# Designing for Bathroom Safety: Understanding Older Adults' Support Behaviors and Grab Bar Needs

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## Abstract

As Taiwan officially transitioned into a super-aged society by the end of 2025—with the population aged 65 and above exceeding 20%—ensuring home environmental safety has become a core issue for implementing "aging in place." This study aims to investigate the functional roles and spatial constraints of support systems used by older adults in bathroom environments, where accidental falls are most prevalent. Through situational observations, expert consultations, and semi-structured interviews with older adults, the research identified significant "support gaps" in existing layouts, revealing that in the absence of professional grab bars, older adults frequently rely on washbasins and door frames for compensatory support during sit-to-stand and transfer movements. These improvised methods, dictated by environmental deficiencies, pose a high risk of injury. To mitigate these risks, the study established three core design dimensions: structural safety, behavior-oriented configuration, and de-institutionalized aesthetics. The findings emphasize that bathroom safety must evolve from the mere addition of individual grab bars toward a "systemic functional integration" of spatial equipment. Specifically, by seamlessly integrating grab bar functions into furniture elements, the design effectively eliminates the clinical feel of medical devices, thereby increasing the psychological acceptance and willingness of older adults to utilize these supports. By implementing "continuous support trajectories" and "invisible assistive concepts," the proposed guidelines provide an empirical framework for designing safer, more dignified, and inclusive living environments. Ultimately, this research seeks to enhance independence and confidence, supporting older adults in living safely and with dignity within their familiar home environments.

*Keywords:* older adults, bathroom safety, grab bar design, support behaviors, aging in place

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## Introduction

Taiwan's population aged 65 and above has exceeded 20% of the total population by the end of 2025, marking its official transition into a super-aged society (National Development Council, 2025). As the elderly population grows rapidly, ensuring home environmental safety has become a core issue in implementing "aging in place" policies. Among all areas within the home, bathrooms and toilets are identified as the most common sites for accidental falls among older adults (Ng et al., 2022).

Recent research emphasizes that physical environmental factors are the most common cause of falls, accounting for 30% to 50% of incidents (World Health Organization, 2007). This high-risk nature makes bathroom modifications—such as the installation of grab bars—a critical priority for fall prevention programs. Studies have shown that specific environmental interventions, including the addition of grab bars and non-slip surfaces, are essential for mitigating hazards in these high-risk zones (Ng et al., 2022).

Preliminary observations reveal a critical lack of appropriate assistive devices in many older adults' homes, with the absence of stable support being the most severe issue. In the absence of professional grab bars, older adults frequently rely on washbasins or towel racks for compensatory support during sit-to-stand and transfer movements. Supporting these observations, recent research emphasizes that such indoor environmental deficiencies significantly heighten the fear of falling, forcing individuals to adapt their movements to perceived environmental hazards (Parab et al., 2025). These non-professional support methods are often restricted by spatial layouts and pose significantly high risks of injury, as existing home hazards often force older adults into unstable movement patterns.

To address the safety crises inherent in a super-aged society, this study focuses on "grab bars" as a core intervention. By conducting field observations and expert reviews, this research aims to investigate older adults' support behaviors and the associated spatial constraints. Ultimately, this study proposes safety-oriented design recommendations to provide older adults with a safer and more dignified living environment, supporting their independence in daily activities.

