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# Mapping Fall Risks in Home Environments: Perceptions and Observations from Older Adults and Researchers in Finland

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## ABSTRACT

Falls at home are a major cause of injury and mortality among older people. This research investigated the alignment between older adults' perceptions and research observations of home-related fall risks via literature review, interviews of older adults, and field observations in their home environments. The results show a clear mismatch in the kind and especially number of risks noted. Also, some risks were brought up by older people but not found in literature. This highlights the importance of raising awareness of fall risks among older people, and of more inclusive home assessment processes. Broadening the concept of home environment in research is also needed.


## KEYWORDS

Aging in place; fall risk; aging; home; perception; older adults

## Introduction

Aging in place policies have been supported in Westernized countries for a long time (Pani-Harreman et al., 2021). Founded on the expected savings in the public sector and the principle that older adults want to live as long as they can in their homes, these policies are aimed at providing healthcare services to community-dwelling older adults in their home environments to support independent living (Means, 2007). Together with a lack of resources (i.e. lack of carers, lack of care home places), throughout Europe, but especially in the Nordic countries, home care for older people is largely prioritized over residential care settings (Rodrigues et al., 2012; Spasova et al.,

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2018). Hence, combined with overall population aging, a growing number of older adults with functional limitations continue to live at home. While the effects of aging are individual to an extent, accidents such as falls can lead to worse outcomes with age (Clegg et al., 2013). As increasing number of older adults spend the majority of their time at home, the home is also the most likely location for falls. A recent study from Finland states that 90% of fatal injuries happen at home and during leisure time (Korpilahti et al., 2021). With the older population rapidly increasing, the number of falls and fall-related injuries is expected to increase as well (Ylitörmänen et al., 2023).

Our research takes place in Finland, a Nordic welfare state with a population of approximately 5.5 million. In comparison to other European countries, Finland has one of the highest numbers of fall-related deaths among older adults aged 70 and above (Haagsma et al., 2020). To a large extent this is explained by the combination of individuals' susceptibility (old age and disease) and exposure to environment related hazards leading to accidents (Rubenstein, 2006). Correspondingly, preparing the housing stock for population aging on different levels is an ongoing effort in Finland. It was emphasized in a development programme on housing for older people led by the Finnish Ministry of the Environment (Ympäristöministeriö, 2020), where providing guidance for older people to prepare for aging by conducting home modifications was also identified as a key recommendation (Kortelainen et al., 2020).

During the years 2000–2022, falling was recorded as the underlying cause of mortality for 22,030 Finnish people aged 65 or older (Statistics Finland, 2023). Accidental falls constituted 2.3% of all deaths within the 22-year period in the age group. Most falls are linked to identifiable factors, e.g. 62.2% of falls in Finland during 2000–2022 were due to slipping, tripping or tumbling while not on stairs, 5.4% on or from stairs, and 5.1% were related to furniture excluding wheelchairs (Statistics Finland, 2023), meaning that addressing those risk factors can help reduce fall rates. While there is extensive research carried out to identify fall risk factors in institutional and community environments (i.e. “intrinsic” factors such as demographic and biological, and “extrinsic” factors like environmental and behavioral), fall risk factors in the home environment are still under studied (Masud & Morris, 2001; Markle-Reid et al., 2010, p. 120).

As falls often result from a combination of “environmental hazards and individual susceptibility” (Rubenstein, 2006, p. 38), understanding older adults' falls in the home environment requires researchers and professionals to also explore how older adults live and perceive potential risks at home. However, research into fall risk awareness among older adults is scarce, as fall risk assessments and hazard observations are often conducted by professionals only (e.g. Deandrea et al., 2010; Gade et al., 2021). In a

comparative study, Kim (2022) found that older adults identified significantly fewer environmental hazards in their home environments in comparison to professionals. Despite these results, Kim (2022) noted that older adults with reduced mobility might be better at identifying some potential risks, and understanding how residents perceive the risks at home allows home risk assessments to have a more comprehensive view of their everyday lives.

