoulder and knee height No chairs or stepladders are required to reach things.	*Can the person easily reach items in the kitchen that are used regularly without climbing, bending, or upsetting his or her balance?* Definition: No chairs or stepladders are required to reach **frequently used items**.	- Removed "cupboards are accessible between shoulder and knee height" to reflect the typical placement of kitchen cabinets in South Korea
	11	Can the person carry meals easily and safely from the kitchen to the dining area? Definition: Meals can be carried safely or transported using a trolley to wherever the person usually eats.	*Can the person carry meals easily and safely from the kitchen to the dining area?* Definition: Meals can be carried safely or transported using a trolley to wherever the person usually eats.	-
Stairs	12	Do the indoor steps/stairs have an accessible/sturdy grab rail extending along the full length of the steps/stairs? Definition: Grab rail must be easily gripped, firmly fixed, sufficiently robust and available for the full length of the stairs.	Do the indoor stairs have an accessible/sturdy grab rail extending along the full length of the stairs? Definition: Grab rail must be easily gripped, firmly fixed, sufficiently robust, and available for the full length of the stairs. **- Adequate grab rail height for wall-mounted handrails: 80–90cm** **- Adequate railing height: Above 90cm** - **Not applicable: No stairs exist inside the house, or the stairs have not been used in the last two years.**	- Specified objective criteria for assessing the height of the grab rail - Added the "Not applicable" response option

Table 2 (continued)

	13	Can the person easily and safely go up and down the steps/stairs inside or outside the house? Definition: Steps are not too high, too narrow or too uneven for feet to be firmly placed on the steps (indoors and outdoors). Person is not likely to become tired or breathless using steps/stairs, and has no medical factors likely to impact on safety on stairs, e.g. foot drop, loss of sensation in feet, impaired control of movement etc.	*Can the person easily and safely go up and down the stairs inside or outside the house?* Definition: Steps are not too high, too narrow or too uneven for feet to be firmly placed on the steps (indoors and outdoors). Person is not likely to become tired or breathless using steps/stairs, and has no medical factors likely to impact on safety on stairs, e.g. foot drop, loss of sensation in feet, impaired control of movement etc. **- Adequate stairs: step height ≤ 18cm, step width ≥ 28cm** - **Not applicable: No stairs exist, or the stairs have not been used in the last two years.**	- Specified objective criteria for assessing the height and width of the steps on the stairs - Added the "Not applicable" response option
	14	Are the edges of the steps/stairs (both inside and outside the house) easily identified? Definition: No patterned floor coverings, tiles or painted areas which could obscure the edge of the step, and there is adequate lighting on the stairs	Are the edges of the stairs (both inside and outside the house) easily identified? Definition: No patterned floor coverings, tiles, or painted areas which could obscure the edge of the step, and there is adequate lighting on the stairs. **- Not applicable: No stairs exist, or the stairs have not been used in the last two years.**	- Added the "Not applicable" response option
	15	Do the outdoor steps/stairs have an accessible/sturdy grab rail extending along the full length of the steps/stairs? Definition: Stairs=Two or more consecutive steps (changes in floor level). Grab rail must be easily gripped, firmly fixed, sufficiently robust and available for the full length of the stairs.	Do the outdoor stairs have an accessible/sturdy grab rail extending along the full length of the stairs? Definition: Stairs = Two or more consecutive steps (changes in floor level). Grab rail must be easily gripped, firmly fixed, sufficiently robust and available for the full length of the stairs. **- Adequate grab rail height for wall-mounted handrails: 80–90cm** **- Adequate railing height standard: Above 90cm** - **Not applicable: No stairs exist outside the home, or the stairs have not been used in the last two years.**	- Specified the criteria for assessing the height of the grab rail again for clarity - Added the "Not applicable" response option
Entrance	16	Are the outside paths, steps and entrances well-lit at night? Definition: Lights exist over back and front doors, globes at least 75w. Walkways used are exposed to light, including communal lobbies.	**Are there enough lights to see the back and front doors**, and are the outside paths, stairs, and entrances well-lit at night? Definition: Lights exist over the back and front doors and globes with at least **30 lux.** Walkways used are exposed to light, including communal lobbies. - **Not applicable: No outside path, step, or entrance exists. The door opens straight onto the public footpath**.	- Added "enough lights to see the back and front doors" to the question so that it encompasses the contents of the definition. - Changed the criterion for assessing lighting from watts (w) to lux - Added the "Not applicable" response option
	17	Can the person use the entrance door/s safely and easily? Definition: The locks and bolts can be used without bending or over-reaching. There is a landing, so the person does not have to balance on stairs to open the door and/or screen door.	*Can the person use the entrance door/s safely and easily?* Definition: The locks and bolts can be used without bending or over-reaching. There is a landing, so the person does not have to balance on stairs to open the door and/or screen door.	