## Literature Review

### The Current Status of Aging in Taiwan

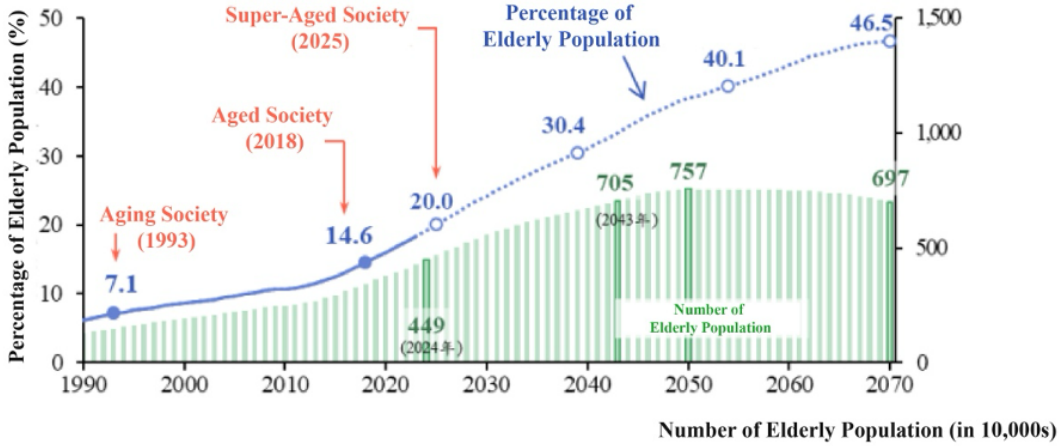
Taiwan is undergoing a rapid demographic transformation. According to the National Development Council (2025), the population aged 65 and above reached 4.67 million by the end of 2025, accounting for 20% of the total population and officially marking Taiwan's transition into a super-aged society. Furthermore, the "oldest-old" (aged 85+) now represent 9.92% of the elderly demographic. This accelerating trend underscores the urgent need for systemic bathroom safety and evidence-based design guidelines for aging in place.

This phenomenon stems from the dual influence of declining mortality and birth rates (Hsu, 2022). Advances in medical science have increased average life expectancy; conversely, shifts in modern perspectives on marriage and childbearing, combined with heavy economic competitive pressure and the sub-replacement fertility, have slashed in the younger population (Jones, 2019). This structural shift represents more than just a demographic

change; it poses severe challenges to the public health system and social care resources (Hsu, 2022).

**Figure 1**

*Projections of the Aging Population in Taiwan (2024–2070)*




*Source:* National Development Council (2024).
*Note.* The demographic data has been updated to 2025 based on the latest information from the National Development Council (NDC) website; however, the supporting charts are sourced from the 2024 NDC Annual Report, which remains the most recent official publication for visualized data.

## Aging in Place

The community care philosophy of "Aging in Place" traces its historical roots back to Nordic countries in the 1960s. During this period, society began to critically reflect on the restrictive nature of large-scale institutions, which lacked privacy and stifled individuality, leading to the "Normalization" and "De-institutionalization" movements (Nirje, 1994). Originally aimed at advocating for the right of marginalized groups, such as those with disabilities, to enjoy a normal rhythm of life, the movement asserted that older adults should also be allowed to live and spend their final years within familiar community environments (Nirje, 1994). This ideology, which emphasizes community reintegration and rejects large-scale institutions, has since profoundly influenced global elderly care policies. As recent qualitative research confirms, the vast majority of older adults prefer to remain in their original residences or familiar communities. Their primary motivation is to maintain the autonomy of their personal living spaces and an independent lifestyle, thereby avoiding the loss of agency and the sense of confinement often associated with entering nursing facilities (Wiles et al., 2012).

Different nations have developed various support models based on their unique social contexts. Danish care policy centers on "Aging at Home," emphasizing the preservation of dignity and the subjectivity of older adults (Healthcare Denmark, 2019). Through a paradigm shift from institutional to home-based care, the policy utilizes structured rehabilitation to reshape the self-care capacities of the elderly, thereby reducing dependence on long-term support services. Similarly, the Japanese government has established "Community-based Integrated Care Centers" in every local district (typically covering school districts of approximately 20,000 residents). These centers, comprised of public health nurses, social workers, and care management specialists, are responsible for preventive care, consultation services, the coordination of community health resources, and comprehensive care management (Hatano et al., 2017). Taiwan officially incorporated "Aging in Place" as a core pillar of its national strategy with the implementation of the "Long-term Care 2.0" policy in

2017, striving to build a community-based care system (Ministry of Health and Welfare, 2016).