Previous research has identified that community-dwelling older adults take precautions to avoid falls (Pohl et al., 2015), engage in avoidant behaviors due to fear of falling (Murphy et al., 2002), and develop various assimilative strategies to create feelings of safety at home (Kim, 2022). However, it has been noted that despite being aware of risks at home, some older adults choose to ignore those risks, believing that nothing will happen to them. Similarly, studies on fall prevention strategies show that the majority of older adults do not adhere to the fall prevention advice they receive (Vincenzo et al., 2022) and some studies estimate that more than 50% of home modification and assistive equipment is rejected and not used (e.g. Hamm et al., 2016). Therefore, interviewing the residents and exploring their daily activities and their choices allows researchers to create a better image of how older adults actively perceive and manage fall risks in their home environment, and where these risks reside.

Earlier research has noted that assessors focusing on objective characteristics of the home environment may fail to identify risks stemming from those characteristics' interaction with the resident's personal characteristics (i.e. "environmental hazards and individual susceptibility"), forming a perspective gap worth investigating (Kim, 2022). Thus, having older residents actively involved in the research process not only allows us to understand how older adults use their homes, but also increases awareness of fall risks and reduces the stigma around falls (Alfaro Hudak et al., 2023; Gardiner et al., 2017). Furthermore, since older adults are expected to proactively prepare for aging by modifying their homes (Ympäristöministeriö, 2020), understanding these potential differences in perspectives is crucial to direct corresponding guidance efforts.

In accordance with the above, the aim of this research was to investigate the differences and similarities between fall risks in older adults' home environments that are perceived by older adults themselves and observed by researchers. Within this aim, the types, causes, and locations of falls are discussed as needed to illustrate the risks, or how they are perceived, but are not the focus of the study. The corresponding research question was as follows:

- How are older adults' perceptions and research observations of home-related fall risks aligned?

## Materials and methods

The mixed methods design of the study comprised the following data collection parts: (1) a literature review to determine fall risks in older adults' home environments identified in existing research articles and field observation guides; (2) semi-structured interviews (see e.g. Galletta, 2012) to investigate older adults' perceptions of fall risks in their home environments; and (3) field observations in the interviewed older adults' home environments to map the fall risks present as observed by the researchers. The above were conducted by an interdisciplinary team as follows: (1) architectural, social sciences, and nursing science researchers jointly; (2) social sciences supported by architectural researchers; (3) architectural researchers. For analysis, the identified fall risks were combined into a single quantitative dataset as well as recorded on the produced home maps. Finally, the analysis of multiple data sources was conducted in triangulation, in which the perspectives of the residents and the researchers were compared to identify similarities and differences in their perceptions (Noble & Heale, 2019).

### *Literature review*

The literature search for the review was conducted in April 2022 in Medline, CINAHL, Nursing & Allied Health, Applied Social Sciences Index & Abstracts (ASSIA), Sage, Science Direct, Social Science Premium Collection, Scopus, and Web of Science databases. The following two search strings were used, and the results matching either one were included:

- Title, abstract, and keywords: (old\* OR eld\* OR aged\* OR senior\* OR pension\*) AND (“fall at home” OR “accident at home”)
- Subject heading: ((MH “Aged”) OR (MH “Aged, 80 and over+”)) AND (MH “Accidents, Home”)

The review was restricted to published, peer-reviewed empirical research articles that reported falls or fall risks in older people's home environments and were written in English, Finnish, or Swedish as supported by the research teams' language abilities. Acknowledging that a large body of literature reviews investigating both individual and environmental characteristics and interventions around falls already exists (e.g. Clemson et al., 2023), we narrowed down the focus of this review to empirical papers related to the physical environment, excluding existing reviews and book chapters. Moreover, studies have shown that older adults often do not adhere to fall prevention strategies, stressing the importance to identify and

