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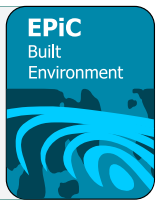

Enhancing Home Safety for the Elderly: Key Flooring Factors to Reduce Fall Risks

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As the global population ages, falls among older adults have become a significant concern in residential settings. This study investigates how flooring materials, finishes, and visual patterns affect fall risk among elderly individuals, based on a qualitative, literature-based comparative analysis focusing on intrinsic human factors. A comprehensive literature review was conducted to identify flooring features that either increase or reduce fall risk. The analysis is derived from peer-reviewed studies, industry reports, and guidelines from the CDC, WHO, and relevant design organizations. Results show that high-friction surfaces, such as carpets and textured tiles, significantly reduce the likelihood of slips, while glossy or low-friction materials increase fall risk. Additionally, low-contrast patterns help minimize visual confusion and improve depth perception, while smooth floor transitions reduce tripping hazards. These findings inform design and material choices that support aging in place and promote universal design principles. Recommendations for construction professionals and designers include selecting non-glare, high-friction materials and maintaining consistent, low-contrast floor patterns for elderly populations. This research provides practical insights to enhance home safety and guide construction practices that facilitate healthy aging as the global population continues to expand.

Key Words: Senior, Fall Risk, Flooring, Intrinsic Factors, Residential Construction

Introduction

According to WHO (Ageing & Health, 2024), by 2030, 1 in 6 people worldwide will be aged 60 or older. The global population aged 60+ will rise from 1 billion in 2020 to 1.4 billion in 2030, and double to 2.1 billion by 2050 (Noto, 2023). Those aged 80+ are expected to triple, reaching 426 million by 2050. In the US, the population aged 65+ will grow from 58 million in 2022 to 82 million by 2050 (Population Reference Bureau, n.d.), with the senior living market valued at USD 112.93 billion, expected to hit USD 150.42 billion by 2029 (Mordor Intelligence, n.d.), reflecting this trend. As the elderly population expands, challenges related to geriatric impairments and diseases, though not necessarily disabilities, will become more prevalent. Common conditions among older adults include hearing loss, cataracts, refractive errors, back and neck pain, osteoarthritis, chronic obstructive pulmonary disease (COPD), diabetes, depression, and dementia. As people age, they are more likely to experience multiple conditions simultaneously (WHO, 2024). Geriatric impairments as people age generally include muscle strength, physical capacity, cognitive function, vision, hearing, and psychological status (Chaudhry et al., 2010).

Falls are a leading cause of injury and hospitalization among adults aged 65+ and can result in fractures, head trauma, and loss of independence (CDC, 2024a). Fall risk involves intrinsic factors (e.g., balance, strength, vision, cognition) and extrinsic factors (e.g., flooring, lighting, obstacles), making residential flooring a key prevention target through construction and design. Construction professionals influence extrinsic risks via material choices and design. This study examines how flooring properties, surface finishes, and visual patterns influence fall risks, aiming to improve safety for older adults by linking flooring features to fall risks and suggesting safer home designs construction.

Background and Literature Review

As the number of people aged 65+ grows, safe homes that support aging in place become more vital. Older age links to risks like declining health, loss of independence, and early death (Beaton et al., 2015; Clegg et al., 2013a; Fjell et al., 2018; Stuck et al., 2015). One in four older adults falls yearly, often causing fractures, head injuries, or death (CDC, 2022). Hip fractures are common, often needing surgery and causing long-term disability or loss of mobility.

The financial impact is also substantial, resulting in $80 billion in healthcare costs, 3.6 million emergency visits, 1.2 million hospitalizations, and 41,000 deaths (CDC, 2024b). In addition to physical injuries, falls can have psychological effects, such as a fear of falling again. This fear often leads older adults to limit their physical activity, which may further decline their physical health and increase social isolation. The financial burden of fall-related injuries is considerable, adding to high healthcare costs for individuals and the healthcare system as a whole. The risks of falls and related injuries are disproportionately high in these populations due to a combination of health issues (like reduced mobility, vision impairments, or balance problems) and unsafe living conditions (e.g., uneven flooring or inadequate support structures in housing).

Fall risks fall into two main groups: intrinsic factors like age, medical conditions, and balance issues; and extrinsic factors related to environment. Curvas-Trisan (2017) details physical exam components for elderly fall risk. Both types influence falls; intrinsic factors are hard to modify quickly, but extrinsic factors can be improved promptly.