### Hazards of the Bathroom Environment

As the aging population grows, “aging in place” has become a strategic priority for preserving the autonomy and dignity of older adults. However, conventional home environments often fail to accommodate age-related functional declines (e.g., ADL/IADL impairment), leading to significant fall risks (Parab et al., 2025; Tsai et al., 2020). Specifically, bathrooms are identified as high-risk zones due to their high dependency and the frequent absence of adequate support fixtures (Ng et al., 2022). Therefore, investigating the integration of bathroom assistive devices—such as grab bars—within spatial configurations is essential for mitigating movement-related hazards and supporting the realization of aging in place.

Although bathroom spaces occupy only a small portion of the home, their high frequency of use and slippery characteristics make them the areas with the highest incidence of accidents and the greatest difficulty in performing Activities of Daily Living (ADL) for older adults (Ng et al., 2022; Parab et al., 2025).

Existing environmental deficiencies, such as floor thresholds, a lack of appropriate support in sink and toilet areas, and overly narrow spatial dimensions, often lead to significant fall risks for older adults (Parab et al., 2025; World Health Organization, 2007). Therefore, optimizing the spatial configuration of bathrooms and the design of support facilities is critical to reducing accidents and supporting independent living for the elderly (Healthcare Denmark, 2019; Ng et al., 2022; Parab et al., 2025).

## Methodology

### Situational Observation Method

This study employs the situational observation method to collect data on older adults' assistive device usage and spatial utilization within bathroom environments. A purposive sampling approach was used to recruit three older adults as participants for the observation. Given the private nature of such activities, a “Simulated Behavioral Demonstration” approach is adopted. Participants are invited to demonstrate daily routines within a simulated setting, allowing for the observation of operational logic, spatial movement, and potential environmental hazards. To ensure data authenticity, researchers do not interfere with the participants' actions during the process. All sessions are video-recorded to facilitate precise behavioral subsequent video analysis.

### Semi-structured Interview

Semi-structured interviews were conducted with the participating older adults to explore their behaviors observed during the sessions and their personal usage experiences. This approach aimed to gain a deeper understanding of the actual difficulties they encountered and their specific needs.

## Expert Consultation and Design Guidelines

Following the conclusion of situational observations, the frequency of specific behaviors (such as compensatory support) was quantified, and the content of the semi-structured interviews with older adults was organized. Subsequently, the study proceeded to the expert consultation phase, involving in-depth interviews with two experts in the fields of aging and spatial design. This stage aimed to transform the empirical data derived from observations and interview findings into concrete design recommendations and guidelines for bathroom environments. Through a professional lens, the results from the previous stage were translated into Design Guidelines for Grab Bar Configuration.

# Result

## Data Analysis of Compensatory Behaviors

According to the situational observations of the three participants, a total of 20 compensatory support behaviors were identified during bathroom activities. The data, summarized in Table 1, reveals that the most frequent behavior was relying on washbasins for support during sit-to-stand transitions (n = 11, 55%). Other significant behaviors included using wall surfaces for stability (n = 4) and grabbing door frames instead of professional grab bars (n = 4) when entering or exiting the space.

The frequent reliance on washbasins indicates that when professional assistive devices are inappropriately positioned or completely absent, older adults instinctively seek the nearest horizontal surface to maintain their balance. When older adults in environments lacking professional grab bars are forced to rely on these unstable fixtures for compensatory support, the structural instability of these objects constitutes a significant environmental hazard, thereby exacerbating both the risk and the fear of falling (Parab et al., 2025; World Health Organization, 2007). As emphasized by Ng et al. (2022), the bathroom is a highly hazardous environment for older adults with functional limitations, and the lack of appropriate professional bathroom modifications (such as safety grab bars) exposes them to considerable danger. Although such compensatory behavior is common, it conceals an extremely high risk of slipping, especially in wet environments (Ng et al., 2022; Parab et al., 2025).