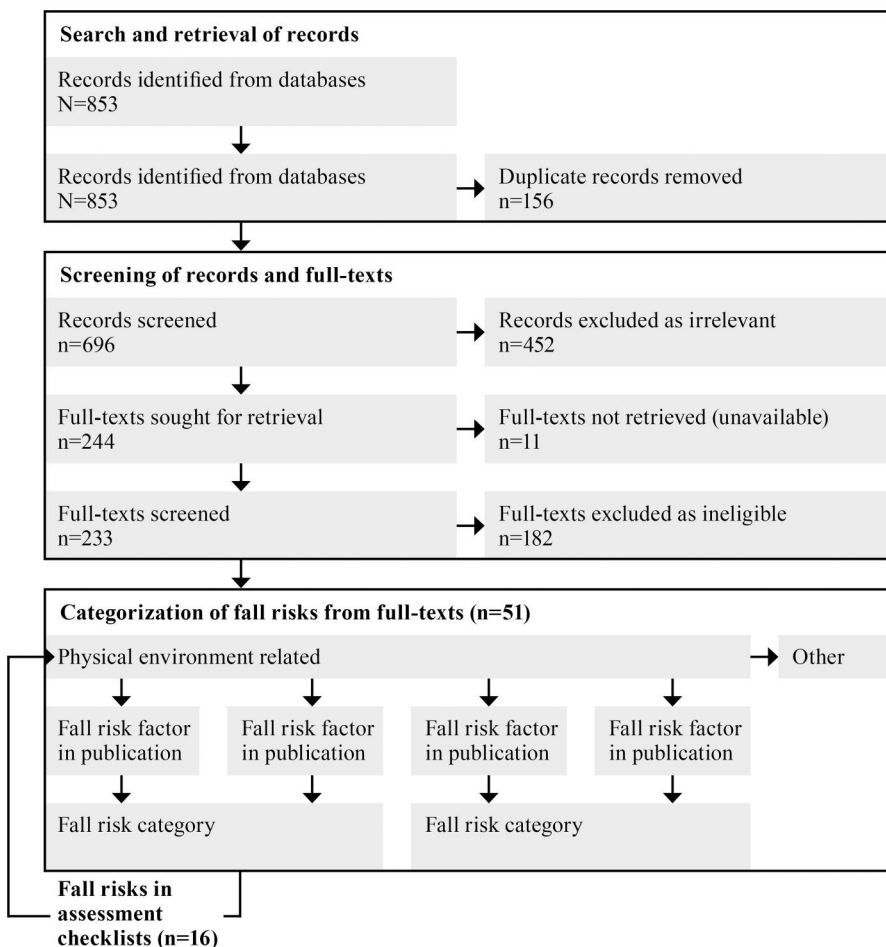
address fall risk issues in the physical environment (Haines et al., 2014). In addition, papers reporting the results of controlled trials and interventions were excluded because we were interested in the presence of fall risks in the physical environment regardless of planned interventions and their effects. Intervention studies within the same initial sample have, however, been covered in a separate review (see Palonen et al., 2023).

Corresponding to the primary focus of the study, fall risks explicitly related to the physical home environment were distinguished from other factors such as those related to a person's medication. The home-related fall risks were further categorized based on their relation to different physical elements of the home environment. The categorization was inductive, based on the descriptions of fall risks found in the literature. Due to the initially very limited number of identified home-related fall risks, and even more limited number of studies assessing those (see "Risk factors reported in literature"), the review of peer-reviewed papers was further extended by a review of existing fall risk checklists, using the same initial sample complemented by a systematic review by Romli et al. (2018). From this process, all checklists that were used or referenced in the papers and could be accessed were included. Non-fall-related risks found in some of the checklists were ignored. The review process is illustrated in [Figure 1](#).

### ***Semi-structured interviews and field observations***

The interviews and initial corresponding field observations were conducted in February–March 2023. These were followed by a set of revisits in May–June 2024 to further check some home environment aspects, particularly related to thresholds in locations perceived as potential high risk such as entrances to balconies and bathrooms.

In spring 2023, participants were recruited by visiting and presenting the research project to various stakeholders (caregivers and older adults) at 12 meeting spaces and service centers for older persons in Tampere, Finland, where the personnel and older people could engage with the researchers. Participants were recruited to participate in the research during these visits by handing out sign-up sheets to those interested, with the possibility to be interviewed together with a close person. This resulted in 67 participants from 49 households, with 17 close persons involved. This paper covers data from a subsample of 15 households (19 participants), where the field observations took place. Participant and dwelling characteristics are described in [Table 1](#). In accordance with the ethical review of the research by The Ethics Committee of the Tampere Region (approval statement number 152/2022), we did not collect any health-related information, but assessed potential participants' ability to give informed consent and thus to



**Figure 1.** Literature review process.

participate in the research individually. A key consideration here was that the recruitment happened face-to-face from the local community, where everyone was a frequent participant in the centers organizing daytime activities for older adults living independently. Before starting the interviews, the residents and their close ones signed informed consent forms. Both interviewers were social psychologists with experience in conducting interviews and monitored the situation throughout for any of the interviewees being unable to continue the interview or give consent.