How Intrinsic Factors Moderate Flooring-related Risks

Intrinsic factors like reduced contrast sensitivity, slower reactions, balance issues, cognitive load, or mobility aid use can increase hazards from flooring features such as glare, high-contrast patterns, or small height changes. While low-risk for healthy 65-year-olds, these pose higher risks for frail older adults or walkers. Recommendations focus on person–environment fit, like low-glare finishes, controlled contrast, and low-profile transitions, to enhance safety. Poorly maintained carpets and uneven flooring raise fall risks, especially for those with mobility challenges, requiring solutions like better healthcare, safer housing, and economic support adults.

Despite extensive research in gerontology and healthcare, few studies link flooring safety with construction material choice and design. This study fills that gap by framing flooring safety in a construction context, showing how design and materials can improve safety and accessibility for the aging population.

Research Approach

Floors often pose hazards like slippery surfaces, uneven levels, and obstacles from furniture. Materials such as tile, polished wood, and wet surfaces increase slip risks, especially for older adults with balance issues. Uneven surfaces from rugs or poor installation can cause trips, and loose rugs in

bathrooms, kitchens, and hallways are particularly dangerous. Factors like material, finish, patterns, and surface transitions affect fall risk among older adults.

This qualitative, literature-based review defines 'older adults" as those ≥65 years and, where possible, considers functional status. Data from peer-reviewed studies, industry reports, and guidelines from CDC, WHO, and design organizations were analyzed. Flooring materials were assessed by friction, finish, contrast, and transitions. A descriptive-analytical approach integrated findings from gerontology, interior design, and construction materials research to evaluate flooring's impact on fall risk. The search covered databases like Scopus, Web of Science, and Google Scholar from 2010-2025, using keywords such as flooring, friction, fall risk, aging-in-place, and safety. Over 50 sources were screened, with 23 selected for detailed analysis based on relevance, rigor, and data quality comparability.

Literature Search and Screening

- Inclusion: residential flooring + older adults + fall risk/Coefficient of Friction (COF)/visual perception/transition hazards; 2010–2025; English; peer-reviewed + key guidelines
- Exclusion: non-residential-only; pediatric/athletic; non-flooring-only; insufficient methods
- Quality checks: study design clarity, measurement method (COF test type), sample relevance, and outcome relevance

Screening summary: Records screened (n > 50); studies included in qualitative synthesis (n = 23).

Data Analysis

Flooring materials are crucial for a space's look and function, offering various options for different needs, tastes, and budgets in homes. Common types include hardwood, carpet, tile, vinyl, and laminate, each suited for specific environments. These were evaluated with a matrix focusing on four key parameters:

- Friction Coefficient (slip resistance index)
- Surface Finish (gloss, texture, or matte)
- Pattern Contrast (visual perception and depth judgment)
- Transition Characteristics (height change, edge profile, threshold/reducer detailing)

Each flooring material has pros and cons, and the best choice depends on the space's specific needs, budget, and aesthetic preferences. Selecting the appropriate flooring requires careful consideration of the space's particular needs, budget, and aesthetic goals, balancing beauty and practicality in residential and commercial environments.

Friction of Flooring Materials

The friction of flooring materials is essential because it directly impacts the risk of falls, especially in areas where slip resistance and safety are priorities. Each flooring material has unique friction characteristics influenced by its texture, finish, and environmental conditions. Table 1 summarizes the friction levels of various flooring materials. As anticipated, carpet flooring has a high friction level.

Table 1. Slip Resistance and Fall-Risk Implications of Common Residential Flooring (older adults)

Flooring Type	Typical COF reporting in literature	Design-relevant guidance	Notes/limitations
Hardwood	SCOF or DCOF (dry vs wet); report range from included studies	Prefer matte/satin finishes; control wetness (entry mats); avoid high-gloss due to glare + lower traction.	COF varies strongly with finish + contaminants (water, dust)
Carpet (low-pile)	Usually not reported as COF; report surface texture/pile and any measured traction where available.	Prefer low-pile, firm backing; avoid loose edges; specify for mobility-aid users separately.	High pile/uneven installation can impede walkers/wheelchairs
Ceramic/Porcelain	Often, wet DCOF (ANSI A326.3 test) or manufacturer DCOF; report numeric values when stated	For level interior areas expected to be walked on when wet, tile commonly targets wet DCOF ≥ 0.42	ANSI A137.1 uses wet DCOF measured by ANSI A326.3 for this criterion
Vinyl	SCOF/DCOF when studied; otherwise, texture /embossing descriptors + wet performance	Prefer textured/embossed, low-glare LVT; detail cleaning method (avoid leave-behind slick films)	Great place to add "retrofit suitability" notes (click-lock vs glue-down)
Laminate	SCOF/DCOF occasionally; otherwise, finish descriptors	Prefer matte/low sheen, add walk-off mats; avoid glossy laminates in wet-adjacent zones	Emphasize wet risk + glare/visual impairment interaction