**Table 1**

*Categorization of Observed Bathroom Hazards and Proposed Assistive Solutions*

| Frequency (n) | Sub-item Frequency | Item | Item Subcategories |
|---|---|---|---|
| 1 | | Mobility Difficulties | |
| 20 | | Compensatory Support Behavior / Lack of Support Points | |
| | 4 | | Relying on wall surfaces for support during sit-to-stand and lowering transitions at the toilet. |
| | 11 | | Using the sink for support when passing by due to the absence of grab bars |

| | | |
|---|---|---|
| | 4 | Relying on door frames for support instead of grab bars when entering the bathroom. |
| | 1 | Standing up from a shower chair without grab bars and without any support point (no bathtub) |
| 1 | Fixture Placement | |
| 1 | Insufficient Space | |

**Semi-structured Interview**

Through semi-structured interviews and situational observations of three older adults (Participants A, B, and C), this study identified three critical dimensions of bathroom-related challenges:

***Physiological Bottlenecks in Postural Transitions and Vertical Instability***

**Strenuous Transitions.** Participants B and C identified the "sit-to-stand" transition (especially after toileting or showering) as the most physically demanding task.

**Postural Collapse Risk.** While Participant A could manage upper-body tasks like hair washing, lower-body instability made "standing while showering" an extremely hazardous activity. This necessitates a forced reliance on shower chairs.

**High Dependency on Specific Equipment.** All participants exhibited a heavy reliance on specific personal items (e.g., shower chairs and anti-slip slippers). This indicates that the primary bathroom environment fails to provide fundamental balance support.

***Environmental Support Gaps and the Threat of "Forced Falls"***

**Ineffective Environmental Support.** Participant B exhibited a passive coping mechanism termed "forced falling" ("I just have to let myself fall"), driven by the total absence of reliable grasping points during moments of instability.

**Distrust of Existing Fixtures.** Participant C's concern regarding the structural integrity of washbasins ("I fear the sink will collapse if I grab it") reveals a deep-seated psychological doubt. This distrust limits the use of existing furniture for compensatory support.

***Dual Psychological Burden: Fear of Falling (FoF) and De-labeling Needs***

**Post-traumatic Anxiety.** Participant C's history of major spinal surgery has resulted in hyper-vigilance toward wet environments, manifesting as a persistent Fear of Falling (FoF).

**Fear-Driven Defensive Behaviors.** Participant A adopted the practice of "wearing anti-slip shoes while showering." This sacrifice of convenience and hygiene for a sense of security highlights a behavior pattern driven entirely by environmental anxiety.

**Table 2**

*Analysis of Behavioral Observations and Psychological Burdens in Bathroom Environments*

| Analysis Dimension | Key Findings | Specific Behavioral Manifestations & Cases |
|---|---|---|
| Physiological Bottlenecks in Postural Transitions | Strenuous Transitions & Vertical Instability | "Participants B and C identified the 'sit-to-stand' transition as the most physically demanding task. Lower-body instability forced Participant A to rely on shower chairs and anti-slip slippers." |
| Environmental Support Gaps & "Forced Falls" | Ineffective Support & Structural Distrust | Participant B exhibited a passive coping mechanism termed "forced falling" due to the absence of grasping points. Participant C expressed psychological doubt regarding the structural integrity of washbasins. |
| Dual Psychological Burden: Fear of Falling | Fear-Driven Defensive Behaviors | Post-traumatic anxiety (spinal surgery) led Participant C to hyper-vigilance. Participant A's practice of "showering in anti-slip shoes" highlights a behavior pattern driven entirely by environmental anxiety. |

## Expert Consultation

Based on the quantitative results derived from situational observations, this study conducted in-depth interviews with two experts, Expert 1 and Expert 2, to transform behavioral data into practical design guidelines. These experts collectively pointed out that bathroom safety should not be viewed merely as the addition of individual assistive devices; rather, it requires a systemic integration across three dimensions: structural safety, behavior-oriented configuration, and de-labeling psychology.

Regarding structural safety, the study focuses on establishing "transitional safety strategies," which involve reinforcing the bases of existing fixtures and implementing edge-grip designs. Expert 1 suggests transforming existing equipment, such as washbasins, into support points by reducing the edge thickness to between 5 and 8 cm to allow for a secure hand grip. However, from a comprehensive defense perspective, Expert 2 reminds us that grab bars are only the last line of defense; the design's origin should prioritize the floor's anti-slip coefficient to compensate for the risks associated with the weight-bearing limitations of equipment.