The topic of perceived and/or realized fall risks was covered as part of a broader interview concerning the participants' views on good everyday life, worries and risks of living at home and use of technology. Furthermore, participants were explicitly asked if they had had falls or near falls at home and if so, to describe the event. They were also asked about potential risk factors for falls and other accidents. In accordance with the semi-structured interview protocol (see e.g. Galletta, 2012), questions were kept open ended

**Table 1.** Characteristics of participants ( $N = 19$ ) and dwellings ( $N = 15$ ), included in the interviews and field observations, respectively.

Variable	Categories	<i>n</i>	%
Sex	Female	14	73.7
	Male	5	26.3
	Other or preferred not to say	0	0.0
Age	65–74	2	10.5
	75–84	13	68.4
	85+	4	21.1
Living status	Alone	11	57.9
	With partner	8	42.1
Use of mobility aids indoors*	Cane	3	15.8
	Walker	4	21.1
	Walking poles	0	0.0
Use of mobility aids outdoors*	Cane	2	10.5
	Walker	5	26.3
	Walking poles	3	15.8
Type of dwelling	Studio apartment	2	13.3
	1 bedroom apartment	6	40.0
	2 bedroom apartment	5	33.3
	Single storey house, with basement	1	6.7
	Two storey house, no basement	1	6.7

\*Some participants had multiple mobility aids even for only indoor or outdoor use, e.g. a walker and a cane.

and the responses were allowed to be free form. Previous research has found open ended questions effective in discussing fall prevention with interviewees (Kiyoshi-Teo et al., 2020). It was also expected that more open ended questions would work better for drawing out personal perceptions as well as any related information not explicitly asked about. The full interview protocol can be found in [Supplemental material A](#). The interviews were recorded (audio only) and transcribed. For the purposes of this article, a content analysis (Krippendorff, 2018) was conducted on the interview data to map the potential risks identified by the residents.

Field observations in the participants' dwellings occurred either during the interview (by a separate set of two researchers) or during a separate visit. Observations included home environment mapping to collect multi-modal data of fall risks and light use, covering aspects such as layout and organization, furniture placement and heights, presence/absence of hand-rails, floor furnishings, thresholds, uneven floor finishes, electrical sockets and leads, light conditions during the day and in the evening, after sunset. These observations were documented using written notes and photographs. Comprehensive sets of additional photographs of the dwellings were also taken during the observation visit to allow further consideration. Furthermore, scale drawings of the dwellings' floor plans were obtained from the residents if available or by measuring and drawing. The drawings were used to record the locations of the potential fall risks as documented in the literature (see [Tables 2](#) and [3](#)). Post-interview, participants' perceived fall risks were then combined and overlaid on their house floor plans. The full set of assessed risk factors and corresponding assessment criteria is

**Table 2.** Risk factors reported in peer-reviewed papers.

Fall risk category	Fall risk factor	References
Slipping	Slippery surface	Kongwattanakul et al. (2020) Morfitt (1983) Sattin et al. (1998)
	Unspecified	Chaumon et al. (2016) Downton and Andrews (1991) Panatto et al. (2009) Torres et al. (2022)
Tripping	Caught heel	Morfitt, 1983
	Clutter on floor	Graham and Firth (1992) Morfitt (1983) Sattin et al. (1998)
	Cords on walkways	Sattin et al. (1998)
	Loose rugs	Gill et al. (2000) Graham and Firth (1992) Kongwattanakul et al. (2020) Morfitt (1983) Sattin et al. (1998)
	Poorly visible steps Stairs or steps	Graham and Firth (1992) Byers et al., 2008 Chaumon et al. (2016) Kongwattanakul et al. (2020)
Fixtures	Unspecified	Bath and Morgan (1999) Blake et al. (1988) Chaumon et al. (2016) Downton and Andrews (1991) Morfitt (1983) Panatto et al. (2009)
	Difficult to reach the light switch	Sattin et al. (1998)
	High cabinets	Sattin et al. (1998)
	Inadequate toilet handrails/support	Clemson et al. (1996) Graham and Firth (1992)
	Low cabinets	Sattin et al. (1998)
	No stair handrails	Graham and Firth (1992)

presented in [Supplemental Material B](#), and an illustrative example of a fall risk map is in [Supplemental Material C](#).