*Advisory guidance (not a requirement) recommends a static coefficient of friction (SCOF) of 0.6 for level walking surfaces and 0.8 for ramps; however, current ADA/ABA accessibility standards require surfaces to be "slip resistant" but do not specify a minimum COF because no single consensus rating method is universally accepted. (The Access Board, n.d.-b, n.d.-a)

Floor Transitions

Different flooring types are used in homes based on room function, like bathrooms, living rooms, dining areas, and kitchens. Choices depend on personal taste. Table 2 shows common residential transitions, why they increase fall risk, and recommendations. Floor transitions are vital for safety, accessibility, and comfort, especially for older adults or those with visual impairments. To reduce fall risk, avoid abrupt changes in flooring materials and patterns when transitioning rooms.

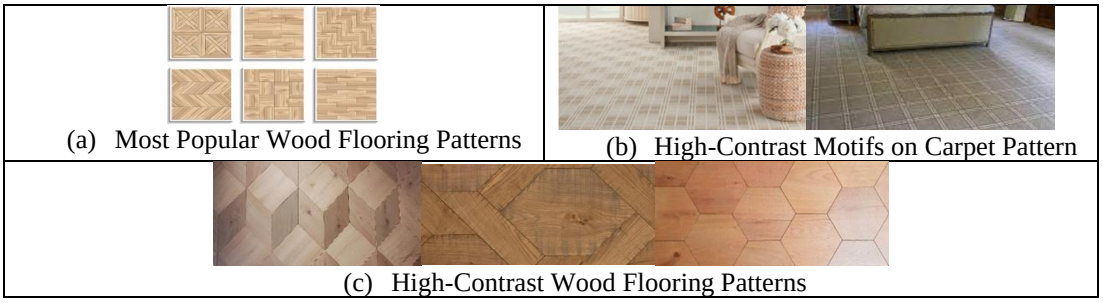
Table 2. Common Residential Floor Transitions, Typical locations, Fall-risk mechanism, and Mitigation (older adults)

Transition Type	Typical "from→to" (how it occurs)	Why it matters for fall risk	Recommended mitigation/spec detail
Hard surface → tile (moist area)	Hallway (LVT/wood) → bathroom tile; kitchen hard surface → laundry tile	Wet tracking + friction drop; glare/contrast at doorway; threshold edges	Use flush/low-profile reducer; specify wet slip-resistance in receiving area; add absorbent mat zone
Carpet → hard surface	Bedroom carpet → hallway LVT/wood; living room carpet → dining hard surface	Edge curl/height change catches toe/walker; visual boundary misread	Use tapered transition strip, secured edges; avoid thick pad at doorway; keep contrast moderate not high

Hard surface → hard surface (different material)	LVT → laminate; wood → LVT (open plan)	Minor height mismatch; sheen change creates perceived "step"	Keep same plane elevation; harmonize sheen (avoid glossy next to matte)
Area rug over hard surface	Living room rug over wood/LVT; bath mat over tile	Rug slip + edge trip hazard (highly prevalent in homes)	Use non-slip backing, low edge profile; avoid throw rugs for mobility-aid users
Door threshold/sill	Entry door threshold; patio slider track	Uneven track/raised threshold interrupts gait; high risk in low light	Specify ADA-friendly low threshold; highlight lighting + contrast at entry

Floor Pattern

Lower contrast and smaller motifs on carpets have been shown to enhance walking performance (Marquardt et al., 2014; Perritt et al., 2005) by creating a smoother visual field that minimizes distractions and helps individuals maintain focus on their surroundings. High-contrast patterns can cause illusions or visual noise, making it harder to judge distances. Reducing contrast and using smaller, subtle patterns creates a more predictable floor, aiding depth perception. Bold patterns may lead to misinterpretation of the floor as obstacles, increasing trip risk. Subdued patterns reduce this risk, preventing falls. Figure 1 shows different floor patterns and how contrast can cause perspective illusions. These patterns are crucial for fall prevention, especially for older adults or those with mobility or visual impairments.