In terms of behavior-oriented configuration, the experts emphasized that grab bar placement must precisely align with ergonomics and correspond to physical movements. Expert 2 detailed the functional differences, noting that horizontal grab bars are primarily responsible for the "pushing up" support during transitions between sitting and standing, while vertical grab bars are used for "holding on" to stabilize the body and prevent slipping. Expert 1 added that through the coordination of L-shaped grab bars, these can effectively serve as pivots to stabilize the center of gravity if dizziness occurs upon standing.

Finally, to uphold the dignity of older adults and reduce psychological resistance, designs should incorporate "de-institutionalized aesthetics." Expert 2 suggests avoiding the cold feel of medical-grade stainless steel in favor of materials that match the wall tones or possess a warm texture. Expert 1 advocates for a universal design mindset, concealing assistive functions within furniture-inspired "stopping points" to replace visually intrusive traditional grab bars. Through the formulation of these three core principles, this study aims to construct a more inclusive and secure bathroom environment for a super-aged society.

## Established Design Guidelines

Through in-depth interviews with two experts specializing in aging and spatial design, this study successfully translated the observed compensatory support behaviors into actionable design guidelines with practical instructional significance. This phase ensured that the empirical behavioral data was professionally synthesized into ergonomic criteria for safer bathroom environments.

### *Principle 1. Structural Safety Priority*

Core Objective is to alleviate psychological fear regarding equipment collapse by reinforcing the stability of hardware.

**Platform-Mounted Configuration and Base Reinforcement.** It is highly recommended to prioritize platform-mounted washbasins and reinforce their bases and wall-bearing points during the early stages of renovation. A solid physical structure provides strong psychological reassurance, convincing users that the equipment can withstand sudden impacts. This effectively eliminates the hesitation to seek support caused by the fear of "fixture detachment."

**Edge-Grip Design.** The front edge of the washbasin or counter should be designed with a thickness of 5–8 cm to facilitate a secure "web-grip" (clamping between the thumb and fingers). This design provides tangible tactile feedback, allowing users with limited manual dexterity to gain a sense of stability through gripping, thereby reducing anxiety when navigating slippery floor conditions.

### *Principle 2. Behavior-Oriented Configuration*

Core Objective is to establish a continuous support trajectory and eliminate the sense of helplessness caused by a lack of accessible support points.

**Continuous Support Trajectories.** The placement of grab bars must consider the user's complete movement workflow within the bathroom. It ensures that at any moment of center-of-gravity transition, a stable support point remains within reach. This continuity significantly enhances the psychological safety of older adults and reduces the perceived lack of environmental control.

**Functional Integration and Synergistic Support.** Horizontal grab bars assist in the transition from sitting to standing, while vertical or L-shaped bars stabilize the center of gravity. Grab bars should be functionally integrated with bathroom fixtures such as showerheads, ensuring that users always have a stable support point for one hand while reaching for objects or performing tasks.

### *Principle 3. De-institutionalized Aesthetics and Psychological De-labeling*

Core Objective is to preserve user dignity and reduce psychological resistance to assistive devices through "invisible" design.

**Affective Material Application.** Designers should avoid cold-toned metals (such as raw stainless steel) that carry strong medical connotations. Instead, materials with warm textures and colors that harmonize with residential interior styles should be utilized. By creating a warmer visual atmosphere, assistive equipment is transformed into "home furniture," mitigating the decline in self-efficacy associated with aging or injury and aiding in the restoration of psychological well-being.

**Invisible Assistive Concept.** Supportive functions should be subtly integrated into everyday environmental objects (such as reinforced washbasin edges or storage shelves that double as grab bars). This functional invisibility protects the user's autonomy and dignity, lowering the psychological barriers to using safety facilities and increasing the willingness to adopt preventive measures.

## Discussion

This study employs situational observations, semi-structured interviews, and expert consultations to deeply analyze the behavioral patterns and psychological needs of older adults in bathroom environments. The following synthesis discusses the core research findings.