## Results

### *Risk factors reported in literature*

Risk factors were included if, in the reviewed study, they were found (based on each study's own criteria and methods) to increase the risk of falling in the studied group. For example, throw rugs may generally pose a tripping hazard, but they may also reduce fall risk if placed on very slippery floors if secure enough. Furthermore, risk factors were included if at least one of the reviewed studies found them significant, even if some other(s) did not. More general forms of risk factors were recorded where reasonable, e.g. slippery floor in the bathroom is not considered its own factor if slippery floors were categorically noted elsewhere.

Of the 51 full texts reviewed, 22 (43.1%) included properties of the physical environment among their studied fall risk factors (see [Table 2](#)). Among those, only 10 were more specific than simply identifying the type of fall

**Table 3.** Risk factors included in fall risk checklists.

Fall risk category	Fall risk factor	Calys et al. (2013)	Carter et al. (1997)	Chandler et al. (2001)	Clemson et al. (1999)	Fisher et al. (2007)	Gill et al. (1999)	Gitlin et al. (2002)	Johnson et al. (2001)	Kongwatthanakul et al. (2020)	Mackenzie et al. (2000)	Morgan et al. (2005)	Morris et al. (1997)	Sadasivam et al. (2014)	Sorcinelli et al. (2007)	Stalenhoef et al. (1998)	Tomita (2017)	
Dimensions	Inadequate landing at the entrance door																	
	Objects reducing the space to move																	
	Toilet layout inappropriate																	
	Insufficient space to walk																	
	Bath is difficult to get into/out of																	
	Difficult to open/close doors																	
	Difficult to reach appliances																	
	Difficult to reach cupboards																	
	Difficult to use the bathroom																	
	Difficult to use the entrance door																	
Fixtures	Inadequate/no shower handrails/support																	
	Inadequate/no stair handrails																	
	Inadequate/no toilet handrails/support																	
	Toilet is too low/high																	
	The light switch is difficult to reach																	
	Light switch far from the bed																	
	Light switches are difficult to find																	
	The bed is difficult to get up from																	
	Chair is difficult to get up from																	
	Unstable furniture																	
Layout	Poorly located toilet																	
	Abrupt changes in lighting																	
	Glare																	
	Insufficient daylight																	
	Insufficient lighting																	
Lighting	Shadows across the room																	

(continued)

Table 3. Continued.

Fall risk category	Fall risk factor	Calys et al. (2013)	Carteret al. (1997)	Chandler et al. (2001)	Clemson et al. (1999)	Fisher et al. (2007)	Gill et al. (1999)	Gitlin et al. (2002)	Johnson et al. (2001)	Kongwattanakul et al. (2020)	Mackenzie et al. (2000)	Morgan et al. (2005)	Morris et al. (1997)	Sadasivam et al. (2014)	Sorcinelli et al. (2007)	Stalenhoef et al. (1998)	Tomita (2017)	
Slipping	Slippery surface																	
	Loose rugs																	
Tripping	Clutter on the floor																	
	Cords on walkways																	
	Uneven surface																	
	Floor level differences																	
	Inclining floors																	
	Stairs uneven																	
	Stairs in poor condition																	
	Folded rugs																	
	Furniture in walkways																	
	Inadequate stair dimensions																	
	Items on stairs																	
	Loose rugs																	
	Other	Narrow path outside																
Poor condition paths outside																		
Poorly visible steps																		
Raised thresholds																		
Difficult to reach items																		
No telephone near the bed																		
Stairs too long																		
Inadequate/no banister on stairs																		
Steep path outside																		
Non-level areas outside																		
Difficult to use curtains/blinds																		
Difficult to use the entrance																		
Difficult to use windows																		

(e.g. slipping or tripping). A total of 12 distinct physical environment related to fall risks were found in these studies (excludes “unspecified” and the ambiguous “caught heel” in Table 2).

The 16 fall risk checklists reviewed contained 54 distinct fall risk factors related to the physical environment (see Table 3). Similarly to the factors in peer-reviewed papers, their specificity and subjectivity varied greatly.