Table 2 (continued)

	18	Are paths around the house in good repair, and free of clutter? Definition: No cracked/loose pathways, overgrowing plants/weeds, overhanging trees, or garden hoses encroaching on walkways	Are there **no hazards** or obstructions on the **pathused to enter and exit the house?** Definition: No cracked/loose pathways, overgrowing plants/weeds, overhanging trees, or garden hoses encroaching on walkways. **- Not applicable: No garden, path, or yard exists.**	- Revised "good repair" to "no hazards" - Limited the scope of "paths around the house" to "path used to enter and exit the house" - Added the "Not applicable" response option
Entire house	19	Aren't all the paths hindered by wires and the miscellaneous? Definition: There are no wires and the miscellaneous (boxes, newspapers, and other objects) in the paths. There must be no furniture or objects blocking the doors and the paths. There must be nothing behind the door, so the door must fully open. No raised thresholds in doorways.	**Are the doorways without raised thresholds**, and aren't all the paths hindered by wires and the miscellaneous? Definition: There are no wires and the miscellaneous (boxes, newspapers, and other objects) in the paths. There must be no furniture or objects blocking the doors and the paths. There must be nothing behind the door, so the door must fully open. No raised thresholds in doorways.	- Added "doorways without raised thresholds" to the question so that it encompasses the contents of the definition.
	20	Are the floor coverings in good condition? Definition: Carpets/mats lie flat/no tears/not threadbare/no cracked or missing tiles – including coverings on stairs.	Are the **flooring and floor coverings** in good condition? Definition: **Flooring materials, such as tiles or linoleum are not damaged**. Carpets/mats lie flat/no tears/not threadbare/no cracked or missing tiles – including coverings on stairs.	- Revised "floor coverings" to "flooring and floor coverings" for clarity - Added "Flooring materials, such as tiles and linoleum, are not damaged" in the definition
	21	Are loose mats securely fixed to the floor? Definition: Mats have effective slip resistant backing/are taped or nailed to the floor	Are loose mats securely fixed to the floor? Definition: Mats have effective slip resistant backing/are taped or nailed to the floor. **- Not applicable: There are no mats in the house.**	- Added the "Not applicable" response option
	22	Are floor surfaces non-slip? Definition: Score "no" if lino or tiles are in the kitchen, bathroom or laundry, in addition to any polished floors or tiled/lino surfaces elsewhere. Can only score "yes" if, in addition to other rooms, the kitchen, bathroom and laundry have non slip or slip resistant floor surfaces.	Are floor surfaces non-slip? Definition: Can only score "yes" if, in addition to other rooms, the kitchen, bathroom, and laundry have non-slip or slip-resistant floor surfaces.	- Removed "Score no if lino or tiles are in the kitchen, bathroom, or laundry, in addition to any polished floors or tiled/lino surfaces elsewhere" to reflect the common use of these materials in South Korean homes
	23	Are all the lights bright enough for the person to see clearly? Definition: The brightness of the light bulbs in each space must be over 75 watts, or they should be fluorescent lights. No shadows thrown across rooms, no excess glare.	*Are all the lights bright enough for the person to see clearly?* Definition: **The house's brightness meets or exceeds the minimum lighting standards.** No shadows thrown across rooms, no excess glare. **- Adequate lighting: Bathroom ≥ 60 lux, bedroom ≥ 15 lux, living room ≥ 30 lux, kitchen ≥ 60 lux, indoor staircase ≥ 30 lux, inside the entrance ≥ 60 lux**	- Changed the criterion for assessing lighting from watts to lux to increase the assessment's feasibility - Deleted "should be fluorescent lights" as it did not fit the home environment in Korea - Specified objective criteria for assessing illumination

Table 2 (continued)