### Ergonomic Crises Underlying Compensatory Behaviors

Findings reveal that over 55% of compensatory support behaviors occur in the washbasin area, uncovering a critical "support gap" in existing environments. This is particularly evident in rental housing, where older adults are often prohibited from drilling holes to install professional grab bars, forcing them to rely on non-professional fixtures like washbasins and door frames. While these "intuitive" behaviors address immediate balance needs, they overlook structural load-bearing limits. The proposed "edge-grip design (5–8 cm)" and "platform-mounted washbasins" specifically address this crisis by transforming hazardous fixtures into sturdy and graspable safety points, providing reliable support without the need for wall-drilling.

### "Forced Falls" and the Perception of Environmental Discontrol

The psychological state of "forced falling" identified during interviews reveals a total loss of environmental security among older adults. When support trajectories are discontinuous, the resulting fear drives individuals toward extreme defensive behaviors, such as wearing anti-slip shoes while showering. This underscores the critical importance of "continuous support trajectories"—safety must evolve from isolated, individual grab bars toward a systemic defense that covers the entire workflow of movement.

### Impact of De-labeling Design on Aging in Place

The "de-institutionalized aesthetics" emphasized in this study represents more than mere visual enhancement; it serves as a critical safeguard for the "self-efficacy" of older adults.

Through the concept of invisible assistive devices, we can effectively mitigate the labeling anxiety often triggered by conventional medical equipment. When design seamlessly integrates into daily life rather than highlighting functional impairment, older adults demonstrate a higher degree of autonomy and a greater willingness to lead independent lives.

## Conclusion

Through situational observation and expert consultation, this study confirms that compensatory support behaviors—arising from the lack of professional grab bars in home bathroom environments—pose a high risk of falls for older adults. The findings reveal that washbasins and door frames are frequently misused as makeshift support points, reflecting significant "support gaps" within existing spatial layouts.

Based on these discoveries, this research proposes three core design principles: structural safety, behavior-oriented configuration, and de-institutionalized aesthetics. By integrating "reinforced platform-mounted washbasins" with "continuous support trajectories," these interventions provide intuitive and stable physical support while preserving the dignity of older adults through de-labeling design strategies.

In summary, bathroom safety should transcend the mere "addition" of assistive devices and instead focus on the "functional integration" of spatial equipment. The design guidelines proposed in this study provide an empirical foundation for future modifications of age-friendly housing and the development of related assistive products, ultimately realizing a vision of "aging in place" that is both dignified and secure.

## Recommendations

While this study establishes a foundational framework for bathroom design guidelines, several areas warrant further investigation to enhance the safety of super-aged societies:

### Expansion of Sample Diversity and Size

Due to the exploratory nature of this study, the sample was limited to three participants. Future research should recruit a larger and more diverse cohort, including older adults with varying levels of physical impairment (e.g., those using walkers or wheelchairs) to develop a more granular and tiered set of design standards.

### Longitudinal Evaluation of Design Effectiveness

This study focuses on identifying behaviors and establishing design principles. Future research should evaluate the practical impact of "assistive-integrated" fixtures on reducing fall rates and enhancing user confidence through long-term utilization in home environments.

### Cross-Cultural and Spatial Comparisons

Future studies could investigate how different cultural living habits and varied urban housing layouts (such as comparing high-rise apartments with traditional houses).

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## Declaration of Generative AI and AI-Assisted Technologies in the Writing Process

The author declares that Google Gemini, OpenAI ChatGPT, and Google NotebookLM were used during the preparation of this manuscript.

- Google Gemini was utilized for conducting preliminary literature searches, information retrieval, and refining the academic prose for better flow and clarity.
- OpenAI ChatGPT was employed for the translation of specific draft sections from Chinese to English and for linguistic polishing to ensure terminological consistency.
- Google NotebookLM was used as a document analysis assistant to verify the internal logic of the research findings and to cross-verify the accuracy of cited literature sources.

The use of these AI-assisted technologies was strictly limited to linguistic refinement, translation, and the verification of existing research data. The author further declares that the core ideas, research design, experimental procedures, findings, data analyses, and discussions were originally conceived and derived from the systematic conduct of the research. The author has reviewed and edited the final output and accepts full responsibility for the integrity and accuracy of the manuscript's content.

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