### ***Risk factors perceived by residents and observed by researchers***

Following the risk assessment of homes and content analysis on the interview data, the study identified 299 researcher-observed fall related risks and 37 risks that residents mentioned in their interviews (Table 4). Most common researcher-made observations were risks related to tripping ( $N=78$ ) such as stairs, clutter, furniture or electrical cords on the walkways ( $N=75$ ), followed by risks related to fixtures ( $N=76$ ) such as kitchen cupboards being too high or low to reach. In addition, researchers observed potential difficulties around using the home ( $N=56$ , categorized as other) such as reaching items, using curtains, and cleaning windows. The risks residents mentioned focused on floors, with the most common categories being slipping ( $N=15$ ), for instance due to slippery surfaces, and tripping ( $N=14$ ), for instance over raised thresholds. In contrast, risks observed by researchers were much more evenly spread. Risk factors were only considered perceived by residents if the residents brought them up during the interview, either with no prompting or following a general question about their experiences or thoughts regarding daily life. Despite the researchers not mentioning specific risks at home, the residents in all interviews brought up some potential risks in their daily lives. Risks not found in literature but brought up by any resident (marked only under RI in Table 4) were assessed in all residents’ homes. Among these were for instance risks related to cleaning high up surfaces at home, as illustrated by the following interview excerpt:

Woman, 81, living alone: How can I safely wipe the dust off that lamp? When I don’t have anything to hold onto.—I’ve used some cloth, wet rag and a broom combination, but I am afraid to climb, because there is no support, so I would be all alone [without support] on a high stool.

It is important to note that some residents had already eliminated risks by either adjusting their environment, e.g. getting rid of rugs prone to folding, or their behavior, e.g. stopping reaching to high places. In the next excerpt, a study participant describes such efforts:

Woman, 81, living alone: I don’t have any rugs here because I don’t want to trip over them anymore.



**Table 4.** Risk factors perceived present by residents or observed by researchers.

Fall risk category	Fall risk factor	Fall risk source*				Perceived by resident(s)		Observed by researchers		Not identifiable**		Not applicable***	
		PL	AC	RI	Yes	n	Yes	n	Yes	n	Yes	n	
													Yes
Dimensions	Inadequate landing at the entrance door		x										
	Objects reducing the space to move		x										
Fixtures	Difficult to reach the light switch					1							
	Inadequate/no stair handrails	x											
	High cabinets; difficult-to-reach cupboards	x											
	Low cabinets; difficult to reach cupboards	x											
	Bath is difficult to get into/out of		x										
	Difficult to reach appliances		x										
	Difficult to use the entrance door		x										
	The light switch is far from the bed		x										
	Light switches are difficult to find		x										
	Difficult to use the bathroom		x										
Furniture	Difficult to open/close doors		x										
	Inadequate/no shower handrails/support		x										
	Inadequate/no toilet handrails/support	x											
	Toilet is too low/high		x										
	Difficult to reach lamps												
	Unstable furniture		x										
	The bed is difficult to get up from		x			1							
	Chair is difficult to get up from		x										
	Poorly located toilet		x										
	Layout	Insufficient daylight		x									
Insufficient lighting			x										
Abrupt changes in lighting			x										
Glare			x										
Shadows across the room			x										
Slippery surface inside		x											
Loose rugs		x											
Slippery surface outside													
							6						

Tripping	Clutter on the floor	x	x	0	14	0	0
	Cords on walkways	x	x	1	13	0	0
	Poorly visible steps	x	x	0	1	0	0
	Stairs or steps	x	x	2	5	0	0
	Uneven surface	x	x	0	1	0	0
	Inclining floors	x	x	0	0	0	0
	Folded rugs	x	x	2	8	0	0
	Furniture in walkways	x	x	1	13	0	0
	Inadequate stair dimensions	x	x	1	2	0	12
	Items on stairs	x	x	0	3	0	12
	Raised thresholds	x	x	6	12	0	0
	Narrow path outside	x	x	0	0	15	0
	Poor condition paths outside	x	x	0	0	15	0
	Thick rugs	x	x	1	4	0	0
	Difficult to reach items	x	x	1	15	0	0
	No telephone near the bed	x	x	0	0	0	15
	Stairs too long	x	x	0	0	3	12
	Stairs uneven	x	x	0	1	0	12
	Stairs in poor condition	x	x	0	0	1	12
	Inadequate/no banisters on stairs	x	x	0	0	1	12
Steep path outside	x	x	0	0	15	0	
Other	Difficult to use curtains/blinds	x	x	1	13	0	0
	Difficult to use the entrance	x	x	0	2	0	0
	Difficult to use Windows	x	x	0	12	0	0
	Difficult to clean windows	x	x	2	14	0	0

\*PL: peer-reviewed literature; AC: assessment checklists; RI: resident interviews.