(a) Most Popular Wood Flooring Patterns

(b) High-Contrast Motifs on Carpet Pattern

(c) High-Contrast Wood Flooring Patterns

Figure 1. Example of a Floor Pattern with Varying Contrasts

Identify the Disproportionate Factors between Flooring Materials and Intrinsic Human Risks

Falls among older adults result from interactions between intrinsic factors (human factors such as strength, balance, and vision) and extrinsic factors (environmental factors such as flooring and lighting). Flooring is a key modifiable factor in residential design that directly influences safety, mobility, and comfort.

Figure 2 illustrates how flooring qualities and human factors affect fall risk. Flooring connects biomechanics and environment, depending on friction, resilience, texture, and pattern visibility. Intrinsic factors like decreased contrast sensitivity, slower reactions, gait problems, and cognitive load can increase risks. For example, a high-gloss finish might be safe for a healthy 65-year-old but dangerous for an 85-year-old with poor vision or a walker, as glare, slower responses, and less toe clearance raise the chances of slips and trips.

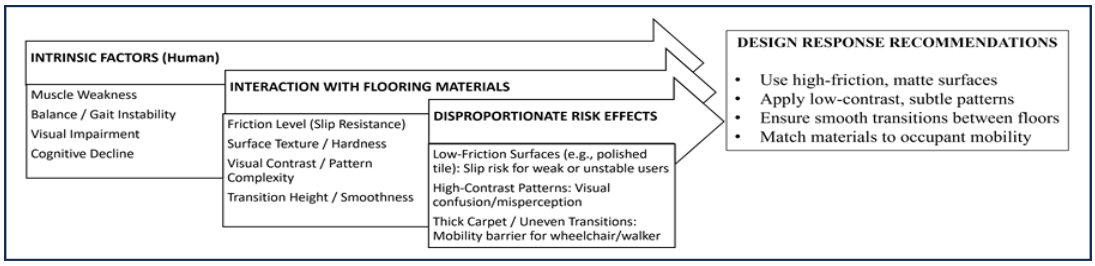


Figure 2. Relationship Between Flooring Materials and Intrinsic Human Factors Affecting Fall Risk

Empirical studies show that smooth surfaces like glossy hardwood or laminate have low friction and increase slipping risk, especially when wet. Carpets and textured tiles provide better traction and cushioning but can obstruct wheelchair or walker use, posing safety concerns. Choosing materials involves balancing slip resistance with accessibility and user safety abilities.

Comparative Evaluation of Flooring Types

Different flooring types influence fall risk: carpet offers high friction and cushioning, ideal for bedrooms and living rooms; hardwood, vinyl, and laminate are smoother and may slip when polished or damp. In kitchens and bathrooms, opt for water-resistant, high-friction materials like textured vinyl or matte tiles. Vulnerabilities interact with flooring: visual impairment can be affected by reflective surfaces; cognitive decline may confuse patterns with obstacles; reduced muscular control increases slip risk on hard, smooth surfaces weakness.

The Role of Floor Transitions and Patterns

Floor transitions and patterns influence mobility and perception. Sudden flooring shifts can disrupt gait and cause tripping. Low-profile strips offer smooth transitions, ideal for open spaces. Subtle patterns help orientation, while bold designs can create visual illusions, leading to confusion or missteps, especially in older adults.

Design Principles for Aging-in-Place

Universal design promotes continuous, level, slip-resistant surfaces and smooth transitions to improve safety and aesthetics. Interior designers favor consistent flooring in open areas with low-profile transitions (Fall Prevention Foundation, 2025; Morada Senior Living, 2025). Choices like vinyl plank or rubber flooring provide slip resistance, easy maintenance, and warmth, combining high friction with low glare (Rosarium Health 2025). Adequate lighting is crucial: reflective floors under bright lights cause glare, while poor lighting creates shadows hiding obstacles. Using matte or textured finishes and strategic lighting reduces these issues.

Practice Considerations

- **Perceived comfort & "home-like" feel**: Favor warm-toned, low-glare finishes that reduce an institutional appearance (e.g., matte LVT in wood-look tones; satin-finish hardwood).
- **Wayfinding without confusion**: Use consistent palettes and subtle patterns to support orientation while avoiding high-contrast motifs that can be misread as edges/steps.