24	Is the person wearing well-fitting slippers and shoes? Definition: Person is currently wearing supportive, firmly fitting shoes with low heels and non-slip soles or slippers which have not worn and support the foot in a good position. Score 'No' if indoor shoes are not worn.	Is the person wearing well-fitting **and stable indoor shoes**? Definition: Person is currently wearing supportive, firmly fitting **indoor** shoes with low heels and non-slip soles or slippers that have not worn and support the foot in a good position. Score "no" if indoor shoes are not worn.	- Changed "shoes" to "stable indoor shoes" to reflect the Korean practice of not wearing outdoor shoes inside the home - Added "stable" to the question so that it encompasses the contents of the definition.
25	If there are pets, can the person care for them without bending or being at risk of falling over? Definition: pets = any animals that the person has responsibility for. To score "yes" person does not have to feed pets when they are jumping up or getting under foot, person does not have to bend to the floor to refill bowls/dish or clean pets, and pets do not require a lot of exercise.	*If there are pets, can the person care for them without bending or being at risk of falling over?* Definition: pets = any animals that the person has responsibility for. To score "yes" person does not have to feed pets when they are jumping up or getting under foot, person does not have to bend to the floor to refill bowls/dish or clean pets, and pets do not require a lot of exercise. **- Not applicable: There are no pets/animals.**	- Added the "Not applicable" response option

Note: Bold text indicates the revised or modified content compared to the original K-HOME FAST. Underlined and italicized items represent those reflecting the functional status of the participants

Validity

The I-CVI of the Revised K-HOME FAST ranged from 0.8 to 1.0, except for one item. Against the criterion of I-CVI ≥ 0.78 [21], one item in the Bathroom/Toilet category, "Is the person able to *get in and out* of the bath easily and safely?" (Definition: Person is able to step over the edge of the bathtub safely, sit or stand in the bathtub without holding on to objects, or sit or stand in the bathtub without risk and use the shower) received an I-CVI of 0.7. The experts highlighted the fact that healthy adults often hold onto their surroundings when they get up from the bathtub. Consequently, the definition of the item was modified to: Person is able to step over the edge of the bath without risk (or uses a bathboard or stands to use the shower over the bath without risk). The I-CVI for evaluability ranged from 0.8 to 1.0 for all items. The S-CVI/Ave was 0.90 (95% CI, 0.86–0.93), meeting the criteria for both content appropriateness and evaluability at 0.9 [14].

Reliability

The internal consistency (KR20) of the final Revised K-HOME FAST was 0.65 (95% CI = 0.58–0.71) higher than that of the K-HOME FAST (0.62) [11]. The average survey time was 19 min (range: 8 ~ 27 min), similar to 20 min for the original tool. The inter-rater reliability of the Revised K-HOME FAST was as follows: The agreement percentage for each item ranged from 92% to 100%, with 100% agreement for 19 items. The average ICC was 0.95 (95% CI, 0.91–0.99). The ICC value ranged from 0.64 to 1.00. For two items ("Is the person able to walk in and out of the shower stall easily and safely?" and "Are slip-resistant mats or non-slip strips used in the bath/bathroom/shower recess?"), ICC values between 0.5 and 0.75 indicated moderate reliability, while the remaining 23 items had ICC values above 0.75, indicated good or excellent reliability (Table 3).

Discussion

This study developed the Revised K-HOME FAST and evaluated its validity and reliability to improve the assessment of home hazards that may contribute to fall occurrence among older adults. The development of the Revised K-HOME FAST represents an advancement in the assessment of home environments among Korean older adults.

This study showed improved evidence of the reliability and validity of the Revised K-HOME FAST compared with previous studies [11, 22], particularly in terms of inter-rater reliability. This progress was achieved through a phased development plan that included feasibility testing, content validation, and reliability assessments. Creating an evaluation manual that specifies objective criteria and integrates photographic documentation of risk factors was instrumental in achieving a more standardized and objective evaluation. The sensitivity of the HOME FAST may vary with changes in the level of item description, and the precision with which items are conveyed can affect the evaluation [11]. Therefore, conducting evaluations using questionnaires but without an evaluation manual can compromise the assessment's rigor owing to various factors [11]. The use of the evaluation manual developed in this study strengthens the uniformity and objectivity of the assessment. Furthermore,

Table 3 Inter-rater reliability (*N*=20)