\*\* Presence of risk could not be determined.

\*\*\* Relevant feature (e.g. stairs, bathtub) not present.

Correspondingly, these were not included as risks perceived by those specific residents as being present even though they, respectively, had been perceived by the resident as a potential risk, or might be observed by a researcher. In dwellings with two interviewed residents, risks perceived by either one were counted together.

As Clemson et al. (1996, p. 100) note, “the existence of a hazard depends in large degree on the functional status of the person in whose home the potential hazard exists.” Thus when assessing the presence of certain fall risks, such as inadequate toilet handrails or space to move, the mobility status of the resident was considered (see [Supplemental material B](#)). For example, lack of toilet handrails was only deemed a fall risk if the resident used a mobility aid. An individual assessment of the participants’ ability to function, through e.g. observation of different tasks, was not conducted.

## Discussion

Less than half of the reviewed studies documented fall risks attributable to properties of the physical environment. While researchers observed a total of 299 home-related fall risks in the visited dwellings, residents only brought up a total of 37. These results align with Kim’s (2022) observation that residents do not consider all potential fall risks in their homes, for which existing research has proposed multiple potential reasons. For instance, older adults may not be able or willing to identify fall risks in their own homes because they do not want to identify as people who fall, being old, or having mobility issues (Gardiner et al., 2017; Haines et al., 2014). Research has also shown that older adults often avoid talking about falls as falls and prefer to use softer terms such as “stumble”, “trip” or “lose balance” to mitigate the seriousness of the accident (Brim et al., 2021). Similarly, there is research indicating that older adults may be hesitant to report falls and often have a different understanding of what constitutes a fall than researchers (Dollard et al., 2014; Freiburger & de Vreede, 2011).

As [Table 4](#) highlights, the share of dwellings where the resident perceived a certain risk was consistently lower than where one was observed by researchers, but the difference varied. Notable examples of a major difference are high or low cabinets, which no resident brought up in the interviews, but researchers observed in every case. In fact, out of the 15 fixture related risks none were mentioned by the participants, while nine were observed by researchers, totaling 76 occurrences. Similarly, clutter on floor, a very common item in checklists ([Table 3](#)) was observed in all but one of the 15 visited dwellings, but never brought up by the residents. Issues with windows and curtains or blinds were also observed in nearly all dwellings but only brought up by a very few residents. The above could be due to a

general lack of awareness of the potential risk of falling related to furniture's characteristics (Pohl et al., 2015). The discrepancy also highlights designers' such as architects' (and construction companies'), role in avoiding the creation of fall risks by e.g. specifying sufficient and easy to reach storage space, suitable locations for fixtures, as well as appropriately placed and distinguishable light switches. In some of the interviews outside the current visited sample, however, participants did mention avoiding the use of top cupboards specifically due to them being hard to reach. Similarly to clutter, cords on walkways were observed in nearly all cases but only brought up by a single resident. A vast majority of the homes were very dimly lit, both during daytime and after sunset, but almost none of the participants mentioned insufficient light as a risk. Likewise, no participant mentioned difficult to find or operate light switches or lamps, possibly due to the simple fact of being familiar with their own homes.

In contrast, for slippery surfaces the shares of risks perceived by residents and researchers were much more even, although still weighted toward researcher observations. For these, some residents specified the increased risk when wearing wool socks, which hints at an indirect risk from poor thermal comfort. Raised thresholds were also relatively commonly noted by residents, especially at the balcony door. As things that did not come up in existing literature, the interview participants noted risks connected to cleaning windows and lamps, both of which often require reaching or climbing, as well as tripping over thick (but not necessarily folded or loose) rugs or slipping in the yard.

In general it appeared that a lack of space, too much furniture and other items, or a combination thereof was a common problem, with dwellings that could be considered cramped or cluttered usually containing more fall risks. Furthermore, some residents had a walker but mentioned not using it inside due to insufficient space. Considering the share of extremely compact dwellings in recent Finnish new construction (see e.g. Pelsmakers et al., 2021), this is a worrying observation.