- **Space-fit examples**: Bedrooms/lounges may benefit from softer, quieter surfaces (e.g., low-pile carpet or cork where appropriate), while kitchens/bathrooms prioritize durable, cleanable, moisture-tolerant surfaces (e.g., textured LVT or matte/textured tile).
- **Implementation note**: Pair finish choices with lighting to limit glare and shadowing that can reduce perceived comfort and increase uncertainty during walking.

By combining safety, accessibility, and aesthetics, designers and construction professionals can create residential environments that are not only fall-resistant but also psychologically supportive and conducive to healthy aging in place. Table 3 consolidates evidence on friction/finish/pattern/transition into a material-by-material selection guide that construction professionals can use during specification and retrofits.

Table 3. Flooring material safety & selection matrix for aging-in-place (by risk factor + mitigation)

Material	Slip resistance focus	Finish/glare	Pattern/contrast	Transition/edge	Best rooms	Maintenance & retrofit	cost
Low-pile carpet	High traction/cushioning; watch loose edges	Low-glare	Prefer subtle, low-contrast motifs	Secure seams; taper at doors	Bedrooms, low-moist living areas	Avoid high-pile for walkers; ensure tight installation	$$
Hardwood (matte/satin)	Moderate; risky when wet	Avoid glossy; glare increases visual confusion	Avoid high-contrast inlays at thresholds	Use flush reducers	Living/dining if moisture controlled	Add mats at entries; refinish impacts slip	$$$
LVT/vinyl (textured)	Good in wet-adjacent areas if textured	Low sheen recommended	Avoid “busy” high-contrast prints	Excellent with low-profile reducers	Kitchen, hallways, baths (with correct product)	Strong retrofit option; easy clean	$$
Laminate	Can be slick when wet	Prefer matte	Avoid bold striping/strong contrast	Ensure no lip at joints	Dry bedrooms/living	Moisture sensitivity; avoid bathrooms unless rated	$–$$
Tile (textured/matte)	Must be vetted for wet areas	Matte/texture reduces glare	Avoid high-contrast grout grids in critical paths	Use flush thresholds	Baths/laundry/kitchen if slip-resistant	Grout maintenance: add mats where wet	$$–$$$

Cork/rubber	Often higher traction + resilient	Low glare	Typically, visually calm	Manage seams; flush transitions	Bedrooms, long corridors	Comfort + joint relief; verify durability	$$–$$$

Discussion

This study confirms flooring is crucial in fall risk among older adults, especially when interacting with balance, muscle strength, and vision. Flooring is easily modifiable in the built environment and can reduce fall risks through careful design, materials, and installation. Carpeted and textured tiles offer higher friction and cushioning, making them safer in bedrooms and living areas. Polished hardwood, laminate, and glossy tiles have lower friction and higher slip risk, especially when wet. Surface friction, glare, and transition height are key environmental factors affecting stability. Patterns and transitions are vital: low-contrast patterns aid depth perception, while high-contrast designs can cause perceptual errors. Poorly designed or elevated transitions can disrupt gait and cause tripping. Low-profile transitions and uniform flooring reduce these hazards risks.

Furthermore, we note that flooring decisions often involve practical co-benefits beyond fall prevention (e.g., perceived comfort and residential character). These considerations are summarized as practitioner guidance in the Practice Considerations (non-safety co-benefits) subsection and should be applied alongside safety-driven specifications (slip resistance, low glare, and smooth transitions).

Conclusion

As the global population ages, ensuring safe, inclusive living environments becomes a priority. This study shows flooring design is crucial in reducing fall risk among older adults and must be part of safety planning. It highlights links between flooring features and vulnerabilities like decreased balance, vision problems, and cognitive decline, offering guidelines for safer, aesthetic materials. Construction professionals can reduce falls by focusing on high-friction, matte finishes, consistent low-contrast patterns, and smooth transitions. The study emphasizes that fall prevention needs a comprehensive approach combining engineering, design, and human-centered strategies. Universal design flooring lessens hazards and supports dignity, independence, and emotional health for seniors.

Future research should test flooring in real-world conditions and develop models linking surface qualities to biomechanical responses. Greater collaboration between construction management, materials science, and gerontology will strengthen evidence for safer, durable housing for older adults. Ultimately, thoughtful flooring choices and integration can help the construction industry build healthier, inclusive communities—homes focused on safety, comfort, and longevity use.

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