Items		%	ICC
Bathroom/Toilet			
1	Is the bathroom close to the bedroom?	100.0	1.00
2	*Is the person able to get on and off the toilet easily and safely?*	100.0	1.00
3	*Is the person able to get in and out of the bath easily and safely?*	100.0	1.00
4	*Is the person able to walk in and out of the shower stall easily and safely?*	96.0	0.66
5	Is there an accessible/sturdy grab rail/s in the bath/bathroom/shower stall?	100.0	1.00
6	Are slip-resistant mats or non-slip strips used in the bath/bathroom/shower recess?	92.0	0.64
Bedroom			
7	*Can the person easily and safely lie down and get up from the bed*?	96.0	0.91
8	Can the person switch a light on easily from his or her bed (sleeping area), or is there appropriate night lighting?	96.0	0.86
Living room			
9	*Can the person get up from the living room sofa easily and safely*?	96.0	0.89
Kitchen			
10	*Can the person easily reach items in the kitchen that are used regularly without climbing, bending, or upsetting his or her balance*?	100.0	1.00
11	*Can the person carry meals easily and safely from the kitchen to the dining area*?	96.0	0.86
Stairs			
12	Do the indoor stairs have an accessible/sturdy grab rail extending along the full length of the stairs?	100.0	1.00
13	*Can the person easily and safely go up and down the stairs inside or outside the house*?	100.0	1.00
14	Are the edges of the stairs (both inside and outside the house) easily identified?	100.0	1.00
15	Do the outdoor stairs have an accessible/sturdy grab rail extending along the full length of the stairs?	100.0	1.00
Entrance			
16	Are there enough lights to see the back and front doors, and are the outside paths, stairs, and entrances well-lit at night?	100.0	1.00
17	*Can the person use the entrance door/s safely and easily?*	100.0	1.00
18	Are there no hazards or obstructions on the path used to enter and exit the house?	100.0	1.00
Entire house			
19	Are the doorways without raised thresholds, and aren't all the paths hindered by wires and the miscellaneous?	100.0	1.00
20	Are the flooring and floor coverings in good condition?	100.0	1.00
21	Are loose mats securely fixed to the floor?	100.0	1.00
22	Are floor surfaces non-slip?	100.0	1.00
23	*Are all the lights bright enough for the person to see clearly?*	100.0	1.00
24	Is the person wearing well-fitting and stable indoor shoes?	100.0	1.00
25	*If there are pets, can the person care for them without bending or being at risk of falling over?*	100.0	1.00

%=agreement percentage among 6 raters; ICC: single-measurement, absolute agreement, 2-way mixed-effects model

Note: Underlined and italicized items represent those reflecting the functional status of the participants

the characteristics of Korean home environments often require the option of "Not Applicable" for things such as baths, shower stalls, and indoor stairs. Reducing the ambiguity of response options also contributes to the rigor of evaluations. These, in turn, lead to improved reliability and validity of the Revised K-HOME FAST in identifying and mitigating fall risk in the older adult population.

A multidisciplinary approach is crucial to comprehensively address home fall prevention among older adults [23, 24]. The Revised K-HOME FAST was verified by experts in home fall prevention among older adults and evaluation of home environments. In addition, we engaged with the creators of the HOME FAST [9] and the K-HOME FAST [11] and obtained their approval for the revisions. Such collaborative efforts led to a comprehensive understanding of the factors that may contribute to fall occurrence within homes and helped revise the K-HOME FAST. Moreover, we could not only incorporate the opinions of the experts but also preserve the foundational contributions of the original tools, ensuring that the Revised K-HOME FAST aligns with established research while also broadening its application.

The need to develop the Revised K-HOME FAST arose from the realization that the original tool, including its initial Korean adaptation, fails to fully capture the complexity of the home environment in Korea. Thus, environmental risk assessment tools should be regularly assessed and modified based on regional characteristics [8] and differences in living environments [25]. The enhancements of the Revised K-HOME FAST, such as the classification of items based on the area of the house and the introduction of detailed sub-items, underscore a critical advancement in providing a nuanced and comprehensive tool. These improvements facilitate the identification of specific risk factors and targeted interventions,

underscoring the significance of the revisions in enhancing the precision and practical utility of the tool in fall prevention strategies.