When examining the results, certain limitations must be considered. Firstly, our recruitment was limited to people somewhat active in the community, i.e. present at the locations visited. Within this group, the labor intensive home mapping process also restricted the sample size. Following the review, existing literature may have limited the researchers' assessment of what constitutes a fall risk. This was, however, alleviated by including risks brought up by residents. These risks had no direct literature backing, but did have clearly identifiable connections to literature such as folded versus thick rugs, the latter of which was only mentioned in the interviews. It's possible that the visits themselves impacted the state of the homes via e.g. the residents cleaning up clutter (although it was still very common) or

turning on more lights. Residents may also use furniture or items around the house as support when walking that researchers may identify as clutter but in reality works as preventative measure, i.e. something to hold onto. These type of assimilative coping strategies were also noted by Kim (2022) when a resident for instance used a shower chair or towel rack as support when they did not have a handrail installed in the bathroom. Individuals may also have left out some avoidant behaviors from their talk that neutralizes the fall risks (e.g. if you do not use top cabinets, they are not a risk for you). In general, determining whether something is a fall risk is nearly always somewhat subjective. Since our researcher observations were based on checklists, and participants' ability to function was considered based on their use of mobility aids or lack thereof, it is possible that we missed fall risks that would have become evident through more comprehensive functional assessments, potentially conducted by occupational therapists. It is notable, however, that there is research supporting the reliability of photograph based fall risk identification by non-therapists (Ritchey et al., 2015), as well as studies showing that older adults may not feel comfortable discussing potential fall risks in their homes with occupational therapists despite their person-centred approach (Lo Bianco et al., 2020). Interviewees may also have had different views on what constitutes a fall since they were not given a strict definition (Freiberger & de Vreede, 2011) or, as noted above, whether they personally were at risk (Gardiner et al., 2017; Haines et al., 2014) and what they themselves perceive as a fall. The Finnish language may also have had an impact, since the words "kaatuminen"/"kaatua" ("a fall"/"to fall"), at least as commonly understood, refer specifically to falling over and not, e.g. falling from a height. Finally, the Finnish context with local dwelling characteristics and climate conditions (notably, long dark nights and icy outside conditions during winter) has to be taken into account in international comparisons.

## Conclusions

Understanding what risks older adults perceive in their home environments is vital for creating better suited solutions to prevent accidents at home. This article gathered evidence from previous research identifying fall risks at home and compared it to fall risks identified by residents themselves and researchers.

The results clearly indicate a mismatch between research and residents. This first of all shows there is a need to raise awareness of potential risks in home environments among older adults, which can facilitate proactive behavioral changes and/or home adaptations. Secondly, it is important to have older adults actively involved in their home assessment processes

through, e.g. discussions, since outside observers might well miss important issues. Thirdly, designers and, where relevant, construction companies need to account for different and changing needs throughout the life-course so, e.g. dangerous reaching, climbing, or clutter potentially due to a lack of storage space can be avoided.

The literature review showed there to be very little research looking into what older adults consider a risk and why, indicating a corresponding need for further study among community-dwelling people. This is also needed to direct efforts related to facilitating proactive fall risk mitigation. A majority of the literature was also rather old, indicating that the field could benefit from new research that takes into account the increasingly heterogeneous housing arrangements and trends today. Furthermore, in existing work the concept of home environment appeared quite strictly limited to the interior. In contrast, our interviews had slipping outside as the (tied) most common risk perceived by the participants. To support active aging and community participation, the home environment needs to be examined more broadly, especially in places with cold winters like the Nordic countries.

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## Author contributions

CRedit: **Tapio Kaasalainen**: Conceptualization, Data curation, Formal analysis, Investigation, Methodology, Project administration, Supervision, Visualization, Writing – original draft, Writing – review & editing; **Annika Valtonen**: Conceptualization, Data curation, Investigation, Methodology, Project administration, Supervision, Writing – original draft, Writing – review & editing; **Raúl Castaño De la Rosa**: Conceptualization, Methodology, Writing – original draft; **Elisa Enlund**: Data curation, Investigation; **Katri Keskinen**: Methodology, Writing – original draft, Writing – review & editing; **Mira Palonen**: Conceptualization, Methodology, Writing – original draft, Writing – review & editing; **Sofie Pelsmakers**: Conceptualization, Funding acquisition, Investigation, Methodology, Project administration, Supervision, Writing – original draft, Writing – review & editing; **Tuuli Turja**: Conceptualization, Methodology, Writing – original draft, Writing – review & editing; **Emmi Villberg**: Data curation, Investigation.










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