Additionally, the distinction of items reflecting the functional status of older adults enhances the strength of the Revised K-HOME FAST in evaluating the interaction between individual behaviour and the home environment. This dual focus on environmental and personal factors allows for an in-depth analysis of the risk factors of fall occurrence and supports the development of customized and effective home fall prevention strategies. This distinction also underscores the necessity of involving older adults in the assessment process, thereby strengthening personalized approaches. Such a structured assessment tool not only enhances the awareness and engagement of older adults regarding fall risk factors [26], it also provides evaluators the opportunity to educate them about assessment outcomes and specific conditions [24]. Studies have suggested a lack of involvement of older adults and personalized approaches in assessing environmental risk factors [24]. The Revised K-HOME FAST can be utilized in this regard because it emphasizes the participation of older adults.

The development of the Revised K-HOME FAST emphasizes the need to cater to the distinct cultural and environmental characteristics of Korean home environments. Moreover, there has been a continuous emphasis on the need for tools that reflect cultural and regional characteristics in the assessment of home environments for fall prevention among community-dwelling older adults [8, 27]. However, often, these aspects are not adequately incorporated [24]. For instance, the Brazilian Portuguese [28], Vietnamese [14], and pre-revision Korean versions [11] of the HOME FAST have undergone only translation processes and have not been modified to reflect contextual characteristics. In this study, we incorporated the characteristics of Korean home environments, such as the use of floor bedding and low tables, and changed the measuring unit of lighting from watts to lux. By making such modifications, we enhanced the practicality and applicability of the K-HOME FAST and ensured that the tool effectively evaluates the home environment in Korea.

Despite the significant advancements made with the Revised K-HOME FAST, this study has some limitations. First, we did not conduct a test-retest reliability assessment, as maintaining the same risk conditions for re-evaluation in the home environment is challenging. Considering the critical role of test-retest reliability in determining the stability of an assessment tool over time, it is essential that future research utilize photos or videos of the home environment to conduct test and re-test [29]. Additionally, this study only assessed the immediate reliability and validity of the Revised K-HOME FAST and did not examine its long-term efficacy in reducing falls. As the HOME FAST has been reported to effectively reduce fall risk, it is important to assess the sensitivity of the Revised K-HOME FAST. Longitudinal studies are needed to evaluate the impact of this tool on fall prevention strategies and outcomes over time.

Based on the findings of this study, we propose the following directions for future research. First, because this study validated the Revised K-HOME FAST among older adults residing in various types of housing in Korea, it can be used to interpret outcomes based on the characteristics of the participants' housing. Future research should identify the degree of fall risk based on the general and housing-specific characteristics of older adults. Second, we recommend identifying the key items of the Revised K-HOME FAST and developing a short-form version. This approach reflects the successful development of the Short-Form Thai Home Fall Hazard Assessment Tool, a shorter, more time-efficient, and precise version that significantly improves the practicality and applicability of the tool [30]. Developing a short form of the Revised K-HOME FAST will enhance the practical usability of the tool and facilitate timely interventions to improve the safety of older adults.

Conclusions

The Revised K-HOME FAST has satisfactory validity and reliability for assessing the risk of falls in the home environment of community-dwelling older adults in Korea. The tool represents a significant step forward in the tailored assessment of fall risk factors in Korean home environments.

Abbreviations

HOME FAST	Home Falls and Accidents Screening Tool
K-HOME FAST	Korean version of the Home Falls and Accidents Screening Tool
ICC	Intraclass correlation coefficient
KR20	Kuder–Richardson Formula 20
I-CVI	Item-Content Validity Index

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Authors' contributions

All authors meet the criteria for authorship: (1) substantial contributions to conception and design (GSK, MP, LK, JJL, NK, SBY), or acquisition of data (MP, LK, JJL, NK), or analysis and interpretation of data (GSK, MP, LK, JJL); (2) drafting the article (MP) or revising it critically for important intellectual content (all authors); and (3) final approval of the version to be published (all authors).

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Data availability
The datasets generated and/or analysed during the current study are not publicly available due to still being used for further analysis. However, upon approval of the final manuscript related to these data, they may be provided by the corresponding author upon reasonable request.

Declarations

Ethics approval and consent to participate
This study was approved by Institutional Review Board of Yonsei University Health System, South Korea (IRB No. 4-2023-1381 and dated January 12, 2024). All participants provided written informed consent and all methods were carried out in accordance with relevant guidelines and regulations.

Consent for publication
Not applicable.

Competing interests
The authors declare no competing interests.

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